

## **LATEST ADVANCES IN SAWMILLING**

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### **ABSTRACT**

This paper highlights the most significant recent developments for the optimization of small log processing. The topics discussed include: log debarking, three-dimensional scanning for optimizing sawing decisions; advances in bandsawing equipment; the use of optical scanning and circular sawing equipment for curve sawing; and application of thin, spline arbor guided saw blades and variable thickness saw blades. Originally developed for small conifer logs, this technology can be adapted for processing fast-grown plantation *Eucalyptus*.

### **INTRODUCTION**

Never before has the pressure been greater to maximize recovery in the wood industry. As the supply of logs decreases and prices go up, the industry faces continued pressure to improve its operating margins. With the advent of growing competition from a global economy, only those companies which are able to get the most out of their raw materials and can quickly adapt to the marketplace will survive.

Optimization of the primary log breakdown process requires accurate measurement, positioning, and transport of logs, cants and boards during processing, as well as optimum sawing decisions and narrow kerf accurate sawing. This article highlights recent developments in the technology of small log processing including: log debarking; scanning and optimization of the primary log breakdown; and associated equipment. The emphasis is placed on band sawing and circular sawing systems used in North America. Although this technology was developed for small conifer logs, it can also be adapted to processing young plantation-grown *Eucalyptus* (20).

### **ADVANCES IN THE TECHNOLOGY OF DEBARKING LOGS**

A variety of debarkers have been used including hydraulic debarkers, drum debarkers, rosserhead and mechanical ring debarkers (6, 22, 23). The mechanical ring debarker is the type most commonly in use in sawmills currently. It is characterized by feed rates up to 125 m/min, and the ability to debark a wide range of log species, of varying diameter and length, and under various operating conditions (green, dry), with minimal fiber loss and log end damage (6).

Debarking of several eucalyptus species has been investigated by Krilov (10). He concluded that the design of a small-size hydraulic debarker is feasible and should be a commercially viable proposition.

Any debarker should be set up to operate at the lowest practical feed speed and the greatest feeding efficiency. According to Dickinson (6) an industry average of 60% indicates that the majority of ring debarkers are running at higher feed speeds than needed to make up for idle time.

Improvements have been also made in noise reduction (as much as 17 dbA) by use of a rosserhead debarker with a staggered arrangement of cutters and reduced operating speed (3).

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## ADVANCES IN SCANNING TECHNOLOGY AND PROCESS OPTIMIZATION

The greatest opportunity for maximizing yield when processing logs into lumber is in the area of accurate determination of log shape and quality, and optimization of sawing decisions. Early log scanning systems measured logs in either one or two planes, and the log was modeled as a "truncated frustum of the cone" with circular diameters, length and a measured taper rate. With the emergence of precision log transport systems, it has been possible to precisely measure not only the vertical and horizontal log dimensions, but also the true log edge positions with respect to the machine center and datum lines. It is now also possible to rotate the log for best recovery or value.

For example, Porter Engineering Ltd. of Richmond, S.C., Canada has developed real time software, Real Time for Real Trees (RT<sup>2</sup>) for canters, end-doggers, Chip-n-Saws TM, twin and quad band mill primary breakdown systems. These programs feature full graphic displays for the operator and accurate true shape computer modeling of each log in three dimensions. A special version of RT<sup>2</sup> is used to automatically rotate the log for an additional increase in recovery. RT<sup>2</sup> has also been developed for optimum bucking applications, taking into account Sweep, Crook, and Rotation.

In recent years, many companies, primarily in North America, have become involved in three-dimensional scanning (6, 9). The most sophisticated scanning systems can now scan logs for shape and provide full three-dimensional images from which computers can calculate the best rotational axis and optimum sawing solution for each log.

The Coe Manufacturing Company of Tigard, Oregon, has recently introduced the Halo Scanner to their line of 3D log scanning systems. This scanner utilizes a ring of lasers to precisely measure the shape of a log as it passes longitudinally through the scanner ring. This shape information is passed to the Coe 3D Log Optimizer which in real time determines the log breakdown solution with the highest value or volume. At a recent sharp chain installation, the Halo Scanner is operating at over 16 logs per minute. According to the company, recovery improvement can range from 2% to 5% over conventional 2-axis scanning, depending on log shape and diameter.

There are also several methods of defect detection inside logs that are either currently in use (e.g. Tina Scanner for log sorting in Sweden) or being tested. These methods are gamma radiation, microwaves, x-ray computed tomography and nuclear magnetic resonance (17).

However, even with perfect knowledge of log shape and quality we are still faced with the problem of what the primary and secondary log breakdown equipment will do to the lumber recovery. Operating principles of different small log sawing systems, and their influence on lumber recovery and production rates, have been described elsewhere (11,13,21).

There have been significant developments in scanning systems for the optimization of board edging and trimming. Scanning is now being done at production speed, and the trend is to maximize profile resolution and measurement accuracy, while minimizing the number of scanning components per profile. Gains in yield are substantial. For example, an edger optimizer can consistently achieve 85-95 percent volume recovery at speeds up to 200 m/min (22). The value recovery can be further increased with the use of automated defect detection system. In one application, an xray edger optimizer outperforms "manual" sawing by 22 percent (2).

A very recent innovation is the X-ray Lumber Gauge (XLG) developed by Newnes Machine Ltd., of Salmon Arm, S.C., Canada. This Lumber Gauge uses X-rays to measure the density profile of lumber and accurately predicts the bending, tensile strengths and MOE (stiffness). The XLG is used to produce MSR (Machine Stress Rated) and MEL (Machine Evaluated) lumber. According to Newnes Machinery the non-contact X-ray measuring technique is more precise than conventional mechanical devices. It also allows variable speeds of throughput, and reduces maintenance requirements as well.

## ADVANCES IN SAWING EQUIPMENT

## **New Band Sawing Equipment**

An innovative development in headrig design is the "rotary headrig," installed in the Jordan Lumber Company, Mt. Gilead, North Carolina, U.S.A. (12). This headrig consists of a rotary carriage and traveling bandmill. Its triangular shaped carriage has three log processing stations: clamping, scanning, and sawing. After each log has been clamped, the carriage rotates 120 degrees to the top position where the log is scanned. Then the carriage rotates another 120 degrees and the log is sawn with a traveling double-cut bandmill. The rotary headrig increased the recovery of the Jordan Lumber sawmill by more than 38% over the previously installed Chip-n-Saw headrig, and is capable of processing 300 to 400 logs per hour.

Another innovative design is the CETEC (formerly Ceypan) bandmill, patented by Seneca Systems, Inc., Eugene, Oregon, and manufactured by Denis Comact Company, St-Georges du Beuce, Quebec, Canada. The CETEC bandmill incorporates a double column narrow configuration bandmill with an automatic control of positioning and tensioning of the saw. The bandmill features an ultra-sensitive closed loop automatic strain (axial tension) control, which provides rapid response while maintaining constant strain, and a saw kerf of 0.125 inch with sawing accuracy of 0.002 incho. The bandmill can be mounted vertically or horizontally, or tilted, and can be used as single-cut, double-cut, twin, quad or resaw.

## **Innovations in Circular Sawing Equipment**

There have been interesting developments in the design of circular sawing equipment (16,22). For example, Ari Company of Ornskoldsvik, Sweden, developed a system for curve sawing of cants with guided spline arbor circular saws, using Kockums scanning and optimization system. A similar curve sawing system is offered by Schurman of Woodland, Washington and Applied Theory of Corvallis, Oregon. While the Kockums/Ari system allows variable sweep within a cant, the Schurman/Applied Theory systems allows only a single arc to be followed (11).

Curve sawing, a technique developed in Scandinavia, follows the natural curvature (or sweep) of the log, and results in greater yield from each cant. Investigations made by the Swedish Forest Products Research Laboratory show that, in addition to greater volume, curve sawing produces higher quality lumber in comparison to straight sawing (18).

## **DEVELOPMENTS IN CIRCULAR AND BAND SAW DESIGN AND OPERATION**

### **Band Saw Design and Operation**

The general practice in the industry has been to select saws on the basis of past experience or by an expensive trial and error process. Due to extensive research on saw dynamics, however, it is now possible to design both circular and band saws on the basis of sound engineering principles (15,16).

For band saw design, the saw blade thickness, width, amount of axial tension ("strain"), degree of tensioning, back crown, and wheel tilting must all be considered. Major considerations in any attempt to optimize saw design are saw vibration and stability during operation. The University of California has developed a band saw computer program that can be used to calculate the affect of design and process parameters on the natural frequency of vibration. Basic considerations in the selection of a bandmill has been discussed by Allen (1).

At present, the trend is to apply high "strain" and to use computerized monitoring of band saw displacements and control of feed speed. Also, Stellite tipping of band saws has become increasingly popular.

### **Developments in Circular Saw Design**

In the case of circular saws, computer software for calculating critical speeds of the saw blade, based on design and operation variables, has been available for more than decade. It is now possible to design circular saws and predict their performance on a personal computer using, for example, a CSAW program (15).

Two types of circular saw designs that allow the most substantial reduction in kerf losses are guided spline arbor saws, which are used in the sawmilling industry, and taper saws with large diameter collars, which are used for secondary processing, such as the manufacture of pencil slats (3, 16, 19).

### **Guided Spline Arbor Saws**

Most sawmills in North America resaw cants with spline arbor collarless saw blades with fluid-lubricated guides. Patented by AI Thrasher in 1972, circular saw guides serve to position the saw blade relative to the workpiece, to lubricate and cool the saw blade, to stiffen the saw blade against the transverse forces generated during sawing, and to dampen saw vibrations (16, 19). This sawing system allows the use of thin saw blades having a kerf width as small as 1.5 mm at a cutting depth of 88 mm and feed rate of 24 m/min. The use of multiple guiding systems has been shown to improve saw stability (19).

### **Variable Thickness Saw Blades**

Variable thickness circular saw blades - especially saw blades with thick central hubs and thin, tapered rims clamped in the center-were developed in the late 1950's to cut pencil slats (3). Today, circular saws with a kerf of 1.3 mm cut 80 mm square air-dried incense cedar blocks at speeds of 20 meters per minute.

This technology did not gain wide acceptance until recently (5). Three years ago, only two companies used saws similar to the pencil slat saw. Today, about 30 plants are using this saw design in the production process. These saws are tapered within the cutting zone, typically providing 0.5 mm total side clearance at the periphery and as little as 0.1 mm clearance at the base of the taper.

In addition to the tapered region, a thicker integral "hub" is added to the central part of the saw outside the cutting zone which significantly increases blade stiffness. However, one of its limitations is cost. The saw plate may be three times more expensive than a standard design having uniform thickness, and after tipping, the saw could cost 2.5 times as much.

Based on calculations, laboratory results, and sawmill tests, variable thickness circular saws are capable of making very large reductions in saw plate thickness and, consequently, in kerf losses. According to Bird (5), the kerf reductions for clamped saws range from 15% to as much as 40%. For spline arbor saws, plate thicknesses have been lowered 12% to 28%. It is anticipated that this design will make a useful contribution toward efforts to reduce kerf losses and to convert wood into useful products more efficiently. The circular saws discussed above were tipped with either Stellite or tungsten carbide.

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