POTENTIAL SAVINGS THROUGH IMPROVED RECOVERY
UTILIZING OPTICAL SCANNING
AND ELECTRONIC METHODS

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Introduction

This presentation is on the Trim-izer® Scanner/Control System.

This system makes rough green trim operations more productive, more reliable...and more efficient. It was designed to take advantage of today's electronic technology...while at the same time keeping in mind the need for a system that is easy to use...and virtually trouble free.

This narrative provides an overall description of the product and how it operates. The slides used in my presentation supplement this text with highlights of our field test results (both the recovery improvements achieved and the technical problems encountered), and with more insight on the proprietary scanning technique employed in the system.

The Trimming Problem

Inefficient trimming of green lumber can be quite costly to a mill. If bad lumber is not trimmed out, you end up paying for stacking, drying, and planing of unusable material. In addition, you are paying extra money to remanufacture it at a later stage in the process.

Operators can be good...and bad. It's primarily a question of new people versus experienced people. Even a highly-skilled operator can not remain consistent hour after hour, day in and day out. He is also subject to fatigue. The latter is especially harmful because so many trimming decisions are judgment calls that can only be made properly by an alert operator.

Some operators saw back too much and you hardly see any wane or defect. Everything comes out square cornered. If he is so over zealous that he cuts too much wood out when he spots a bad piece, then you are losing valuable lumber...and money.

Other operators are too conservative and you see quite a bit of defective material coming out of the trimmer. It's extremely costly if this material is processed.

If the bad material is cut out before it's dried, it can at least be used for chips...which returns money to your operation. But if it is found after drying and planing, then it can only be used as shavings...which are usually worth less than chips.

Still another problem is allowing defective material in a stack that is going to the kiln. Excessive wane on stacks in the kiln may allow other boards above it to bow or bend...impeding air flow...causing uneven drying...and thereby downgrading a portion of the lumber in the kiln.

Registered trademark of Morvue Electronics
Morvue Electronics has addressed all of these problems and offers an economical and efficient solution in its Trim-Izer Scanner/Control System.

Features

Some of the features of Morvue's Trim-Izer Scanner/Control System are listed below:

- **Efficient cutting**: Defines good and bad portions of board; cuts for maximum efficiency and economy.
- **Pre-set values**: Mill can pre-set minimum acceptable values for such factors as length, width, thickness, etc.
- **Manual override**: Production personnel can switch over to manual operation at any time by simply flipping one switch.
- **Self-checking**: During operation, system periodically checks itself and signals mill personnel if there is a problem.
- **Independent scanners**: Each scanner is independent and completely interchangeable with every other scanner.
- **Non-contact reading**: Electronic scanners eliminate problems and inaccuracy caused by contact-type devices.
- **Display of planned cut**: Before any cut is made, lights on panel indicate which saws are going to drop.
- **No change to existing equipment**: System does not affect any of the existing saw controls; if necessary, existing saw controls may still be used.
- **Accuracy**: Scanners are accurate to .002 of an inch (in laboratory); in mill environment, accuracy is within 1/16 of an inch...or better.
- **Diagnostics**: Self-checking and diagnostic programs reduce the amount of system down time; many problems can be detected and corrected by the mill personnel.

The Basic Idea

The basic concept behind the system is simple. The system uses existing saw controls...and just pushes the buttons for the human operator.

But...unlike the operator...this system performs complex analyses and makes decisions in millionths of a second...reducing your waste, providing consistent decisions according to mill management needs, and working efficiently hour after hour, day after day, month after month. You do not have down time because of illness or fatigue. And the system doesn't bury its mistakes, it lets you know immediately when it detects something wrong.

Because the system is added to your existing equipment, it can be installed and made operational much faster.
System Description

This section is divided into four parts: basic operation, analyzing the board, hardware, and software.

Basic Operation

The Trim-Izer scanner/control system does three basic jobs: it "looks at" each board, it determines where the defects are located, and it "tells" the trim saw where and when to cut in order to trim each board efficiently.

Looking at
the board

The system uses "scanners" to look at the board as it moves along the green chain. Multiple scanners let the system get a good look at the board.

Each scanner is designed to look for the board's thickness, width, and required "top nailing surface." The term "top nailing surface" refers to that portion of the board width that is at or above a specified thickness.

In effect, the combined information from all scanners gives an electronic "picture" of the board which is then fed into the computer.

Locating
defects

The computer...which is the heart of the system...takes this overall "picture" of the board and analyzes it to determine if there are any defects. The computer is mainly looking for wane.

Telling
trim saw
how to cut

Based on its findings, the computer tells the trim saw when to cut. It sends a signal to each saw at the precise moment the saw is to drop. In other words, the computer pushes the buttons for the operator.

Because of the computer's speed and accuracy, trimming is highly efficient. However, the operator can regain control of the operation at any time...by simply pushing a switch.

Analyzing the Board

The Trim-Izer scanner/control system is designed primarily to look for wane. Although many defects require a good judgment call by the operator, in most mills wane is the basis for most trim decisions...and is also one of the most common defects with green lumber. When using a manual system, it's quite easy for the operator to cut off too much or too little of the board unless he can accurately see the wane.

Whether using an automatic or manual system, there are four factors that must be considered when analyzing a board to see where it should be cut. These factors are:
Width
Thickness
Length
Top nailing surface (that portion of board width at or above a specified thickness)

The Trim-Izer scanner/control system lets mill production personnel set up each one of these factors individually...for each board type. In addition, production personnel can select a value or range (called a "parameter") for each of these factors.

Once the values (parameters) are entered into the system...by means of simple thumbwheel switches...then the system automatically cuts out any part of a board that does not conform to the pre-set values.

The initial system handles the 10 basic board types listed below. The control panel has a separate set of switches for each board type. This lets the production personnel set up the required values for each type of board.

- 1 x 4
- 1 x 6
- 1 x 8
- 1 x 10
- 1 x 12
- 2 x 4
- 2 x 6
- 2 x 8
- 2 x 10
- 2 x 12

Because the thumbwheel switches are so easy to read, the values for each board type are always visible to production personnel. In addition, a series of lights on the panel and at the scanners, displays each planned cut before it is made.

Production personnel set appropriate values...for each board type...by using the associated thumbwheel switches on the control panel. There is a separate set of switches for each board type. The pre-set values for a board type can be changed any time during the operation, if desired.

The available switches for each board type are briefly described below:

Minimum acceptable length (MAL)  Production personnel use these switches to set the minimum acceptable length of the board.

For example, a 2x4 may have to have at least 8 feet of good board before it is considered an acceptable 2x4.

Minimum width (WIDTH)  These switches set the value for the minimum acceptable width of the board type.

For example, a 2x4 may have to be at least 3.75 inches wide before it is considered a valid 2x4.

These switches are used in conjunction with the RANGE switches to define the total width tolerance of the board.

Width range (RANGE)  These switches define the maximum deviation allowed for the width of the board.
The range and minimum width switches are used together to set the total tolerance for the board width.

For instance, in setting up tolerances for a 2x4, production personnel may set minimum width at 3.75 inches and range at .25 inches. Because this setting means a tolerance of +.25 and -0, then any board that was in the range of 3.75 inches to 4.00 inches would be considered a valid 2x4.

<table>
<thead>
<tr>
<th>Switches</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top nailing surface (TNS)</td>
<td>These switches are used to define the proper value for the top nailing surface of the board (TNS is that portion of board width at or above a specified thickness).</td>
</tr>
<tr>
<td>Thickness (THICKNESS)</td>
<td>There are two sets of these switches: one set for 1-inch boards, the other set for 2-inch boards. These switches set the minimum acceptable thickness (or height) of the board. For example, the switch may be set at 1.75 inches as the minimum rough green size that will be accepted for a 2-inch board.</td>
</tr>
<tr>
<td>Minimum thickness (MT)</td>
<td>One set of switches that sets the minimum thickness a board must be before the system recognizes the board. In effect, this is set for acceptable wane. For example, if the minimum thickness of each board type must be at least 0.6&quot;, then this value must be set in.</td>
</tr>
<tr>
<td>Maximum defects (DEF)</td>
<td>There is a set of these switches for each board type. The system saves the largest good board and slashes the rest. However, if the bad piece is small (that is, has less than the maximum defects allowed)...and is not in danger of breaking or separating during handling...then the entire board may be processed and the bad section removed later. Whether or not this is allowed, however, is dependent on how the system is set up when initially purchased. The maximum defects switches set the maximum length of the defect that will be allowed.</td>
</tr>
</tbody>
</table>
The remaining controls on the control panel are concerned with the extensive diagnostic capabilities built into the system.

**Hardware**

The Trim-Izer Scanner/Control System hardware (physical components) consists of four main elements: scanners, shaft encoder, computer, and control panel.

**Scanners**

Multiple "scanners" look at each board as it passes along the green chain. Each scanner looks at the board's thickness, width, etc.

Each scanning unit has a microprocessor so that the information seen by the scanner can be analyzed and then transformed into a signal that can be read by the main computer. These signals are then sent to the computer.

In order to get a good look at the board, scanners are mounted at 1-foot intervals along the path of the board. There may be up to 32 of these scanners in a system depending on such factors as spacing, number of saws, etc.

One advantage of scanners is that they never touch the board...they are a non-contact device. Thus, problems with mechanical wear and friction are eliminated.

Another advantage of the scanners is that they are completely interchangeable...making troubleshooting and repairs easier, and eliminating the need for carrying more than one or two spare scanners in your repair kit.

**Shaft encoder**

The shaft encoder measures the rotation of the shaft driving the feed chain. Thus, it electronically reads the distance it takes the board to pass through the entire scanning area. The shaft encoder provides pulses that are used by the scanner to measure the width of the board; i.e., one measurement for every 1/32" of forward travel.

**Master processor**

The master processor is the "heart" of the system. It takes information from the scanners, analyzes it, determines the most efficient way to cut the board, and then tells the saws when to drop.
As the board moves from the scanners toward the saws, the processor analyzes the data sent from the scanners along with the specification data (parameters) taken from the control panel. Based upon this, the processor decides which saw profile will properly trim the board.

When the board reaches the proper point, the processor actuates the relays which control the appropriate saws, and they drop...trimming the board properly.

A self-checking feature periodically asks each scanner if it is operating properly. If the answer is "no", then the processor warns the operator by activating the appropriate light on the panel.

This panel contains all of the controls and indicators needed to run...and troubleshoot...the system.

Controls on the panel let production personnel set the values (parameters) for each board type. Personnel can change board specifications and they will then be read by the processor whenever production personnel decide to reset the system.

During processing, a series of lights show personnel which saws will drop when the board reaches them. At any time, personnel can push one switch to override the system and exercise manual control.

When in the "troubleshooting" (diagnostic) mode of operation, personnel can have the processor run internal tests to isolate malfunctions so that downtime is held to a minimum.

Software

Any computer must be told what to do...and how to do it. This is done by loading in a series of step-by-step instructions called a "program." All computer programs are referred to collectively as the "software." The software is invisible to the user of the system...although mill personnel can select certain programs to run the computer during troubleshooting.

Morvue Electronics has written two types of software for the Trim-Izer Scanner/Control system...operating software...and diagnostic software.

Operating software This software consists of the instructions that run the computer...and the system...during normal trimming operations. It also handles the reporting functions.
All jobs done by the computer are controlled by this software...such as asking the scanners if they are operating...analyzing the board by using information from the scanners and values from the control panel...and telling the saws when to drop.

Data from the board processing operation is sent to a terminal. This data includes information from the scanners and reporting data such as: number of boards processed, length of first and second boards, and downtime reports. From this information, reports can be selected according to the needs of the individual mill.

Diagnostic software

This software consists of the instructions used by the computer during the troubleshooting (or "diagnostic") mode of operation.

The idea behind this software design is to offer an extremely reliable system. Software takes full advantage of the computer's power...using it to check itself and all other system components.

These diagnostic programs are arranged in a "tree" structure. By following the steps in the Operator's Manual, production personnel can run programs in an efficient pattern so that the problem can be quickly defined.

In order to help mill personnel find a problem ...and/or decide which program to run next... display lights on the control console light up in various patterns which tell personnel what to do next.

Operating Cycle

Before the boards are fed into the Trim-Izer Scanner/Control System, an operator must make sure that each board is even ended and wane side up.

As each board approaches the scanning area, it is raised about 1/4 inch above the level of the feed chain and then slides along a series of reference plates (one for each scanner). These plates remain in a known position so that each scanner always knows where the bottom of the board is.

As the board passes beneath the scanners, variations in thickness from the standard are measured.

Each individual scanning area is a spot about 1/8 inch wide and 1-1/4 inches long. Note, however, that these dimensions are averaged so that splinters, etc. do not adversely affect the readings. As the board passes through these individual areas, thickness information about the board's top surface is read by each scanner. The microprocessor in each scanner then analyzes the information. It then converts the analog signal into a digital value that can be read by the computer (central processor).
The shaft encoder measures the rotation of the shaft driving the green chain. Thus, it electronically reads the distance it takes the board to pass through the entire scanning area. The shaft encoder provides pulses that are used by the scanner to measure the width of the board.

As the board moves from the scanning area towards the saws, the computer (central processor) analyzes the data from all scanners and from the shaft encoder. Based on this data, it assembles a mathematical profile of the board which includes the width and thickness at each scan point and the length of usable board.

The computer uses this mathematical profile to determine which saw profile will trim the board properly. Once the board reaches the appropriate point, the computer actuates relays controlling the selected saws, and they drop. All saws will drop except in the area where a good board length is found.

At any time during the operating cycle, mill personnel can use a manual override to override the electronic system so they can go back to manual operation. However, when this manual override is pressed, it overrides the selection for only one board.

The AUTO/MANUAL switch on the control panel is used to activate or remove computer controls for all boards processed.

Operating Software

The software that runs the computer during normal board processing must be able to determine:

- Beginning and end of each board
- Type of board (1x8 or 1x10, etc.)
- If board is a valid board
- If one or more valid board lengths are present
- Which saws are to be dropped

Beginning and End of Each Board

Under control of Morvue's software, the computer begins by inspecting data from the scanners. It first analyzes scanner 0 to see if it saw a board. If it did not, then the computer analyzes scanner 1 to see if it saw a board. This process continues until the computer finds a scanner that sees a board. This is then marked as the "start" of the board.

The computer next analyzes the last scanner. If this scanner does not see a board, then the computer analyzes the next to the last scanner. This process of analyzing scanners in reverse order continues until the computer finds a scanner that saw a board. This is then marked as the "end" of the board.

Once the start and end of the board has been found, the computer can ignore all scanners that did not see the board. It is ready for the next step...analyzing the scanners that saw the board in order to find out the true board type.
Type of Board

The computer must now find the "true" board type. It analyzes the data from each scanner between the "start" and "end" of the board. The computer keeps track of the information and compiles a table that looks something like that shown below:

<table>
<thead>
<tr>
<th>SCANNER</th>
<th>HEIGHT</th>
<th>WIDTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>START</td>
<td>0</td>
<td>1&quot;</td>
</tr>
<tr>
<td>1</td>
<td>1&quot;</td>
<td>6&quot;</td>
</tr>
<tr>
<td>2</td>
<td>2&quot;</td>
<td>6&quot;</td>
</tr>
<tr>
<td>3</td>
<td>2&quot;</td>
<td>8&quot;</td>
</tr>
<tr>
<td>4</td>
<td>2&quot;</td>
<td>8&quot;</td>
</tr>
<tr>
<td>5</td>
<td>2&quot;</td>
<td>8&quot;</td>
</tr>
<tr>
<td>END</td>
<td>6</td>
<td>2&quot;</td>
</tr>
</tbody>
</table>

The computer now looks at the "table" and finds the greatest height and the greatest width. It does this because green boards are cut by machine and it is assumed that the largest values found truly represent what the machine wanted the board to be.

In the above example, the largest height found is 2" and the largest width is 8". Therefore, the computer assumes that the board type is a 2x8.

At this point, the computer knows that any part of the board...as seen by scanners...that is not at least 2" high and 8" wide must be a defect of some kind.

Finding the Defect

The computer now takes the true board type (in our example, a 2x8) and compares it with the information from each scanner. If a scanner saw a true board, then the computer enters "1"; but if a scanner does not find a true board type, then it enters a 0. The result shows which portion of the board is a bad section as shown below. (The previous illustration is repeated to the right for reference.)

<table>
<thead>
<tr>
<th>BOARD</th>
<th>SCANNER</th>
<th>HEIGHT</th>
<th>WIDTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start</td>
<td>START 0</td>
<td>1&quot;</td>
<td>4&quot;</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>1&quot;</td>
<td>6&quot;</td>
</tr>
<tr>
<td>0</td>
<td>2</td>
<td>2&quot;</td>
<td>6&quot;</td>
</tr>
<tr>
<td>1</td>
<td>3</td>
<td>2&quot;</td>
<td>8&quot;</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
<td>2&quot;</td>
<td>8&quot;</td>
</tr>
<tr>
<td>1</td>
<td>5</td>
<td>2&quot;</td>
<td>8&quot;</td>
</tr>
<tr>
<td>End</td>
<td>END 6</td>
<td>2&quot;</td>
<td>8&quot;</td>
</tr>
</tbody>
</table>

Finding Valid Board Length

As shown in the figure below, the computer has made an internal chart showing all good portions of the board (represented by 1's)...and all bad portions of the board (represented by 0's).
At this point, the computer compares each good portion with the minimum acceptable length (MAL) set up by the operator. If the section is equal to or greater than the MAL, then it is considered a "valid" board length. If it is less than the MAL, it is considered to be an "invalid" board length.

The portion of the program that does this comparison must be modified to reflect the actual physical distance between scanners at the customer's installation. In addition, if needed, Morvue will modify this program if a movable fence is attached to the trim line.

Up until now the computer has been analyzing the board to find out the type of board, defects in the board, and portions of good board that are within the specified minimum acceptable length.

The final step is to tell the saws where to cut.

Telling Saws How to Cut

There are three available cutting methods. Although only one of the three methods can be used on any given system, the customer has the option of deciding which method he wants.

The three methods are:

- Cut out the single largest valid length.
- Cut out the two largest valid lengths (this assumes there are a number of defective sections between the valid lengths).
- Cut out a single rough board containing two valid lengths separated by a small number of defective board sections.

Method 1 - Find the largest length

When this method is used, the computer finds the largest length of valid board. It then takes the number of the "start" and "end" scanners of this board length and uses this information to tell the saws where to cut.

Method 2 - Find the two largest lengths

The same procedure used in Method 1 is followed to find the largest board length. The computer then finds the next largest length. The "start" and "end" scanner numbers for both board lengths are then used by the computer to tell the saws where to cut.
In effect, the system cuts out one "bad" section between two "good" board lengths, resulting in two good boards.

Method 3 - Finding largest length with minimum defect
The same procedure used in Method 1 is followed to find the largest board length. The computer then looks for a board next to the largest board...but separated by a defective piece. It then analyzes the defective piece to see if it is within the tolerance specified by the operator. If it is within the tolerance, then the "end" scanner number (or the "start" scanner number) of the first board is changed to the "end" scanner number of the second board. In effect, the scanner numbers now reflect a single board...consisting of the first board, the defective piece, and the second board.

With this method, a board with a small defect can be processed at maximum length and the bad piece cut out after drying and planing.