High Speed Lumber Marking with Laser Technology

An innovative new lumber marking and tracking system for rough sawn and planed lumber throughputs.

Cumberland Systems Ltd has developed a lumber marking and tracking system for lumber grading systems. The specific requirement is to mark and track boards as they exit an Xray lumber grading system and tracking the boards into trimming and sorting systems.

Figure 1: Lumber marking system
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Background:
Machine vision and Xray lumber grading systems are becoming more commonplace. It is a requirement to maintain the identity of each board on the conveying system whilst the grading information is required for work on the lumber piece.

First In First Out (FIFO) software is commonly used to provide virtual tracking of boards, where the assumption is made that boards will maintain their order throughout this process.

However, boards can break, become scrambled and out of order thereby rendering FIFO systems useless. A means of marking and tracking was required that was able to physically mark boards as they exited the grading system and read the marking at a downstream position with upwards of 200 boards in the conveying system buffer.

Cumberland was able to convert its patented base technology, originally developed to track carcasses and meat cuts through meat processing plants, to track boards.

The major feature of this technology is a liquid label that is applied to the item to be tracked and then laser printed with text and/or barcodes.

Cumberland was quickly able to prove in principal that a liquid label was able to be applied to lumber and laser marked at a line speed of up to 600m / minute. The challenge was to then produce a robust system that would consistently and reliably enable tracking at this speed and higher speeds under industry conditions.

![Diagram of marking system equipment](image)

Figure 2: Overview of arrangement of marking system equipment
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Project:
Once the concept was proven, work commenced on developing the physical layout of the marking system. The component parts were identified as follows:

1. Liquid Label application system
2. Liquid Label curing system
3. Laser printing system
4. Laser print job
5. Marking Control system
6. Camera system
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Label application system
The label application system consists of automatically triggered spray guns and the associated liquid handling system.

The technical challenge was to spray a liquid label onto a board moving up to 600m/minute. We estimated that the laser print job would require a label 50mm long x 25mm wide as a minimum.

The liquid label is a viscous liquid that requires to be constantly stirred and if necessary continually pumped through a dispensing system.

We concluded that the most appropriate method for applying the label would be to spray it onto the board as it moved along the conveying system. However, the spray gun system would need to have an opening/closing duration of <5msec.

Consideration had to be given to the different types of products being graded with the Xray grading system. The product was both rough sawn lumber and planed lumber. It became noticeable that in order to print onto the rough sawn boards that an extra layer of ink would be required on the boards. This is because the rough sawn board has a greater surface area due to the wood fibres and the tendency for the ink to be absorbed into this fibrous layer. As a result of this we decided to install two spray guns. The system could select single and dual spray guns as required.

Figure 3: Liquid label application spraying system

We decided to design and build our own spraygun systems in order to meet the precise performance requirements. Additionally we also concluded that a coil operated spraygun system would offer advantages over a pneumatically operated spray gun system.
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The current spray gun design includes a spring return for the plunger needle; however, we intend to incorporate reverse polarity electrical voltage to the coil to increase the change from fully open to closed positions.

Electronic controls will provide adjustment of the spray duration.

Figure 4: Coil operated spray gun

Figure 5: Exploded drawing of the spraygun including coil and plunger assembly
The liquid handling system comprises a basic air driven pump system complete with pressure regulator and filtering system. The spray guns are designed for through flow circulation which allows the liquid to return to the supply container.
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Label Curing System
The laser power produced by laser marking systems is relatively low and in addition laser energy is dissipated by the label if it is not dry or cured, resulting in poor print quality.

Due to the short time interval between application of the label and printing it, UV curing is the only effective way to dry the label sufficiently to achieve an acceptable print quality.

![UV Curing System Diagram](image)

Figure 7: Liquid label curing system

We carried out research to understand the dynamics between the speed of marking vs. energy required to activate the initiator, to arrive at a suitable curing energy density and duration. The UV curing unit we selected had the ability to adjust the output energy of the lamp, allowing us to fine tune the label response and the lamp power.

Future systems will use a fixed UV energy system.

The electromagnetic waves generated by UV systems react directly with photoinitiators in the liquid label, producing a "cold" photochemical reaction and curing the material in a fraction of the time compared with the conventional drying processes.

UV curing also allows the use of inks containing low levels of Volatile Organic Compounds (VOC), or solvents, which reduces emissions which may pose fire or health hazards.
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Laser Printing System
Because the printing speed required is very fast only a single pass is possible and therefore it was decided to use a human-readable numbering sequence of 0001 -> 9999 recurring.

The laser system is a super high speed marking laser by virtue of the fact that the galvanometer head speed is 20m per second maximum.

Laser Print Job
The laser print job is not only the actual printing; it is also the generation of the number to be printed as a primary key to the data stored in the grading system database, and the handshaking between the laser printer and the grading system which generates the number. A print job timing chart and a software connections diagram are shown below.
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**Timing Chart:**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Time x</th>
<th>Time y</th>
<th>Time w</th>
</tr>
</thead>
<tbody>
<tr>
<td>Board detection photocell</td>
<td>1</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>X-ray grader board '661' sent to Laser-HMI</td>
<td>3</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Laser-HMI sends '661' to Laser</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laser-HMI sends PLC 'READY TO PRINT' command</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Board position rotary encoder</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>'SPRAY GUN' command</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spray gun duration</td>
<td>9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laser 'PRINT'</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laser 'PRINT DONE'</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PLC PRINT DONE</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Description of Operation:**

1. Board leading edge detected by photo-switch on outfeed side of X-ray grader.
2. X-ray grader sends new board number to Laser-HMI.
3. Laser-HMI waits for 'PRINT DONE' command from PLC or 'not READY TO PRINT' from PLC.
4. Laser-HMI sends new number to Laser and it is now waiting for the 'PRINT' command from the PLC.
5. Laser-HMI sends 'READY TO PRINT' command to PLC.
6. The board exits the Banner photo-switch the encoder starts counting pulses.
7. When a predetermined number of pulses is counted the 'SPRAY GUN' command is triggered by the PLC.
8. When a predetermined number of pulses is counted the 'PRINT command is triggered to print by the PLC.
9. When the Laser has finished printing it sends a 'PRINT DONE' command to the PLC.
10. The PLC sends a 'PRINT DONE' command to Laser-HMI and RESETS the 'READY TO PRINT' bit.

Figure 9: This timing drawing shows the requirements for printing each board.
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Marking Control system
The control system for the laser marking system is called the LaserHMI and resides within the Xray grading system computer and communicates with the other programs via UDP protocol messaging.

Figure 10: LaserHMI screen shot showing the various equipment controls
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Camera system
The camera system is responsible for reading the laser marked boards when they arrive at the grading area. The camera reads the number printed on the board and passes it to the PLC controlling the sorting and trimming systems.

![Diagram of camera system](image)

Figure 11: Liquid label camera system

The Future
The high speed lumber marking system as installed in this project has been run at 600m per minute and 700m per minute in pre-installation testing.

Based on what we have learned from this system we are confident of building a super high speed laser marking system that can run at 1000m per minute. We have begun developing the next generation laser and spray gun systems required to achieve the required speed.

Please visit our website to view our details: [http://www.cumberlandsystems.co.nz](http://www.cumberlandsystems.co.nz)