Introduction

- Forestry companies are investigating new scaling methods to reduce costs while maintaining scale accuracy.

- A potential new scaling method is using laser log scanning technology.

- Laser scanners are used in British Columbia sawmills to optimize cutting programs.
Study objectives

- Evaluate the log scanner’s measuring precision on log top diameter, butt diameter and length
- Compare manual (stick) scaled log volume to scanner scaled volume
- Compare historical mill records of scanner scaled volume to stick scaled volume
Study site and methods

- The study took place in Sept. 2011 near Vancouver, British Columbia.
- The logs were first manually scaled at Pacific Custom sortyard.
- The logs were then bundled and towed to International Forest Product’s (Interfor) Acorn sawmill.
- At Acorn the logs were debarked and then scanned by a laser log scanner.
Scaling and scanning the logs

- 68 (130 m$^3$) (25.4 MFBM$^1$) of second growth sorted Western Hemlock and balsam logs were used in the trial.
- Three scalers scaled each log 3 times.
- Each log was scanned 3 times at the sawmill.

$^1$Conversion = 1 MFBM = 5.128 m$^3$
Microtec laser log scanner

DiScan scanning heads

Typical scanner installation

Images courtesy of Microtec Industries
Scanner and scaler measurements

- The scanner measures diameter in millimetres (1mm = 0.04 inches) and length in cm (1 cm = 0.4 inches).
- The scalers measured diameters in 2 cm classes and length to the nearest 10 cm (4 inches).
- The scanner measurements were converted to the same units as the scalers in order to compare the two scaling methods.
The difference between scaler and scanner measured top diameter was 2.0 cm (0.8 inches) cm or less in 98% (200) of the measurements.
In 97% of the logs the scanner measured the top diameter to a precision of 1 cm (0.4 inches).

1 Maximum diameter – minimum diameter from 3 scans
• In 25% of the logs the scanner measured the butt diameter to a precision of 1 cm (0.4 inches).

**Scanner butt diameter precision**

1 Maximum diameter – minimum diameter from 3 scans
Why did the scanner measure the butt diameter less precisely than the top?

- The scanner measured top diameters are “filtered” by an algorithm that uses the average and a regression to calculate the most accurate measurement for the top diameter.
- This algorithm was not used when calculating the butt diameter and this caused more variation in the butt diameter measurement.
- Microtec said precision of butt diameter measurements will be similar to the top diameter precision when the algorithm is applied.
Length precision ¹

- In 59% of the logs the difference between repeated scans was 5 cm (1 inch) or less

<table>
<thead>
<tr>
<th>Precision category cm (inches)</th>
<th>No. of logs</th>
<th>% of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-2 (0 -0.8)</td>
<td>21</td>
<td>31</td>
</tr>
<tr>
<td>3-5 (1.2 - 2.0)</td>
<td>19</td>
<td>28</td>
</tr>
<tr>
<td>6-8 (2.4 -3.1)</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>9-11 (3.5 - 4.3)</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>12 (4.7)</td>
<td>12</td>
<td>17</td>
</tr>
</tbody>
</table>

¹Maximum length – minimum length from 3 scans of each log
There was no difference\(^1\) between scaler and scanner lengths in 56% (114) of the measurements.

\(^1\)Difference = Scaler length – scanner length  
1 dm = 4 inches
The debarkers’ proximity to the scanner affected scanner length measuring

- Scanner measures length using a photocell and encoder mounted on a conveyor chain.
- The debarking arms held the log back while the chain conveyor was trying to move the log forward causing the log to “slip” on the conveyor.
- Log “slippage” on the conveyor caused the encoder to record an incorrect length.
- At other sawmills Microtec has found length is measured accurately to 2 cm.
Volume calculation formulas

Segment

Smalian’s

\[ V = \frac{(A1 + A2)}{2} \times L \]

\[ V = \text{volume} \]

\[ A1 = \text{area of small end of log} \]

\[ A2 = \text{area of the large end of log} \]

\[ L = \text{length} \]
## Average load volume

<table>
<thead>
<tr>
<th>Load</th>
<th>Scaler 1 (m³)</th>
<th>Scaler 2 (m³)</th>
<th>Scaler 3 (m³)</th>
<th>Scanner segment formula (m³)</th>
<th>Scanner Smalian's formula (m³)</th>
<th>Maximum difference scanner (segment formula) compared to scalers (m³)</th>
<th>Maximum difference scanner (Smalian) compared to scalers (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>44.50</td>
<td>44.14</td>
<td>44.11</td>
<td>44.77</td>
<td>41.14</td>
<td>0.66</td>
<td>3.36</td>
</tr>
<tr>
<td>2</td>
<td>46.82</td>
<td>47.01</td>
<td>46.86</td>
<td>47.33</td>
<td>44.05</td>
<td>0.51</td>
<td>2.96</td>
</tr>
<tr>
<td>3</td>
<td>47.2</td>
<td>48.48</td>
<td>48.1</td>
<td>49.92</td>
<td>45.74</td>
<td>2.72</td>
<td>2.74</td>
</tr>
</tbody>
</table>
There was less variation in scanner (segment formula) log volume than scaler (Smalian’s formula) volume.
Difference between stick and scanner scaled boom volume

- On larger volumes there was only a small difference between stick and scanned volume.

<table>
<thead>
<tr>
<th>Sort</th>
<th>Booms #</th>
<th>Logs #</th>
<th>Stick scaled volume (m$^3$)</th>
<th>Scanned volume (m$^3$)</th>
<th>Difference (m$^3$)</th>
<th>Difference (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thrifty</td>
<td>43</td>
<td>36 215</td>
<td>60 434</td>
<td>60 465</td>
<td>-31</td>
<td>- 0.1</td>
</tr>
<tr>
<td>Standard</td>
<td>29</td>
<td>10 781</td>
<td>22 488</td>
<td>22 669</td>
<td>-181</td>
<td>- 0.8</td>
</tr>
<tr>
<td>Mix</td>
<td>7</td>
<td>1 458</td>
<td>2 870</td>
<td>2 848</td>
<td>22</td>
<td>0.8</td>
</tr>
<tr>
<td>All Other</td>
<td>2</td>
<td>354</td>
<td>977</td>
<td>928</td>
<td>49</td>
<td>5.0</td>
</tr>
<tr>
<td>Utility</td>
<td>1</td>
<td>215</td>
<td>468</td>
<td>487</td>
<td>-19</td>
<td>- 4.5</td>
</tr>
<tr>
<td>Total</td>
<td>82</td>
<td>49 023</td>
<td>87 237</td>
<td>87 396</td>
<td>-159</td>
<td>- 0.2</td>
</tr>
</tbody>
</table>

$^{1}$ Volume calculated from segment formula.
$^{2}$ Stick scaled volume – scanner volume
$^{3}$ (Stick scaled volume-scanner volume)/stick scaled volume x100
Summary

- The scanner measured log top diameters precisely and as accurately as the scalers.
- The scanner measured individual log volume more consistently and with less variation than the scalers.
- The scanner scale of load volumes was similar to the scalers.
- The difference in scale volume between the scanner and stick scaling was of 0.2% on 87,237 m³ (82 log booms).
Continuing work on scanner scaling

- The Canadian Standards Association Technical Committee on Scaling of Primary Forest Products is working to develop a national measurement standard for electronic/laser type scanners.
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The Canadian Standards Association Technical Committee on Scaling of Primary Forest Products is working to develop a national measurement standard for electronic/laser type scanners. The standard will likely focus on the measuring accuracy of log top and butt diameter and length. Measurement Canada will test and certify scanners to ensure they meet this standard.