RESEARCH ON PRODUCING GREEN DIMENSION DIRECTLY FROM HARDWOOD LOGS

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ABSTRACT
Because of rising timber costs and an increasing demand for high-grade timber, suppliers of solid wood products need additional material options. We feel that European and Japanese processing concepts of producing green dimension and other clear material directly from logs could provide an answer. In this paper we present a brief overview of our research results on producing green dimension from logs. We include yield results, mill designs, and a look at the economics.

INTRODUCTION

With rising timber costs and increasing demand on our limited supply of high-grade timber resources, manufacturers and suppliers of solid wood products need additional material options. These options need to employ efficient processing methods, be economical, and use our very abundant medium and low-grade timber resources. To address these issues, we conducted a series of studies to determine the potential yields, production plant designs, and the economics of processing hardwood logs directly to green dimension.

The processing concept of producing green dimension, clear strips and clear boards is widely used in Europe and Japan. They skip the intermediate steps of lumber manufacturing, grading, trading, shipping, drying, and storage. We attempted to put an "American" styled system together to mimic the European and Japanese processing concepts. Our goal is to give producers enough information to start thinking about producing green dimension.

In the direct processing system (Figure 1), logs are sawn into flitches that mayor may not be rectangular pieces, depending on the sawing patterns used. These flitches are immediately cut into green rough dimension parts. The green parts are then dried and shipped to furniture makers, cabinet makers, and other users of solid wood parts. The dried parts can also be processed to edge-glued panels prior to shipping. The main advantage of the direct processing system is that it can efficiently use low and medium grade logs. We can capture some of the clear material that normally ends up as chips and we take defective areas and make them into green chips prior to drying.

In this paper, we will present a brief overview of our completed and published research on producing green dimension directly from logs. For more complete information, contact the authors or obtain copies of the following papers:

- Dimension yields from factory grade 2 and 3 red oak logs — Lin, Kline and Araman, 1994.
- Design and evaluation of log-to-dimension manufacturing systems using system simulation — Lin, Kline, Araman and Wiedenbeck, 1995.
- Producing hardwood dimension parts directly from logs: an economic feasibility study — Lin, Kline, Araman and Wiedenbeck, 1995.

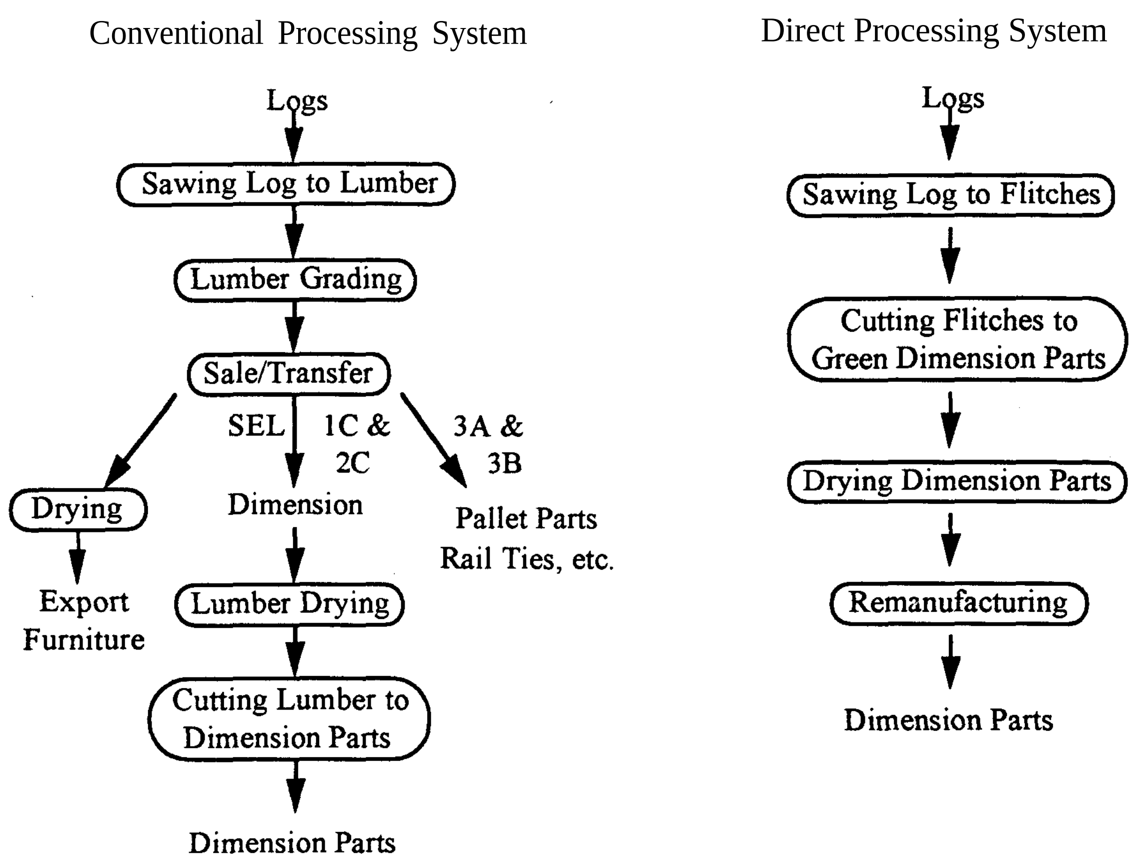

Figure 1. Comparison of the conventional processing system and the direct processing system.

DIMENSION YIELDS FROM FACTORY GRADE 2 AND 3 RED OAK LOGS

In this phase of our research the objective was to determine the potential cutting yields and value recovery of green dimension parts that can be attained directly from logs. In particular we focused on estimating yields and value recovery from both factory Grade 2 and 3 red oak logs. The effect of various processing configurations and cutting bills on yield and value recovery was also investigated.

The specific factors considered in this study included:

- Input log grade (Grade 2 vs. Grade 3)
- Log sawing pattern (live vs. five-part) (fig. 2)
- Different cutting bills (table 1)

Table 1. Cutting bills tested.

Cutting bill	Length category	Cutting length (in.)	Cutting Width (l-5 in.)
1	Mixture	15,18,21,25,29,33,38,45, 50,60,75	Random
2	Shorter	15,18,21,25,29,33	Random
3	Longer	38,45,50,60,75	Random

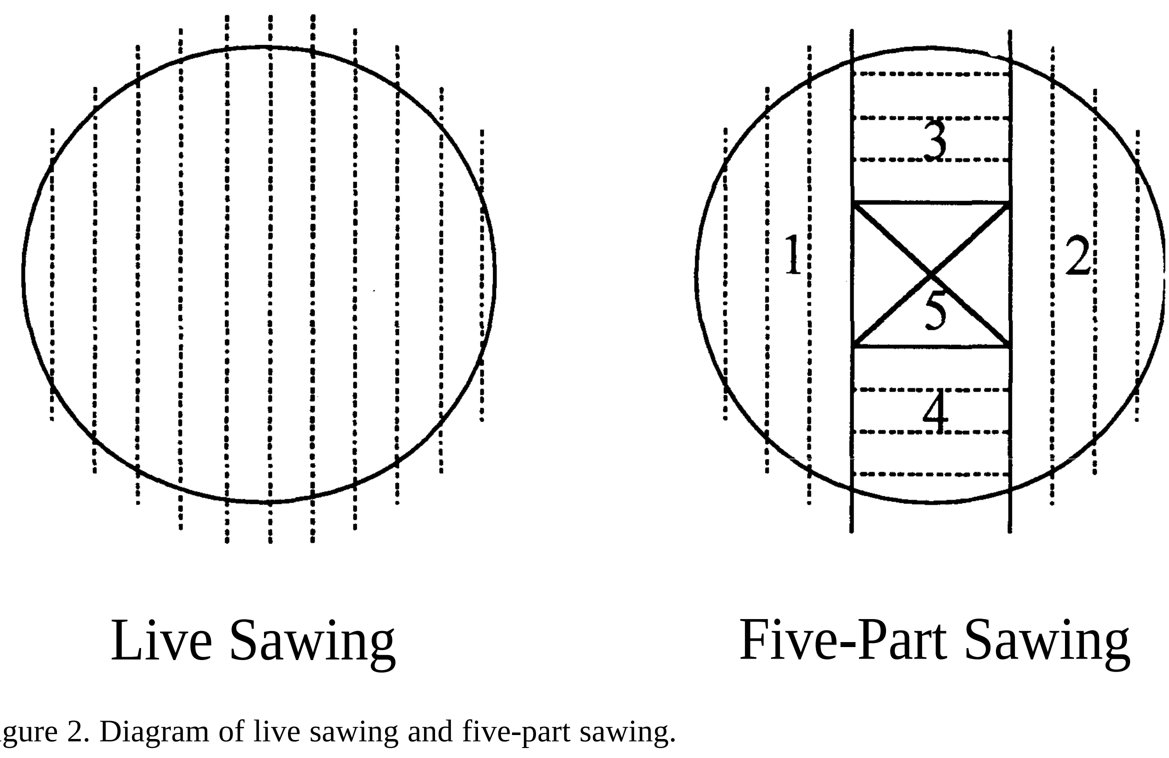

Figure 2. Diagram of live sawing and five-part sawing.

The direct processing system combines sawmill operations and rough mill operations. After producing boards as shown in Figure 2, we simulated producing parts to the three cutting bills by ripping the boards and then cross cutting the resulting strips. We then simulated cutting the same boards with crosscut-first processing. Note that the center cant from the five-part sawing was not used to make green dimension. The center cant was considered to be pallet material.

The overall yields of rough green dimension parts produced from Grade 2 and 3 red oak logs ranged from 52 to 78 percent. Varying from processing system configuration and cutting bill used, the average scaling yield of rough dimension parts ranged from 57.8 to 78.5 for Grade 2, and from 52.3 to 76.7 percent for Grade 3 red oak logs. Overall, 7 percent more dimension yield can be realized from Grade 2 logs over Grade 3 logs.

The value recoveries from Grade 2 and 3 red oak logs in parts, on the basis of scaling BF (International l/4-in.) log input, range from $1.34 to $1.65 for Grade 2 logs and from $1.06 to $1.37 for Grade 3 red oak logs. On the basis of log value, $1 of log input can produce a range from $3.62 to $4.45 value of products output for Grade 2 logs and from $8.82 to $11.39 value of products output for Grade 3 red oak logs. Although Grade 2 logs average 24 percent greater value recovery than Grade 3 logs on a log volume basis, Grade 2 logs average 60 percent less value recovery than Grade 3 logs on a log value basis. To determine the above values we used an average selling price of $2,200 per MBF for dry edge-glued red oak panels.

In considering processing configurations, the results of this part of our study show that the combination of live sawing and rip-first can provide the highest value recovery among the four combinations of sawing patterns and cutting sequences tested, Results indicate that the combined cutting bill with long and short cuttings provides the best yields. With proper processing technology and management techniques, a green dimension processing system can offer a promising alternative in value added processing of lower grade timber resources.

DESIGN AND EVALUATION OF LOG-TO-DIMENSION MANUFACTURING SYSTEMS USING SYSTEM SIMULATION

The ideal way to investigate the operational performance of a manufacturing system is to experiment with a real manufacturing plant. However, since actual dimension plants that process hardwood logs directly into parts are not available for testing, system simulation provides an alternative way to experiment with a direct-processing system. This give us the ability to test different plant designs with different material inputs and outputs.

For this brief presentation of our study, we will just show and present the simulation results for Plant Design #3 (Figure 3). This plant was configured to use five-part sawing and gang-rip-first cutting. After a number of flitches are cut from the two opposite faces of each log (parts 1 and 2 in Figure 2), the remainder of this log then proceeds to the gang-resaw where it is cut into a number of flitches (parts 3 and 4, 4-inches wide) and a 4 by 4-inch cant (part 5). All flitches then go through the edge saw and the planer, and are cut into rough green dimension parts using one gang-ripsaw and six chop saws.

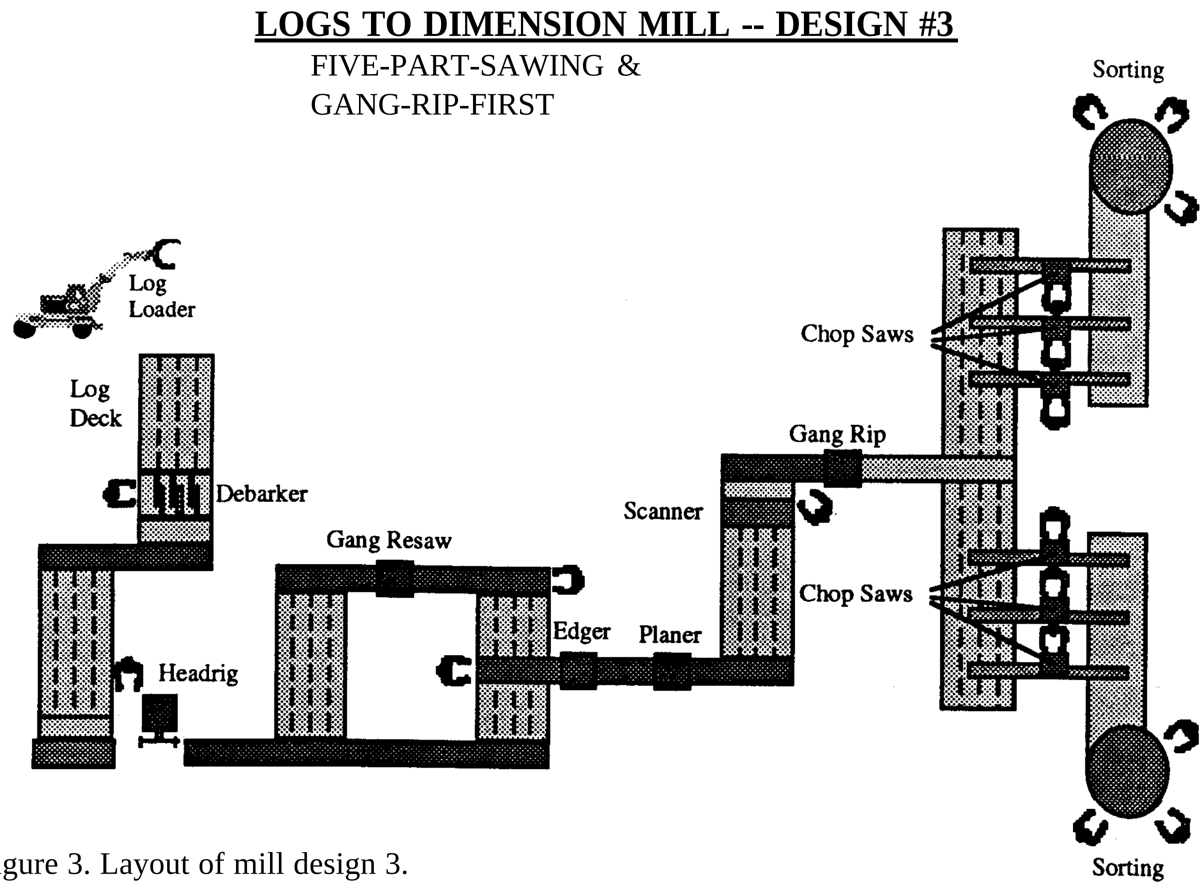

Figure 3. Layout of mill design 3.

In Mill Design #3, our simulation model says that we can produce 14.6 MBF/shift in green parts from 21 MBF of Grade 2 logs, and 11.2 MBF/shift in green parts from 17.9 MBF of Grade 3 logs. The model also shows that when processing Grade 2 logs, the gang-ripsaw is the bottleneck limiting higher production. When processing Grade 3 logs, the gang-ripsaw once again limits higher production levels. The edging saw is next on the list as holding back greater production levels. The headrig operator is the limiting factor as far as labor utilization.

We then added an additional gang-ripsaw to the plant layout. That increased the production rates 46 percent when using Grade 2 logs and 27 percent when using Grade 3 logs. The headrig was now the equipment bottleneck.

Results from the other designs are presented in the referenced papers.

PRODUCING HARDWOOD DIMENSION PARTS DIRECTLY FROM LOGS: AN ECONOMIC FEASIBILITY STUDY

We then conducted an economic feasibility and profitability study of a direct processing system for converting Factory Grade 2 and 3 red oak logs directly into green and then on to dry dimension parts.

Net present value (NPV) and internal rate of return (IRR) were used as the measurement of profitability. NPV and IRR were estimated based on the predicted after-tax cash flow for a 10-year period.

The results indicated that converting Grade 2 and Grade 3 red oak logs directly into green and then dry rough dimension parts is economically feasible. Under a set of assumptions, an initial capital expenditure of $5.25 million will be needed to build a complete mill using Design #3 (Figure 3), with the drying, storage, and remanufacturing facilities to process Grade 2 logs to dry parts. This plant will generate a $4.43 million NPV with an IRR of 27.5 percent. An initial investment of $4.42 million will be needed to build a smaller plant to process Grade 3 red oak logs. This mill will generate a $3.93 million NPV with an IRR of 28.2 percent.

The logs-to-parts mills could be more profitable than current sawmills and dimension plants according to Dun and Bradstreet's annual report on key business ratios. The predicted return on sales (ROS) values of the direct processing mills are 7 to 12 percent higher than the average upper quartile ROS values achieved by the hardwood sawmill industry and by the hardwood dimension industry from 1989 to 1992.

A sensitivity analysis indicates that dry dimension part price, green cutting yield, and drying degrade and remanufacturing losses are the three most important factors affecting the economic feasibility and profitability of the direct processing systems. If the drying degrade and remanufacturing loss is too high, the proposed direct processing system with drying and remanufacturing may not be able to achieve its high profit potential. Much higher log prices and lower dimension prices can also drastically reduce the promising potential for direct processing of logs to dimension.

SOME FINAL WORDS

Because of rising timber costs and an increasing demand for high-grade timber, suppliers of solid wood products need additional material options. We feel that the direct processing of logs to green and then dry dimension concept presented in this paper is one answer to these problems. We use more abundant Grade 2 and 3 red oak logs. We can use "American" styled processing plants. We have shown that the yields in parts can be quite high and that the economics are very attractive.

We do have a couple marketing cautions. Make sure that you have a strong customer base and they understand the product you will be shipping. Your product, while being made from Grade 2 and 3 logs using our suggested processing, will be mixed grain and not always straight grained. Some customers may desire straighter grain material. Unless you sort your material to achieve the straighter grain, you will need higher grade logs. Also push the standard size dimension concept, it would do wonders for production control and higher yields through the proposed plant.

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Advances in Hardwood Utilization: Following Profitability from the Woods Through Rough Dimension

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