USE OF ADVANCED HARDWOOD SAWMILL EQUIPMENT, AND DESIRED FEATURES FOR NEXT-GENERATION SYSTEMS

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INTRODUCTION

The hardwood sawmill industry is extremely important to the U.S. economy. This importance is demonstrated by the yearly consumption of over 13 billion board feet (BBF) of hardwood lumber produced in the U.S. (Hansen &West 1998). This material is the foundation of many value-adding industries worth tens of billions of dollars (U.S. Census Bureau 1999).

Many segments of the forest products industry have seen significant technological leaps in manufacturing. Engineered wood products have developed new production technologies and have adapted to an underutilized as well as a changing raw material base. The softwood lumber industry has adopted scanning and optimizing technology to improve manufacturing. These new technologies and new products are instrumental in meeting the increasing demand for wood products.

The hardwood lumber industry has not followed this trend, however. The hardwood sawmill industry, as a whole, has not readily adopted advancements in sawmill technology. This leaves a great deal of room for improvement in the hardwood sawmill industry.

The demographics of the hardwood sawmill industry may in part drive this reluctance to adopt new technology. Despite the recent trend toward consolidation in the industry, a significant number of hardwood sawmills are small. Companies of this nature may not have the capital or the supporting market share to justify purchasing advanced technology equipment that can cost $500,000 to $600,000. However, a significant number of large- and medium-sized mills do exist, and are a potential market for hardwood sawmill technology. In addition, the existence of several manufacturers of commercial scanning and optimizing technology suggests that there is a

market for this equipment; however, this market is not well developed. A small segment of hardwood sawmills have adopted advanced scanning and optimizing technology such as edger-optimizers and trimmer-optimizers. As the names suggest, these technologies are designed to optimize (or partially optimize) production.

Slow adoption of this technology may also stem from the lack of quality market information supporting scanning and optimizing technology. To promote this technology, information about the customer is needed. First, the differences between those companies that adopt this technology and those that do not are unknown. From a marketing perspective, these differences need to be identified to better define the market. Second, several manufacturers produce scanning and optimizing equipment yielding similar yet different benefits. The hardwood sawmill industry's expectations from this technology must be understood. Third, the hardwood sawmill industry's expectations of the next generation of technology must be understood.

This information will provide scientists and developers of this technology with needed information to assist in the development and adoption of scanning and optimizing technology. Far too often, technology is developed without a clear understanding of the customers' (sawmillers') needs.

STUDY BACKGROUND

In the fall of 1999, researchers at Virginia Tech mailed a nationwide hardwood sawmill survey to over 2000 hardwood sawmills. These sawmills included both NHLA member and non-NHLA member companies. Four hundred and twenty-four useable responses were returned. The information collected from these surveys included general demographic information on the hardwood sawmill industry. In addition, information was collected on scanning and optimizing technology. These technology-related questions collected sawmill feedback on currently used edger-optimizers. They also answered questions on future systems, such as more advanced edger-optimizers and automated grading systems.

RESULTS

Industry Demographics

Overall, the demographic results suggested a trend toward larger production facilities. The average number of employees was 34 per sawmill. The average annual production for 1998 was 7.58 million BE Despite this relatively high mean production figure, the use of technology in the hardwood sawmill was limited.

Table 1 lists six common types of scanning and optimizing technology currently available for hardwood sawmills. The most prevalent technology was the headrig-optimizer in use by 27.1 percent of the respondents.

Table 1. Existing sawmill technology.

Existing Technology	Frequency	Percentage
Bucking-optimizer	2	0.5%
Headrig-optimizer	115	27.1%
Edger-optimizer	43	10.1%
Grade Mark Reader	18	4.2%
Trimmer-optimizer	19	4.5%
Automated Sorting	30	7.1%
Other	21	5.0%
(n = 395)		

Some of the more advanced technology, such as edger-optimizers and trimmer-optimizers, were only in use by 10.1 percent and 4.5 percent of the respondents, respectively. Nearly 73 percent of hardwood sawmills do not have any type of scanning and optimizing technology.

It is interesting to compare hourly production rates for those companies that had existing technology to those companies that did not (Figure 1). It is clear that most of the smaller producers did not have scanning and optimizing technology. Of those smaller producers that did have any of the surveyed technology, it was most often found to be headrig optimization.

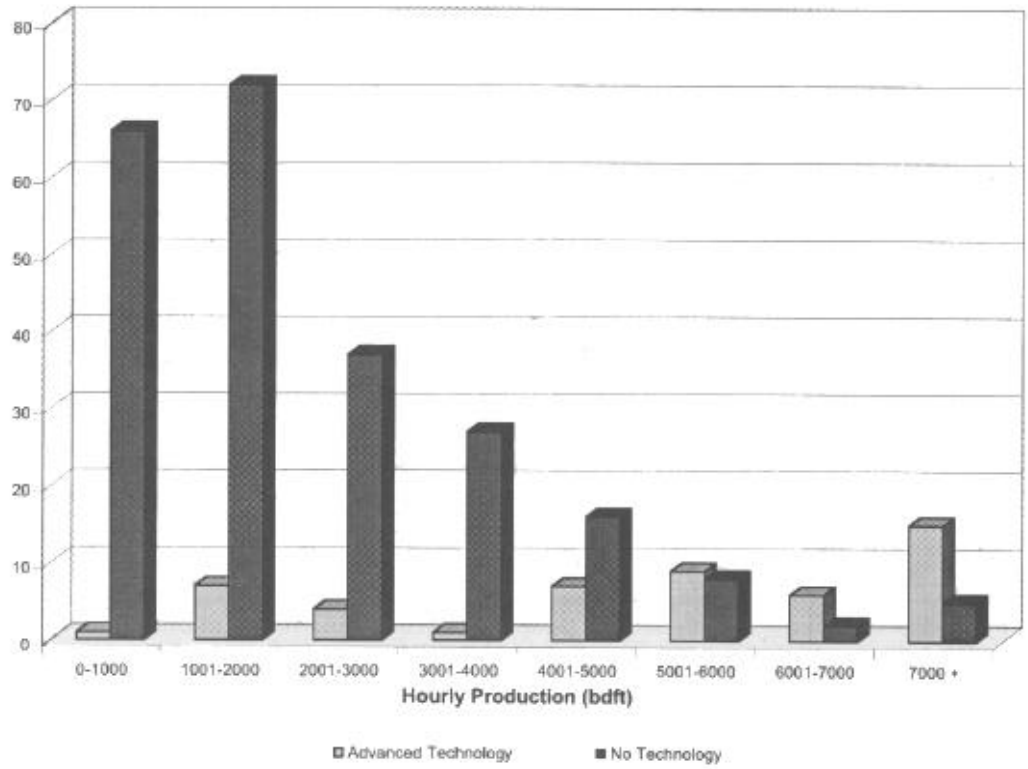

Figure 1. Hourly production comparison by existing technology.

Current and Future Scanning and Optimizing Technology

To better understand the industry's expectations of scanning and optimizing technology, information was collected on current edger-optimizer systems, future edger-optimizer systems, and future automated grading systems. Current edger-optimizer systems include systems that are commercially available today. These edger-optimizers only *partially optimize* based on size and wane information. Future edger-optimizer and future automated grading systems will *fully optimize* based on size, wane, and full defect information.

Current Edger-Optimizer Systems

The respondents were asked to rate factors important in edger-optimizer adoption. Two factors, *improved raw material recovery* and *increased lumber revenues*, were tied for the highest rating. The high rating of these two

factors demonstrates the importance of profit margins in the hardwood sawmill industry. To promote the adoption of this technology, manufacturers should focus their attention on these factors. *Advice from customers* and *advice from sales department* rated at the very bottom. In general, production-related factors were rated higher than non-production-related factors (Table 2).

Table 2. Factor importance in adopting current edger-optimizer systems

Factor	Rank	Mean Importance	Subsets (alpha = 0.05)						
Improved Raw Material Recovery	1	6.5	*						
Increased Lumber Revenues	2	6.5	*						
System Lifespan	3	6.0		*					
Improved Lumber Quality	4	5.9		*					
Ability to Upgrade	5	5.9		*					
Availability of Vendor Support	6	5.8		*					
Increased Production Levels	7	5.8		*					
Improved Lumber Consistency	8	5.7		*					
Ease of Use	9	5.7		*					
Initial Cost	10	5.7		*					
Maintenance Costs	11	5.2			*				
Existing Mill Layout Restrictions	12	5.2			*				
Training from Vendor	13	5.1			*				
Operational Costs	14	5.1			*				
Installation Down Time	15	4.8			*	*			
Advice from Production Supervisors	16	4.7				*	*		
Training of New Operators	17	4.6				*	*		
Advice from Customers	18	4.4					*	*	
New Mill Installation	19	4.1						*	
Advice from Sales Department	20	3.7							*

*** Asterisks indicate significantly different group means at an alpha level of 0.05 using Tukey's Honestly Significant Difference test for homogeneous subsets.**
(n = 355)

One factor, *initial cost,* was expected to be rated highly but fell into the second group. This result may be explained in part from discussions with the sawmill owners. Initial cost may present a barrier for the smaller mills; however, potential payback and gain from the technology is the larger issue.

In addition to the factors that the respondents thought were important, information was collected on what they would be willing to pay for an edger-optimizer. It was clearly stated that the price included the scanners, computers, and edger but *not* the material handling system. Nearly 50 percent chose the lowest cost category, *less than $100,000.* Only one company chose the highest cost category of *greater than $1,000,000.* This particular company has several pieces of hardwood sawmill technology including a headrig-optimizer, a trimmer-optimizer, a grade mark reader, and an automated sorting system. This may help explain their selection of the highest price category (Table 3).

Respondents were clustered to compare how they rated current edger-optimizer factors. These comparisons were large versus small companies, technology versus non-technology companies, and NHLA members versus

Table 3. Acceptable cost for current edger-optimizers.

Cost	Frequency	Percentage
Less than $100,000	179	49.4%
$100,001 - $250,000	94	26.0%
$250,001 - $500,000	56	15.5%
$500,001 - $1,000,000	32	8.8%
Greater than $1,000,000	1	0.3%
(n = 362)		

non-NHLA members. Company size was based on the number of employees, with 19 or fewer employees designating a small company and 20 or more employees designating a large company. Companies with technology were those that had systems such as *bucking-optimizers, headrig-optimizers, edger-optimizers, trimmer-optimizers, grade mark readers,* and *automated sorting* (Table 1). Finally, NHLA members were based on 1999 NHLA membership directory.

Large Versus Small Companies

Significant differences were found among 5 factors between small and large companies. Even though both large and small companies rated *improved raw material recovery* high, large companies rated it significantly higher than small companies. This may indicate that, with higher raw material costs and tighter profit margins, large companies consider the benefits of improved raw material recovery to be more critical than smaller companies.

Large companies also rated *increased lumber revenues* significantly higher than small companies. This is despite the fact that *increased lumber revenues* was the highest rated factor by small companies. This may demonstrate more urgency by the large companies. Large companies rated *availability of vendor support* significantly higher than small companies. This may, in-part, be due to newer or more sophisticated equipment or a larger array of equipment in large hardwood sawmills.

Larger companies rated *advice from production supervisors* higher. A possible cause may be that large companies are more likely to have a production supervisor on staff, while small companies have one person, such as the owner or sawmill manager, that plays multiple roles within the sawmill. This would make it more difficult to distinguish between job descriptions.

Finally, *training of new operators* was rated significantly higher by small companies. On this issue, the large companies may feel that they have the expertise on staff to deal with the training and operation requirements of new technology.

Technology Versus Non-Technology Companies

When comparing companies that have technology to companies that do not have technology, three significant differences were identified. Both *improved raw material recovery* and *increased lumber revenues* were rated significantly higher by companies with technology than by companies without technology. This is not surprising given that the companies with technology parallel the large companies, and the companies without technology parallel the small companies. Finally, companies without technology rated *initial cost* significantly higher. This is reasonable since initial cost could be the barrier preventing the adoption of technology by the small and non-technology companies.

NHLA Versus Non-NHLA Companies

Seven significant differences were found between the factor ratings of NHLA member and non-NHLA members. *Increased lumber revenues, improved raw material recovery,* and *availability of vendor support* were all rated significantly higher by NHLA members. This parallels the company size comparisons. *Initial cost* and *training from vendor* were also rated significantly different. Non-NHLA members rated initial cost higher, which likely represents small companies where cost is a barrier.

Finally, *operational costs* and *advice from production supervisors* were rated significantly different between the groups. *Operational costs* was rated higher by non-NHLA members, which are likely small companies where cost is a significant barrier.

Future Edger-Optimizer Systems

Similar information was collected for future edger-optimizer systems as was collected for the current edger-optimizer systems. The study participants were asked to consider future edger-optimizer systems that fully optimized based on complete defect information and on NHLA grading rules. When asked what features or abilities these new systems would need to have, *improved raw material recovery* and *increased lumber revenues* were selected most frequently. It was surprising to see, however, that *training from vendor* was selected the least amount of times. This may be different with companies that have technology (Table 4).

Table 4. Desired features in future edger-optimizer systems.

Feature	Frequency	Percentage
Improved Raw Material Recovery	333	78.5%
Increased Lumber Revenues	327	77.1%
Reliability	321	75.7%
Initial Costs	284	67.0%
Ease of Use	280	66.0%
Product Consistency	255	60.1%
Flexible Grade Programming	251	59.2%
Availability of Vendor Support	246	58.0%
Maintenance Costs	244	57.5%
Increased Production Levels	230	54.2%
Training from Vendor	218	51.4%
(n = 424)		

There was a large separation between *increased lumber revenues* and *increased production levels.* Often these two terms are considered as one in the same. This clear separation in frequencies may imply that the respondents understand that board upgrade is a key goal for increased revenues. Increased production with no attention to board upgrade may not necessarily increase revenues.

Based on the features that respondents thought were important, information was collected on whether the respondent would consider installing a future edger-optimizer. Thirty-two percent said they would not be interested in installing such technology while 68 percent said they would consider installing the technology. When asked what they would be willing to pay for future edger-optimizers, 37 percent chose the lowest cost category,

less than $100,000. Again, it was clearly stated that the price included the scanners, computers, and edger but not the material handling system. Only one company chose the highest cost category of *greater than $1,000,000* (Table 5). Overall, respondents may be willing to pay more for future systems versus current systems. They may consider total defect information to be more valuable.

Table 5. Acceptable cost for future edger-optimizers.

Cost	Frequency	Percentage
Less than $100,000	106	37.6%
$100,001 - $250,000	83	29.4%
$250,001 - $500,000	62	22.0%
$500,001 - $1,000,000	30	10.6%
Greater than $1,000,000	1	0.4%
(n = 282)		

Future Automated Hardwood Lumber Grading Systems

As with current edger-optimizers and future edger-optimizers, the study sought to identify the important factors and cost levels of automated grading systems. The respondent were asked to rate a number of factors that would be important for adopting future automated hardwood lumber grading systems. *Accuracy of grading* was rated the highest by a large margin (Table 6). Accuracy was rated significantly higher than the second-rated factor, *system lifespan.* This may demonstrate the hardwood sawmill industry's concern for such technology. The second- and third-rated factors, *system lifespan* and *durability,* demonstrate the importance of the durability of such an investment. *Color sorting capabilities* was rated last. As with the current edger-optimizer systems, *training from vendor* was rated near the bottom.

In addition to the factors that the respondents thought were important, information was collected on what they would be willing to pay for a future automated grading system. Again, it was clearly stated that the price included the scanners and computers but *not* the material handling system. Forty-eight percent chose the lowest cost category, *less than $100,000.* As with the current edger-optimizer systems question, this category may have been used as a default. Zero companies chose the highest cost category of *greater than $1,000,000.* Overall, these results were not much different than those from the current edger-optimizer or future edger-optimizer systems (Table 7).

Differences in automated hardwood grading factor ratings by groups were examined. These groups were organized by company size, company technology, and NHLA affiliation.

Large Versus Small Companies

Significant differences were found between three factors: *speed, training from vendor,* and *initial cost.* The rating for *speed* was significantly higher for large companies versus small companies. The high production rates of larger companies would require an automated grading system with speeds capable of handling high volumes and high feed rates.

Table 6. Factor ratings for future automated hardwood grading systems.

Factor	Rank	Mean Importance	Subsets (alpha = 0.05)						
Accuracy of Grading	1	6.6	*						
System Lifespan	2	5.9		*					
Durability	3	5.9		*	*				
NHLA Grading Rules	4	5.8		*	*	*			
Ability to Upgrade	5	5.8		*	*	*			
Initial Cost	6	5.8		*	*	*			
Reduction of Grading Costs	7	5.8		*	*	*	*		
Tallying Capabilities	8	5.8		*	*	*	*		
Simplicity of Operation	9	5.7		*	*	*	*		
Ease of Use	10	5.7		*	*	*	*		
Ability to Modify NHLA Grading Rules	11	5.7		*	*	*	*		
Availability of Vendor Support	12	5.6		*	*	*	*	*	
Speed	13	5.6			*	*	*	*	
Training from Vendor	14	5.5				*	*	*	
Ability to Quickly Switch Species	15	5.5				*	*	*	
Equipment Warranty	16	5.4					*	*	
Compatibility with Existing Equipment	17	5.4					*	*	
Sorting Capabilities	18	5.4					*	*	
Training of New Operators	19	5.3						*	
Color Sorting Capabilities	20	4.8							*

* Asterisks indicate significantly different group means at an alpha level of 0.05 using Tukey's Honestly Significant Difference test for homogeneous subsets.
(n = 359)

Table 7. Acceptable cost for future automated hardwood grading systems.

Cost	Frequency	Percentage
Less than $100,000	174	48.5%
$100,001 - $250,000	112	31.2%
$250,001 - $500,000	54	15.0%
$500,001 - $1,000,000	19	5.3%
Greater than $1,000,000	0	0.0%
(n = 359)		

Large companies also rated *training from vendor* significantly higher than small companies. This result was the exact opposite of the way large companies rated training issues related to current edger-optimizers. It is possible that these large companies felt comfortable with their current technical experience on existing technology but were uncertain about their expertise on future technology. It is also possible that smaller companies would not consider an automated hardwood grading system and saw no need for training. Finally, *initial cost* was rated significantly higher by small companies. Initial cost can be seen as a barrier to small companies.

Technology Versus Non-Technology Companies

Six significant differences were found between the technology and non-technology groups. *Accuracy of grading* was rated the highest by both technology and non-technology companies. However, it was rated signifi-

cantly higher by the technology group. This may represent existing experience with technology. The technology companies may understand that accuracy is key to successful optimization. Experience with technology may also explain why *ability to upgrade* was rated significantly higher by technology companies.

Speed, availability of vendor support, and *training from vendor* were all rated significantly higher by technology companies. Finally, *color sorting capabilities* was rated higher by technology companies. Many of the larger companies and companies with technology were vertically integrated. These companies often require color sorting and color matching capabilities.

NHLA Versus Non-NHLA Companies

Eight significant differences in factor ratings were found between NHLA-member and nonmember companies. As with the technology companies, *accuracy of grading* was significantly higher with NHLA members and was the highest rated factor. Interestingly, *ability to modify NHLA grading rules* was rated at 5.9. It was not surprising that it rated higher than the non-NHLA members since they may not use the rules; however, it may indicate some desire by NHLA members to modify the rules. This was further supported by several comments in the open-ended questions.

Tallying capabilities, availability of vendor support, speed, and *training from vendor* all were rated significantly higher by NHLA members. Finally, *initial cost* and *compatibility with existing equipment* were rated significantly higher by non-NHLA members. Again the non-NHLA members paralleled the smaller companies and initial cost is a significant barrier. Equipment compatibility can also be seen as a cost barrier based on modification expenses.

CONCLUSIONS

Several important findings from this study deserve reiteration. First, scanning and optimizing technology are not the norm—nearly 73 percent of hardwood sawmills do not have any type of scanning and optimizing technology. The most prevalent scanning and optimizing technology is headrig optimization. More advanced scanning and optimizing technologies such as edger-optimizers and trimmer-optimizers are found in 10 percent or fewer hardwood sawmills.

Sawmill expectations of technology were different between groups. Large and small companies viewed cost differently. Cost will always be a significant barrier for a segment (small mills) of the hardwood sawmill industry. Large companies viewed production issues as paramount. Instead of viewing technology as a way of improving the product or customer relations, larger companies view it from a production position.

Manufacturers of this technology need to focus on production issues since this is a major concern within the industry. However, manufactures need to demonstrate that the hardwood sawmill can gain more than just production volume from this technology. Upgrade, product quality, and customer service are important benefits of scanning and optimizing technology. Initial cost will be a barrier; however, payback is an important measure and must be clearly demonstrated to the hardwood sawmill industry.

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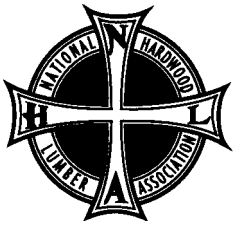

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