Five Generations of Automated Grading and Optimizing

<table>
<thead>
<tr>
<th>Years</th>
<th>Technology</th>
<th>Systems supplied</th>
</tr>
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<tbody>
<tr>
<td>1974-83</td>
<td>GE Nova processors B/W Reticon CCD line elements</td>
<td>23 Edger optimizers &quot;OptiEdger&quot;</td>
</tr>
<tr>
<td>1984-89</td>
<td>TI 320 processors B/W Thomson CCD line elements</td>
<td>14 Edger optimizers &quot;KA4000/8000&quot;</td>
</tr>
<tr>
<td>1990-2002</td>
<td>Inmos processors B/W Fairchild CCD line elements</td>
<td>&quot;BoardMaster&quot; 65 Edger optimizers 53 green trimmer/sorters</td>
</tr>
<tr>
<td>2001-2005</td>
<td>PC-XT + SMT processors RGB Sony CCD line elements</td>
<td>&quot;BoardMaster-NT&quot; 41 green trimmer/sorters 59 dry lumber trimmer/sorters</td>
</tr>
<tr>
<td>2005-</td>
<td>RGB Kodak CCD line elements</td>
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</tbody>
</table>
ScanTech 2006

FinScan

Founded Dec. 6th, 1988
Privately owned company registered and operating in Espoo, Finland, about 10 miles west of downtown Helsinki
Stock capital 500.000 FIM
90.000 EUR

2003 2004 2005
Employees 15 15 15
Turnover / Meur 6.0 6.5 6.8

Main Products:

**BoardMaster** Automated on-line grading of lumber

**ChipMaster** Wood chip on-line analyzer

**PlySpy** Automated on-line grading and optimized clipping system for veneer sheets and band

POB 125
2201 Espoo, Finland
Phone: int. 358 - 9 - 435 5430
Fax: int. 358 - 9 - 452 3385

in May 2006:
... more than
**250**
Automated grading systems sold in 15 countries

<table>
<thead>
<tr>
<th>Edgers</th>
<th>FIN</th>
<th>S</th>
<th>N</th>
<th>D</th>
<th>GB</th>
<th>F</th>
<th>EST</th>
<th>LT</th>
<th>RUS</th>
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</table>
### Automated Grading Worldwide

<table>
<thead>
<tr>
<th>Company</th>
<th>Market Area</th>
</tr>
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<tbody>
<tr>
<td><strong>Fin Scan Oy</strong></td>
<td>Finland &amp; oem deliveries</td>
</tr>
<tr>
<td><strong>ScanWare i Sverige AB</strong></td>
<td>Sweden and Norway</td>
</tr>
<tr>
<td>Örbyhus</td>
<td></td>
</tr>
<tr>
<td><strong>Hekotek AS</strong></td>
<td>Baltic countries, Russia</td>
</tr>
<tr>
<td>Tallin, Esthonia</td>
<td></td>
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<tr>
<td><strong>Wilson Eng. Systems Ltd</strong></td>
<td>New Zealand</td>
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<tr>
<td>Penrose, Auckland</td>
<td></td>
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<tr>
<td><strong>Wilson Eng. Systems PTY Ltd</strong></td>
<td>Australia</td>
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<tr>
<td>Campbellfield, VIC</td>
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<tr>
<td><strong>ScanWare Inc.</strong></td>
<td>USA and Canada</td>
</tr>
<tr>
<td>Portland, Oregon</td>
<td></td>
</tr>
</tbody>
</table>

### New BoardMaster NT
Automated grading
Color scanning
Over 200 boards / min

BoardMaster

* Automated Grading
  Width, thickness and length
  Wanes
  Knots
  Other defects (splits, pitch, blue stain, rot, etc)

* Real Value Optimization
  Short pay back time

* Commercial Success
  252 Systems sold in 14 Countries
  in May 2006
  Secured services
  State of art technical solutions
  Continuous development
BoardMaster

Customers for automated grading

* Midsize and large sawmills: 50 000 m$^3$/a - 600 000+ m$^3$/a, will benefit of very short payback time

* While logs will be smaller and smaller, piece count will increase

* Value added products and components will take a bigger share of the production of sawmills

* Automated grading and value optimization will become more and more important in profitable sawmilling
Automated Lumber Grading  GS4-NT measuring stations
ScanTech 2006

**FinScan**

**Dry Lumber Grading**  
FS4-140NT  3D station, 9 cameras

**Automated Lumber Grading**  
Color cameras and light banks
Advantages of Transverse scanning in sorting lines:

- High capacity applications
- Better accuracy
- Superior detection of deformations
- Fits easy to an existing mechanics

Shortcomings of linear scanning in sorting lines:

- Cannot handle deformations while the boards are transferred from one transporter to the next
- Limited accuracy caused by uncontrolled shaking of boards while the speed of the transporters increases

### Measuring accuracy

**Transverse Scanning** vs **Linear Scanning**

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boards min</td>
<td>m/min</td>
</tr>
<tr>
<td>Transverse</td>
<td>Linear</td>
</tr>
<tr>
<td>30</td>
<td>150</td>
</tr>
<tr>
<td>60</td>
<td>300</td>
</tr>
<tr>
<td>120</td>
<td>600</td>
</tr>
<tr>
<td>180</td>
<td>900</td>
</tr>
</tbody>
</table>

Transverse: good for 200+ boards/min
Linear: only for less than 60 boards/min
**Color image processing**

* True RGB sensor (red-green-blue)
* 4 x 3 cameras for the four faces of boards
* Each CCD line camera with 6144 elements
* Over 1000 exposures per second
* Over 16 M shades of color
* 1.5 G bits / s of data coming from cameras
* Pixel size: 0.4 x 1.2 mm / 0.016 x 0.050 ”
* Capacity: >200 boards / min

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**Defect detection in colour scanning**

* Sound knot: 8 x 10 mm
* Loose knot: 7 x 12 mm
* Split: 0.5 – 3 mm x 740 mm
* Black knot: 2 x 3 mm
Automated Lumber Grading

**Deformations; Crook, Bow and Twist**

*High accuracy: 3 mm / 2m at the production rate of 3 boards/second*

*Deformation profiles are optimized as all the other defects*
Automated Lumber Grading  Blue stain detection

In these grading rules the board is divided into three zones lengthwise. The two edge zones have their own knot rules and the middle zone has its own knot rules.

Grading and Optimizing  Value added grades

* Edge knots

In these grading rules the board is divided into three zones lengthwise. The two edge zones have their own knot rules and the middle zone has its own knot rules.
**Grading and Optimizing**  
**Value added grades**

* **Sound knots and black knots**
  
  In this optimizing both max allowed sizes and min sizes as well max number of knots can be set. These values are separately specified:
  - for sound knots
  - for black knots
  
  This feature allows to specify a desired knot texture for the board.

* **Shop grades and component grades**
  
  Shop grade is a combination grade that consists one or several component grades. Each component has its own grade rules.

  A typical solution can look like this: 

![Diagram showing knot and component grades](image)

---

**Grading and Optimizing**  
**Value added grades**

* **Finger joint grades**
  
  A finger joint grades has as special requirement that at each end of the solution should be full wane and knot free zones. The minimum length (Lmin) of these zones is given in grades rules.

  A typical solution can look like this: 

![Diagram showing full wane and knot free zones](image)

The length of this solution is L. At each end are knot free, full wanes zones L1 ja L2 that are longer than Lmin.
Grading and Optimizing  

Value added grades

- Under development
  - Ripping with multiple blades
  - Shop grades with rippings and secondary cuttings
  - On-Line connection for outside inputs to the optimizing system:
    - Moisture
    - MSR-profile
    - Log tomography scanner

Grading and Optimizing  

Machine Stress Rating

- In use
  - Insta 142
    - Nordic strength grades T0 – T3
    - Corresponding European standard EN338 classes C14 – C30
    - Based on visual rules
    - Certified as an output control system according to EN 14081-2
    - Production installations in Finland since 2005
  - BS 4978
    - Corresponding GS = C16 ja SS = C24
    - Production installations in Finland since 2005
  - Dimensional Lumber / Knot Displacement
    - MSR grading used in North American Stud mills
    - Based on knot connections and cross section knot displacement
    - Over 10 production installations in US and Canada
### Grading and Optimizing Machine Stress Rating

**EN 338 correspondings to INSTA 142 and BS 4978**

<table>
<thead>
<tr>
<th>Class</th>
<th>Insta 142</th>
<th>BS 4978</th>
<th>Bending strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>C 14</td>
<td>T0</td>
<td></td>
<td>14,0 N/mm²</td>
</tr>
<tr>
<td>C 16</td>
<td>GS</td>
<td></td>
<td>16,0 N/mm²</td>
</tr>
<tr>
<td>C 18</td>
<td>T1</td>
<td></td>
<td>18,0 N/mm²</td>
</tr>
<tr>
<td>C 24</td>
<td>T2</td>
<td>SS</td>
<td>24,0 N/mm²</td>
</tr>
<tr>
<td>C 30</td>
<td>T3</td>
<td></td>
<td>30,0 N/mm²</td>
</tr>
</tbody>
</table>

* Under development

- **FEM-method**
  - Improved visual analysis of knot sizes and locations
    - Correlation coefficient $r^2$ better than .35
  - Combining visual analysis of knots with visual analysis of:
    - Ring width
    - Slope of grain
    - Density
Grading and Optimizing Machine Stress Rating, etc

* Under development

- Tomography, visual X-ray for boards

  - Utilizes knot and other defect information available from all 4 faces of a board

  - Knot connections algorithms were created a long ago for stud mill grading systems
Grading and Optimizing Visual X-ray for boards

Knot connection information display

Knot connection information: yearly growth of length
Grading and Optimizing  Visual X-ray for boards

Knot connection information: Location of the heart of the log

...what we see is what you saw ...