SAWTECH 2005

Sawing Technologies to Improve Mill Performance

Rotorua, New Zealand, 30 Nov-1 Dec 2005
Coffs Harbour, Australia, 5-6 December 2005

REAL-TIME BANDSAW PERFORMANCE MONITORING & CONTROL

Todd Buchanan
Managing Partner, Business Development
SICAM SYSTEMS CORPORATION
Unit #10 – 15355 102A Avenue
Surrey, British Columbia V3R 7K1 Canada
Phone: 604-584-7151
Fax: 604-584-7131
Email: tbuchanan@sicamsystems.com
Overview

Leading lumber products manufacturing companies are seeking new and adapted technologies to continuously monitor and control the process in order to improve reliability. A competitive advantage is gained by those companies that can maximize production and quality while minimizing costs. Today, in most sawmills, bandsaw machine centres are utilized to manufacture lumber. A critical area of reliability improvement opportunity is real-time bandsaw performance monitoring and control. Technology currently exists for monitoring and controlling bandsaw performance.

This document describes the lumber manufacturing Real-Time Bandsaw Performance Monitoring & Control system. The system is a new concept that utilizes and integrates technology already widely in use in the lumber industry. These proven technologies are adapted under an innovative approach to create a system that combines the data from a number of key online monitoring technologies to maximize both the production and quality performance of bandsaw machine centres. The technologies of the Real-Time Bandsaw Performance Monitoring & Control system include as applicable depending on the machine:

1. Bandsaw Deflection Monitoring;
2. Depth of Cut Scanning;
3. Bandsaw Motor Draw Monitoring;
4. Lumber Size Control Board Deviation (total standard deviation $S_t$) Scanning;
5. Pre-Cut Speed Control and;
6. In-Cut Speed Control.

These technologies are integrated to provide the fastest possible bandsaw machine centre processing speeds before and during the cutting process while keeping the board deviation within acceptable tolerances. The benefits of the system are maximized production, improved fiber recovery and increased grade outturn, three of the key business drivers in sawmilling. Each of the three key business drivers must be optimized on each machine processor in order to keep the machine in the “sweet spot” of manufacturing performance. Always operating in the sweet spot maximizes operational execution and profitability.

The Real-Time Bandsaw Performance Monitoring & Control system is the next generation speed and quality control system that promises substantial returns from production increases while ensuring stable product quality. Maximized production and stable quality delivers lower cost of manufacturing and improved customer satisfaction, two critical objectives in today’s highly competitive sawmill industry.

The research and development presented in this paper was conducted by SiCam Systems Corporation in association with Weyerhaeuser Canada [herein referred to as “industry partner”] (now Cascadia Forest Products) in 2004. The software used during the research was the SiCam™ RealTime System including lumber size control, feed speed control, bandsaw deflection and motor monitoring features adapted as required. Scanning and sensing technologies where provided by 3DM Devices, Hermary Opto Electronics and Turck Industrial Automation. Installation and programmable logic control (PLC) programming was conducted by the industry partner site personnel.
SiCam Systems Corporation designs, markets and supports the SiCam™ lumber size control and online predictive maintenance and machine control technologies. At the time of this writing, the SiCam™ RealTime System is installed in more than 30 operations and 75+ scan centres. The SiCam™ Caliper System is installed in over 125 sites in four countries. The SiCam™ name is widely known in the lumber industry as the premium lumber size control brand. SiCam Systems’ team is internationally recognized as pioneers and leaders in the field of lumber size control and sawing centre predictive maintenance technology. SiCam Systems Corporation is located in Surrey (Vancouver) British Columbia, Canada and can be reached at:

**SICAM SYSTEMS CORPORATION**

604-584-7151  
www.sicamsystems.com  
info@sicamsystems.com
Concept

Conventional Speed Control using band saw deflection and/or depth of cut and/or bandsaw motor electrical current draw monitoring is a common practice in the lumber industry. Conventional speed control systems, utilizing one of the many saw deflection monitoring systems available on the market, relies on data collected from saw deflection tracking proximity probes mounted under the top guides in bandmills. The data is used to determine if the line speed should be increased or decreased based on the performance of the saws while in the cut. The depth of cut option relies on a pre-cut feed speed set based on the depth of cut and related gullet capacity at command speed. The motor monitoring in-cut speed ramp up or down is based on the level of electrical draw on the saw motors as applicable depending on the configuration of the machine centre.

The primary constraint with the conventional speed control approach is simple. In traditional systems there is no way to accurately correlate saw deflection at the top guide to the actual board deviation on the pieces produced. Therefore, the thresholds of saw deflection that drive the feed speed control are theoretical and may not accurately predict the actual board deviation on the pieces produced by the machine. This constraint limits the system’s ability to maximize the machine feed speed to produce the desired board deviation on the pieces manufactured by the machine. The result is longer periods of operating time of lower than threshold board deviation punctuated by short periods of out-of-control periods of miss-manufacturing that may last for minutes or hours or even days depending on the severity of the event and the ability of the operational personnel to detect it.

This pattern is repeated from saw cycle to saw cycle however the severity of miss-manufacturing, as measured by board deviation (total standard deviation - $S_t$), varies. The short periods of severe miss-manufacturing result in reduced efficiency both in production throughput and quality. Production is negatively impacted due to more pieces going to reman due to manufacturing defects. Quality is negatively impacted due to lost recovery on reman pieces and lost grade on pieces with manufacturing defects that make it through the sawmill process but, negatively impact downstream drying and planing performance.

Real-Time Bandsaw Performance Monitoring & Control, as described in this document, is a new concept for controlling the speed of bandsaw lumber manufacturing machines to maximize production throughput while controlling variation at or just below the maximum acceptable threshold required by the rough target size requirements. The approach utilizes more information than conventional speed control to optimize the block entry speed and ramp up total line speed of each sawing event.

This approach requires accurate depth of cut information of the block on presentation to the machine and accurate measurement of lumber size control characteristics post sawing the piece(s). Real-Time Bandsaw Performance Monitoring & Control combines critical size control information with conventional speed control information to provide improved control through the implementation of the following 2 types of speed controls.

- Pre-Cut Speed Control – determined using a laser (or infeed optimizer if available) to track the depth of cut of each block presented to the machine and previously observed board deviation on the sawn pieces after the machine to maximize speeds as a block enters the saws.
**In-Cut Speed Control** – determined with probes or lasers tracking saw deflection and motor draw monitoring during the saw event or “cut” to decrease or increase speed based on bandsaw deflection and/or saw motor draw correlated to board deviation.

The following images illustrate the logical flow of the Real-Time Bandsaw Performance Monitoring & Control process. The example used is a multi-bandsaw processor with bandsaw deflection monitoring probes and a multi-piece profile (SiCam™ MPP) size control scanner on the outfeed of the machine. Single, twin and quad band machine centres are indicated for this technology.

*Note:*
Sawing variation or board deviation from a laser size control scanner can be used in place of the MPP size control scanner depending on the configuration of the machine.

**Step 1 – Depth of Cut using Height Laser (Pre-Cut Speed Control)**

Once the block moves into the infeed laser scan zone (or infeed optimizer) the height - depth of cut of the block is calculated and the Pre-Cut feed speed is set based on the historical board deviation of previously processed pieces from the height category history. The command speed is pulled from a look up table in the lumber size control software and it is immediately sent to the machine feed speed control PLC.

*Technical Note:*
The Pre-Cut command speed typically has a “profile” in the speed control PLC which includes a combination of: “entry” speed, “ramp up” to command speed and a “flare” compensation speed depending on the application.
**Step 2 – Bandsaw Deflection (In-Cut Control)**

Once the Pre-Cut feed speed profile and the bandsaw positions have been set, the block enters the saws and the saw deflection of each saw is monitored by the saw deflection monitoring system. The board deviation from previous sawing events is linked to the current sawing event saw deflection. The saw motors draws are also monitored throughout the cut. Depending on the observed saw deflection/board deviation and motor draws, the machine feed speed control PLC will either increase or decrease the feed speed of the machine making adjustments throughout the cut to control board deviation at or just below the acceptable threshold.

- Probes or lasers monitor the saw deflection throughout the cut on each saw.
- Infeed laser monitors the depth of cut for the entire length of the block to compensate for flare.
- After the initial entry of the saws the speed might be increased or decreased accordingly.
- The size control scanner monitors the actual board deviation which is linked to saw deflection.
**Step 3 – Size Measuring**

As the block moves through the saws and lumber size control scanner on the outfeed the lumber size control system collects size data from each piece in the stack. This size data is captured at specific intervals along the pieces using an encoder integration to track the board deviation to length increments. The size control data is tracked to the already observed height on the piece (depth of cut), saved in history and provided in the look-up table to drive both the Pre-Cut and In-Cut speed controls. The saw deflection and motor draw characteristics are also captured and saved in the SiCam™ System database for every piece and sawing event.

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**Additional Feature Note:**

*After measuring the sizes, the system looks up the height and width constraints to provide a fatal stop. If a current piece exhibits dimensions outside the control limits the line will be stopped immediately. This feature ensures that pieces destined for downstream machines will not get past physical size restraints or get stuck in the downstream machine. This feature has proven to reduce or eliminate “piece stuck” events thereby reducing downtime on the downstream machines.*
**Step 3 – Block Finished**
After the block has passed through the bandsaws and the size scanner, the board deviation is calculated for the last $n$ pieces. The board deviation value is used to modify the Pre-Cut and In-Cut speed control for each new piece or sawing event.

Additional Feature Note:
After measuring the sizes, the system looks up the maximum acceptable board deviation constraint to provide a fatal stop. If a current piece exhibits board deviation outside the control limit the line will be stopped immediately. This feature assists to stop the line if a bandsaw is operating too far outside acceptable parameters and has proven to prevent bandsaw “wreck” events.
Research & Development Plan
The initial Real-Time Bandsaw Performance Monitoring & Control research and development project was conducted on a Quad bandsaw resaw machine centre. The project was implemented in several phases. These phases involved the cooperation of internal staff at the industry partner site, third party vendors and outside contractors. The following section outlines the phases of the research project.

Phase 1 – Laser Test for Bandsaw Deviation
A number of lumber manufacturers are seeking a more reliable approach to bandsaw deflection monitoring than the conventional proximity probes mounted under the top guides method commonly used today. To address this option, for the initial research project, laser sensors were mounted 6-7 inches away from the bandsaws to accomplish the bandsaw deflection monitoring. Due to the fact that each application may have unique environmental conditions of debris, oil, water and lighting, in this phase the lasers were tested on the bandsaws in order to ensure that they perform in an accurate and stable manner. Proximity probes were also mounted under the top guides to provide comparative data.

Phase 2 – Pre-Cut Speed Control Installation
The Pre-Cut Speed control utilizes the piece height (depth of cut) and lumber size control information to command initial feed speeds. The first key component is the MPP or Laser lumber size control scanner. The second key component is the ability to track depth of cut. The depth of cut can be obtained from either the infeed optimizer via integration if available or from a separate laser tracking piece height mounted on the infeed of the machine. For this phase of the research project, we implemented a laser on the infeed of the machine to scan the depth of cut and an MPP scanner on the outfeed for the size control data.

Phase 3 – In-Cut Speed Control Installation
The final decision on whether to use probes or lasers to handle the saw deflection monitoring was implemented. If applicable, the existing saw deflection system and feed speed control could have been used or the industry partner had the option to implement an upgraded in-cut speed control. The industry partner was solely responsible for the decision and implementation of the in-cut speed control. For the research project probes mounted under the top guide on each of the 4 bandsaws was implemented.

Phase 4 – Analysis Interface Implementation
The analyses interfaces are configurable. During this phase, the analyses tools were customized for machine operators, sawfilers, quality control and management staff appropriately. The interfaces utilize the lumber size control, feed speed control and the saw deflection monitoring software tools.

Phase 5 – Performance Analysis
Once the equipment and software was installed and commissioned, the performance of the system was analysed. Initially, the laser performance was compared to the probes mounted under the top guides. The industry partner preferred the probes. Other analyses included a comparison before and after the project of efficiency key performance indicators such as the number of blocks processed per hour and the board deviation observed.
Prototype System

The following section outlines the equipment, software and features of the prototype system that was designed and installed to support the research and development project.

Pre-Cut Speed Control

The Pre-Cut speed control manages the block entry feed speed based on depth of cut and board deviation. This section outlines how the Pre-Cut speed can be adjusted by height and board deviation. The board deviation values are read from the lumber size control software which is configured to view different windows of deviation through user defined parameters. For example the average within board variation ($S_w$) may be used for the last $n=5$ pieces to determine the “board deviation” which in turn drives the Pre-Cut feed speed or command speed to the feed speed control PLC.

Basic Speed Setup (using Depth of Cut)

The basic setup uses the height-depth of cut of each block presented to the machine to determine the initial Pre-Cut feed speed of the line. Each height category has a corresponding command feed speed profile. The command speed is sent by the feed speed control software to the machine speed control PLC. The machine speed control PLC then executes the appropriate command speed profile which may include, entry speed, ramp up to maximum speed and flare compensation speed.

Advanced Speed Setup (using Actual Piece Variation)

The advanced variation setup utilizes the board deviation information gathered from the lumber size control system on the machine centre outfeed correlated to the piece height – depth of cut. This approach allows the system to push higher Pre-Cut speeds when variation is low for certain height categories. The setup can be modified to add any number of variations for each speed setting and height category.
**Board Deviation Calculations**

The board deviation calculations are handled by the lumber size control software. The methods of calculating the values are completely configurable and parameter driven in order to create logical rules for each separate sawline and height category depending on observed performance. This feature ensures that the information is updated appropriately for each sawline and height category. As an example, saws that typically process fewer pieces (outside saw on quad resaw) may require fewer pieces in the board deviation table.

Each of the board deviation values is pulled from a current table of size control data broken down by depth of cut (height). The following example is how this data might look at a specific instant in time.

<table>
<thead>
<tr>
<th>Size Var Monitor Name</th>
<th>Last N</th>
<th>Value</th>
<th>Last Update</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.000” – 4.000” Height sw</td>
<td>15/15</td>
<td>0.011</td>
<td>1:45:23 AM</td>
</tr>
<tr>
<td>4.001” – 6.000” Height sw</td>
<td>10/15</td>
<td>0.009</td>
<td>1:27:25 AM</td>
</tr>
<tr>
<td>6.000” – greater Height sw</td>
<td>15/15</td>
<td>0.013</td>
<td>1:45:24 AM</td>
</tr>
</tbody>
</table>

This information must be verified as current and accurate before it is applied to the speed look up. If the information is determined to be old it is not used in the calculation and the default height/speed will be selected. Data older than \( n \) minutes is not used to modify the speed.
Size Control Scanner Hardware
The following image shows an example of the size control scanner hardware which in this case is a multiple piece profile (MPP) scanner.

Size control scanner on outfeed of the quad bandsaw line

Size control scanner laser line scanning sizes on each piece in the stack
**In-Cut Speed Control**
The In-Cut speed control utilizes sensors on the bandsaws to monitor the current performance and deflection of each saw. The saw deflection performance is linked to the board deviation performance. The motor draw is also monitored. This information is tracked and stored in the SiCam™ System data management software. The customers’ machine speed control PLC system uses the data to make decisions to increase or decrease speed during the cut. This component of the system also links together with the line PLC and set works to determine exactly where the block is in the process.

**Saw Deflection Hardware**
The image below outlines the position of saw deflection probes.

The picture below shows the installed probe below the bandsaw top guide.
In-Cut Speed Control Process

The saw deflection is monitored in real-time and piece by piece. The real-time processing calculates the average size and board deviation within a given number of scans. The motor electrical draw is monitored for each saw. The total piece information is a summary of all data collected from start to finish on the piece. The following outlines the steps of the process:

1. New bandsaws are placed on the bandmills.
2. The saw deflection sensors calibration is done automatically at the beginning and throughout the shift while the bandsaws are running between the sawing events or cuts.
3. The bandsaws move into position for the piece prior to entry.
4. Bandsaw deflection and motor draw monitoring begins to watch for possible speed change and continues monitoring throughout the sawing event. Bandsaw deflection is linked to previous board deviation to correlate information for in-cut speed control.
5. The feed speed is increased or decreased based on the performance of the bandsaws within the defined measurement window and depending on the previously observed board deviations.
6. The block passes out of the saws and the saws unlock signalling the end of the piece.
7. The bandsaw saw deflection and motor draw information is stored in the database for the block.
8. As the pieces move through the size control scanner on the outfeed of the machine, size data is collected and stored for the piece including board deviations.
9. The saw deflection and motor draw information is linked with the size control information gathered on the outfeed for each and every piece.
10. Feed speed thresholds for the in-cut speed control are automatically recalculated and benchmarked on \( n \) pieces based on the correlation between the depth of cut, saw deflection and board deviation.

Speed Conditions

The actual modification of the speed requires a number of conditions to be met before a change in speed is accepted. These conditions are completely configurable to speed up or slow down accordingly and there are no limits to the number of groups allowing for fine adjustment as the machine performance is benchmarked. Again, the benchmarking process is the dynamic analysis of the correlation the depth of cut to saw deflection to board deviation values. The objective is to create a monitoring and control system that will always seek the maximum speed while ensuring that the board deviation is maintained at or just below the allowable threshold.

The following example table can contain any number of conditions based on deflection and/or other key system variables.

<table>
<thead>
<tr>
<th>Criteria Num</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Saw 1 Between .010 and .025 Deviation</td>
</tr>
<tr>
<td>2</td>
<td>Saw 2 Between .010 and .025 Deviation</td>
</tr>
<tr>
<td>3</td>
<td>Saw 1 Between .026 and above Deviation</td>
</tr>
<tr>
<td>4</td>
<td>Saw 2 Between .026 and above Deviation</td>
</tr>
</tbody>
</table>
Speed Condition 1-
If Criteria #1 and Criteria #2 = true then speed up 5%

Speed Condition 2-
If Criteria #3 or Criteria #4 = true then slow down by 5%

Any number of conditions can be assembled to create the basis for controlling speed in the cut.

Technical Note:
With the Real-Time Bandsaw Performance Monitoring & Control the actual board deviation is linked to the actual saw deflection on every piece processed to provide an expanded understanding of the relationship between these two constraints. This information is used to benchmark and optimize the feed speed for each machine based on the attributes and performance of the machine providing greater sawing control at increased production levels.

Saw Deflection Interface
There are several tools available in the software to monitor the variation and performance of the saws. These include real-time feedback, historical charts and histograms. The saw interface provides an immediate view of the performance of each saw along with a historical control chart of the last \( n \) saw measurements. The graphs are plotted for each of the saws in the system. The image below provides an example of one saw deflection control chart. These tools complement the tools available in the saw deflection monitoring system(s).
**Piece Analysis**
The Real-Time Bandsaw Performance Monitoring & Control system monitors actual size, board deviation, motor draw and the saw deflection for each piece. This feature allows the data to be unified delivering unique automated analyses capabilities. The following is an example of the type of information that is available for the detailed analysis of the machine. The image shows a single “stack” on the outfeed of the machine with three pieces being produced.

- **Length position tracked via encoder integration on the line**
- **Histogram of measurements or board deviation data**
- **Saw deflection that occurred directly on each saw in use in the stack of pieces**
- **Each piece in the stack is drawn - the information includes summary and detailed shape analyses**
- **Speeds that occurred Pre-Cut and In-Cut of the sawing event correlated to length position**
**Machine Operator Interface**

A primary objective of the system is to provide the machine operator with critical summary information on each saw event as it is occurring. The machine operator interface must pass the glance test to be effective. While the machine operator interface software is customizable to each application and user, the following screen capture shows an example of the software.

- **Command or recommended speed**
- **Sawing variation results last 30 pieces**
- **Speed and height information for current saw event**
- **Dynamic saw deflection tracking for each saw**
**System Hardware Overview**

The schematic example below shows saw deflection sensors, depth of cut laser and MPP size scanner which feed data into the Real-Time Bandsaw Performance Monitoring & Control computer. The information is stored, processed and speed parameters are outputted to the internal machine feed speed control PLC from the computer. The following drawing provides and overview the main hardware components of the system:

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**Total Speed Control System Overview**

- Speed Control Computer
- Company Internal Network
- PLC Connection
- Speed Control Electrical Box
- Power Supply
- External Power Supply
- Line Encoder
- Height Laser (Depth of Cut)
- Saw 1 Deviation Monitor (Probe/Laser)
- Saw 2 Deviation Monitor (Probe/Laser)
- Saw 3 Deviation Monitor (Probe/Laser)
- Multipiece Scanner System
- Flat Screen Operator Panel
- PC Modem Connection
- Outside Dialup line

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PLC System Interface
The Real-Time Bandsaw Performance Monitoring & Control system interfaces with the machine speed control PLC in order to send and receive critical information. Much of the control is done inside the machine PLC utilizing the various inputs to setup the correct speed for each piece. The following table outlines some of the key information that will be used in the speed decision by the PLC.

<table>
<thead>
<tr>
<th>Num</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pre-Cut Command Speed (Sent from PC to PLC Prior to the Cut)</td>
</tr>
<tr>
<td>2</td>
<td>In-Cut Saw Deflection/Board Deviation and Flare Compensation “Command Speed” (Sent from PC to PLC Repeatedly While in Cut)</td>
</tr>
<tr>
<td>3</td>
<td>Saw In Cut (Sent from PLC to PC while saws in the cut)</td>
</tr>
<tr>
<td>4</td>
<td>Manual Control (Set in PLC for Operator Speed Control)</td>
</tr>
<tr>
<td>5</td>
<td>Bandsaw Motor Amperage Draw (Used in PLC as Speed Override)</td>
</tr>
<tr>
<td>6</td>
<td>Watchdog Signal (Sent from PC to PLC)</td>
</tr>
<tr>
<td>7</td>
<td>On/Off Signal (Sent from PC to PLC When System Running)</td>
</tr>
<tr>
<td>8</td>
<td>Height Laser Alarm (Sent from PC to PLC When Laser Problem)</td>
</tr>
<tr>
<td>9</td>
<td>Size Scanner Alarm (Sent from PC to PLC When Scanner Problem)</td>
</tr>
<tr>
<td>10</td>
<td>Encoder Alarm (Sent from the PC to the PLC When Encoder Fail)</td>
</tr>
<tr>
<td>11</td>
<td>Fatal Stop Alarm (Sent from PC to PLC to Stop the System)</td>
</tr>
<tr>
<td>12</td>
<td>Message Board (Sent from PC to PLC for Operator Messaging)</td>
</tr>
</tbody>
</table>
System Software Overview

The system software has several key components communicating together to create the Real-Time Bandsaw Performance Monitoring & Control system. These components work in concert with the feed speed control PLC to optimize the machine speed performance as outlined above. The image below outlines the main software of the system.

Feed Speed System Architecture

Technical Note:
The customer is responsible for the development and implementation of the In-Cut speed control.

Software Components

The following section outlines the software components of the system that were configured and developed for the project.

1. **Size Control Software** – The SiCam™ RealTime System lumber size control software provides board deviation information to the SiCam™ Feed Speed Control Pre-Cut Speed Server to optimize the pre-cut speed value. (provided by SiCam Systems Corporation)

2. **Pre-Cut Speed Server Software** – The SiCam™ Feed Speed Control Pre-Cut Speed Server sends the initial speed information to the machine feed speed control PLC immediately after the depth of cut has been scanned and matched to board deviation value for the height of the piece entering the cut. (provided by SiCam Systems Corporation)

3. **Saw Deflection Monitoring Software** – The SiCam™ Saw Deflection Monitoring software handles the saw deflection monitoring, constantly reading the variation of the saws. This information is used for display purposes and also passed to the customer’s machine feed speed control PLC. The SiCam™ Saw Deflection Monitoring system can be integrated to other saw deflection monitoring systems to provide added features and the total piece saw deflection, motor draw and board deviation analyses outlined above. (provided by SiCam Systems Corporation)
4. **In-Cut Speed Control Software** – Actual speeds while the piece is “in the cut” are ramped up and down using this component. The depth of cut, saw deflection, board deviation, motor draw and PLC inputs are combined to provide the correct fastest speed throughout the cut. This is handled by the customer’s PLC system.

5. **PLC** – The PLC software/hardware is the interface to the machine centre being controlled. The PLC receives and sends data from the SiCam™ System and it executes the commanded Pre-Cut and In-Cut feed speeds. This is handled by the customer’s PLC system.

6. **User Interface Software** – The SiCam™ System user interface software provides both analytical tools and real-time interfaces to the machine operator and mill personnel. It includes lumber size control, saw deflection and motor draw monitoring user interfaces, set-up and configuration parameters, management and reporting. (provided by SiCam Systems Corporation)

7. **Database Management Software** – The Real-Time Bandsaw Performance Monitoring & Control system relies on integration of the sensing technologies, hardware and software described above. In order to provide Real-Time Bandsaw Performance Monitoring & Control, the data from these systems must be integrated into one data management system. The SiCam™ System uses Microsoft’s SQL-Server database and our own data management software to organize, unify, filter, analyse and store all the data. The *Cascade Data Filter, Statistical Process Control Engine* and *User Interfaces* provide a unique, highly accurate and reliable package capable of integrating the data from the different sensing technologies, filtering the data to ensure accuracy and reliability, and displaying the data for unified, simple analyses and control. (provided by SiCam Systems Corporation)
Research Results

The following section outlines the results and findings of the Real-Time Bandsaw Performance Monitoring & Control research and development project outlined herein. The major findings have been summarized for this writing. Please contact SiCam Systems Corporation for additional information about the Real-Time Bandsaw Performance Monitoring & Control product.

Laser versus Probe Bandsaw Deflection Monitoring

It was found that both the Laser and proximity probe approaches to bandsaw deflection monitoring delivered strong accuracy results with the accuracy at +/- .001” or better. Negative effects on laser accuracy were noted over time due to water, oil mist, sawdust and debris build up on the faces of the laser sensors. The proximity probes did not exhibit the negative effects due to water, oil mist, sawdust and debris.

At the outset of the project it was predicted that the Laser sensors would be less susceptible to impacts from bandsaws, debris, wood pieces and other objects than the proximity probes. However, the Laser sensor(s) did suffer from impact related damage to viewing port(s) more frequently than the probes. In fact, the laser sensors were damaged twice due to impact and once due to water and the probes were not damaged at all during the study period.

Due to these findings, the industrial partner for this research selected the probes as their preferred option for the bandsaw deflection monitoring devices. At the time of this writing, the probes continue to function as designed more than a year after the project without damage or repairs being required.

Impact on Efficiency

Two factors were tracked for the analysis of the impact on efficiency resulting from the project, blocks through the machine per hour and sawing average board deviation (total standard deviation – $S_t$) of the lumber made by the machine. The method was to establish the pre-project benchmarks for three (3) months and then assess the results for three (3) months post implementation of the equipment. The following outlines the findings.

The machine board deviation ($S_t$) was measured by the lumber size control MPP scanner. Key criteria was analysed on groups of 30 pieces throughout each shift including:

- Maximum $S_t$;
- Minimum $S_t$;
- Average $S_t$. 
The results of the analysis of the impact on efficiency of the board deviation (quality) capability of the machine (all saws) are:

**The average board deviation observed increased by .007”**.
The pre-project average board deviation was .017” ST and post project average variation was .024” ST. *The board deviation target threshold was .025” ST.*

**The average maximum board deviation observed decreased by .059”**.
The pre-project maximum board deviation observed on one shift was .087” ST. The post-project maximum board deviation was .028” ST. *Groups of 30 pieces exhibiting greater than .025” ST triggered an alarm whereby the manufacturing team took action to resolve the cause of the increased board deviation. This change in process management resulted in the elimination of miss-manufacturing events that prior to the project, went unchecked for minutes, hours and sometime entire shifts.*

**The average minimum board deviation observed increased by .005”**.
The pre-project minimum board deviation observed was .016” ST. The post-project minimum board deviation was .021” ST. *The average ST increased due to the speed control function that seeks an increase in speed when board deviation is below the acceptable threshold.*

The lumber size control scanner was installed prior to the project and all the board deviation data was collected automatically by the MPP scanner. Periodic audits were conducted by digital caliper manual measuring to confirm scanner accuracy throughout the pre-project and post-project timeframes.

The reduction of the average maximum board deviation made a significant impact on production, recovery and grade outturn. While these factors were not studied as part of this project, the industry partner personnel confirmed that there are reduced pieces going to reman taking lug spaces to the sorter. Fewer reman pieces taking lug spaces means increased production through the sorter. Fewer reman pieces means less recovery loss due to remanufacturing. Grade outturn improved from a reduction of skip due to board deviation manufacturing related defects. In addition, drying defects decreased due to less thick and thin pieces in kiln charges further improving grade outturn performance.

While the minimum average board deviation and the average board deviation increased, existing rough target sizes had more than sufficient board deviation (sawing variation) allowances to accommodate these increases. This is due to an attempt to compensate for the maximum average board deviation, in the rough target size, performance prior to the project.
The results of the analysis of the impact on efficiency of the block count (production) capability of the machine are:

**The average shift block count increased 1.2%**.
The blocks in count average pre-project was 750/shift. The blocks in count average post-project was 759/shift. The mill runs a 3-shift basis for 750 shifts per year therefore this increase in blocks through the machine delivered 9 extra shifts of production on an annualized basis.

**The number of wrecked saws decreased by 30 over one year.**
A benefit verified by the industry partner site personnel was fewer saw wrecks. In the year immediately following the project they had 30 fewer saw wrecks than the previous year. The benefit resulted in less downtime due to unscheduled saw changes and reduced operating costs of purchasing saws.

Production data was gathered by the PLC on the machine centre. Block counts were gathered on an hourly basis from the PLC generated production shift reports.

The actual financial impacts of the production and quality gains outlined above have been kept confidential at the request of the industry partner.
Summary
Today, leading sawmills are seeking improved online performance control and alarming systems to improve manufacturing reliability, efficiency and quality. Real-Time Bandsaw Performance Monitoring & Control is a new concept that relies on existing and proven technologies adapted and integrated under an innovative approach to provide the best lumber manufacturing bandsaw machine centre feed speed control system.

The research herein shows that this new approach to Real-Time Bandsaw Performance Monitoring & Control optimizes both the Pre-Cut and In-Cut speeds to maximize production while at the same time assuring that quality of the manufactured product meets the specifications of the operation and its customers. The benefits of the system are maximized machine production, improved fiber recovery and grade outturn.

Please contact us if you require additional information.

Todd Buchanan
SICAM SYSTEMS CORPORATION
Tel. 604-584-7151
Cel. 604-671-8324
tbuchanan@sicamsystems.com