Automatic grading and scaling of saw logs

Timber Measurements Society
Coeur D’alene, Idaho, April 2014

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Grading and sorting simultaneously

• Every sawmill sorts for highest possible product value.
• Grading and sorting by timber measurement associations.
• Grading for payment: Must be identical where the instruction is used.
Manual grading

- Grade
- Crook
- Species
- Rot
- Knot
- Bark
- Log type
Check scaling
# Pine grades from 1 January 2008

<table>
<thead>
<tr>
<th>Grade 1</th>
<th>Grade 2</th>
<th>Grade 3</th>
<th>Grade 4</th>
<th>Cull log/no grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butt log</td>
<td>Top log</td>
<td>Top- and butt log</td>
<td>Crooked logs</td>
<td>Metal</td>
</tr>
<tr>
<td>Only small knots</td>
<td>Sound knot</td>
<td>Some knot</td>
<td>Some rot</td>
<td>Big crook</td>
</tr>
<tr>
<td>Narrow ring width</td>
<td></td>
<td></td>
<td>Some blue stain</td>
<td>Burned/coal</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Big knot allowed</td>
<td></td>
</tr>
</tbody>
</table>

The National Council for Timber Measurement Development (VMU)
Our partners
Automatic grading in three steps

- Manual evaluation
  - Rot
  - Species
  - Blue stain

- Automatic downgrading,
  - Metal
  - Crook
  - Max/min diameter

- Grading according to x ray,
  - Log type
  - Knot
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Step 1
Manual evaluation of rot, scar, blue stain etc

Step 2
Automatic grading
-X-ray or coil for metall
-3D for ubf/crook and dimension

Step 3
Automatic grading with x-ray for grade 1-4,
X-ray

X-ray LogScanner

Signal from one log, detector 2

Signal from one cross section

Detector 2

D₂

Detector 1

D₁

Signal from one log, detector 1

Source 1

Source 2

knot volume, density, knot size, heartwood diameter etc

Index grade 1, grade 2, grade 4.

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Example

High grade 1 index > limit grade 1
Low grade 2 index < limit grade 2

High grade 2 index > limit grade 1
Low grade 1 index < limit grade 2

The limits decides the distribution of grades
## Adjust grading on control logs

<table>
<thead>
<tr>
<th>Kontroll</th>
<th>Nya gränsvärden</th>
<th>Befintliga gränsvärden</th>
<th>Justera</th>
</tr>
</thead>
<tbody>
<tr>
<td>Klass1</td>
<td>0,46</td>
<td>0,46</td>
<td></td>
</tr>
<tr>
<td>Klass2</td>
<td>0,42</td>
<td>0,42</td>
<td></td>
</tr>
<tr>
<td>Klass4</td>
<td>0,22</td>
<td>0,22</td>
<td></td>
</tr>
</tbody>
</table>

### Automatisk klassning

<table>
<thead>
<tr>
<th>Kontroll</th>
<th>Klass 1</th>
<th>Klass 2</th>
<th>Klass 3</th>
<th>Klass 4</th>
<th>Andel kontroll</th>
<th>Klassträff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Klass1</td>
<td>15,5</td>
<td>0,0</td>
<td>4,8</td>
<td>0,0</td>
<td>20,2</td>
<td>76%</td>
</tr>
<tr>
<td>Klass2</td>
<td>0,1</td>
<td>15,9</td>
<td>4,1</td>
<td>2,8</td>
<td>22,9</td>
<td>69%</td>
</tr>
<tr>
<td>Klass3</td>
<td>6,5</td>
<td>4,9</td>
<td>37,5</td>
<td>0,6</td>
<td>49,5</td>
<td>76%</td>
</tr>
<tr>
<td>Klass4</td>
<td>0,3</td>
<td>1,9</td>
<td>2,7</td>
<td>2,4</td>
<td>7,4</td>
<td>33%</td>
</tr>
<tr>
<td>Andel auto</td>
<td>22,4</td>
<td>22,7</td>
<td>49,0</td>
<td>5,8</td>
<td>100,0</td>
<td></td>
</tr>
</tbody>
</table>

- **Antal röntgenklassade kontrollstockar**: 997
- **Träffprocent automatklassning**: 71%
- **Värdekvot**: 1,01
Results so far

• Better degree of correct classified logs than full manual grading
• Easier to adjust with less manual assessments
• Better ways to evaluate each cause of downgrade

• Manual grading can be seen as more trustworthy,
Straightness – loss of yield

Loss of yield cm

≤ 20 cm = ok
21 – 120 cm = poor grade
> 120 cm = cull
X-ray metal
Growth ring detection

Installation of camera and light

Grey Weighted Polar Distance Transform for Outlining Circular and Approximately Circular Objects

(c) The shortest path to each of the 16 end pixels in the object.

The research approach seems justified

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Diameter under bark – tracheid method

A log with some bark missing

Estimation of \( D_{ob} \) and \( D_{ub} \)

Applied since 2008

Problems with snow and sprinkled logs

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Installation of camera and light

Grey Weighted Polar Distance Transform for Outlining Circular and Approximately Circular Objects

(c) The shortest path to each of the 16 end pixels in the object.
Filtering of "bumps"

The diameter may, seen from the butt end, not increase.

Filtered "bump" - constant diameter across the bump
Measuring solid volume - application

Control

Measuring

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Image analysis using stereo camera
The End