Draft: 16-September-21

LORCAT: An easy-to-use Hardwood Log Recovery Analysis Tool

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Abstract

The LOg ReCovery Analysis Tool (LORCAT) was developed to enable anyone involved in the breakdown of logs to examine the consequences of changing the many interdependent factors that influence hardwood log recovery. LORCAT is a spreadsheet-based software based on the Microsoft Excel®[1] or LibreOffice® spreadsheet applications. LORCAT allows users to interactively view the results from the breakdown of a single log or view aggregated results using the results from the breakdown of hundreds of logs. LORCAT reports the expected total number and volume of lumber and cants produced and the projected recovery by National Hardwood Lumber Association grade once users entered log size and grade information along with the pertinent sawing parameters. LORCAT also enables users to estimate the economics of sawing logs using their own set-up and to find the most profitable solution.

Keywords: sawmill, yield, log recovery, simulation, hardwood

Introduction

Numerous factors influence product recovery and efficiency in hardwood sawmills. Some factors relate to the geometric and quality characteristics of the logs processed; others to processing details such as kerf size, sawing variation, or sawing strategy. Also, the geometric dimensions and the type of products sawn impact recovery yield. Examining and developing an understanding of the inter-relationships among these numerous interdependent factors is the key to maximizing yield and profit for every sawmill operation.

Lumber recovery is affected by factors relating to log features (species, diameter, length, taper, and grade), sawmill parameters (kerf width and sawing variation), and recovery goals (sawing strategy, green and kiln dry-dressed lumber size) (Steele 1984, Lin et al. 2011). These factors, due to variances in log resource, processing parameters, and recovery goals, are rarely consistent from mill to mill (Steele 1984).

Given the importance of all these factors and their interrelated interaction on mill profitability, numerous sawmill simulation tools to help sawmill managers explore the impact of these settings on mill operations have been created. However, these analysis tools typically require extensive mill data and possibly specialized training to accomplish even minor analyses. The newly developed Log Recovery Analysis Tool (LORCAT) was designed to avoid the complexities of past tools by being straightforward to set-up and use with easily understood results.

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1 The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the U.S. Department of Agriculture or the Forest Service of any product or service to the exclusion of others that may be suitable.

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About the Tool

LORCAT simulates the sawing of logs using one of three common sawing methods. The first method simulates sawing logs to a cant with a specified size (e.g., 6 in x 4 in; Figure 1a). The second method simulates using a gang-resaw to saw the cant produced from sawing the first two faces into lumber (Figure 1b). The third method simulates the European method of live or flitch sawing where the log is sawn through-and-through (Figure 1c). Users can select the method and all sawing parameters to suit their operation or their analysis needs.

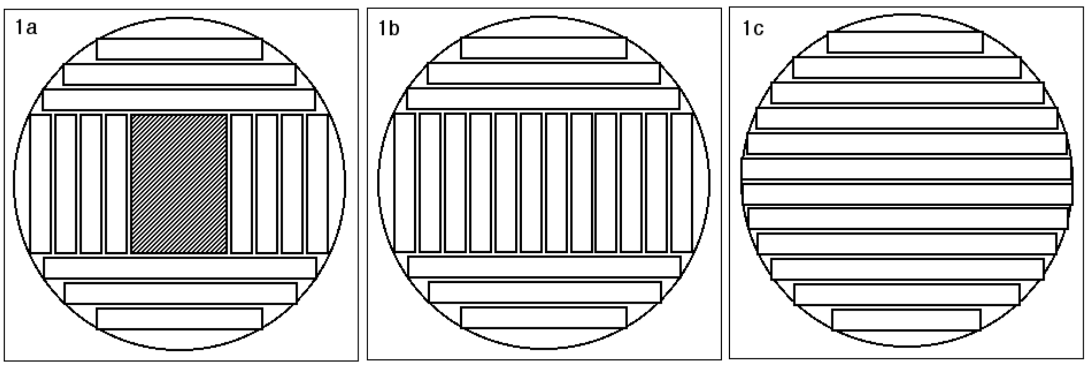


Figure 1. a. Sawing to a specified cant size; b. Sawing to specified cant thickness then completing sawing using a gang-resaw; c. live sawing.

For all three sawing methods, users can choose either split-taper or full-taper sawing (Malcolm 1961). In split-taper sawing, the taper of the log is split between opposite faces and the log is sawn parallel to its central axis (Hallock et al. 1978). This sawing method has the potential to produce shorter boards if the amount of taper is large enough, yet increase recovery of lumber. Full-taper sawing saws the log parallel to f the outside faces of the log (Hallock et al. 1978). Thus, the grain will be parallel to the board surface in the resulting boards, making lumber sawn stronger in general than split-taper sawn lumber.

Using the Tool

LORCAT is an easy-to-use, spreadsheet-based analysis tool that requires minimal data input from the user. The main user interface of LORCAT is shown in Figure 2.

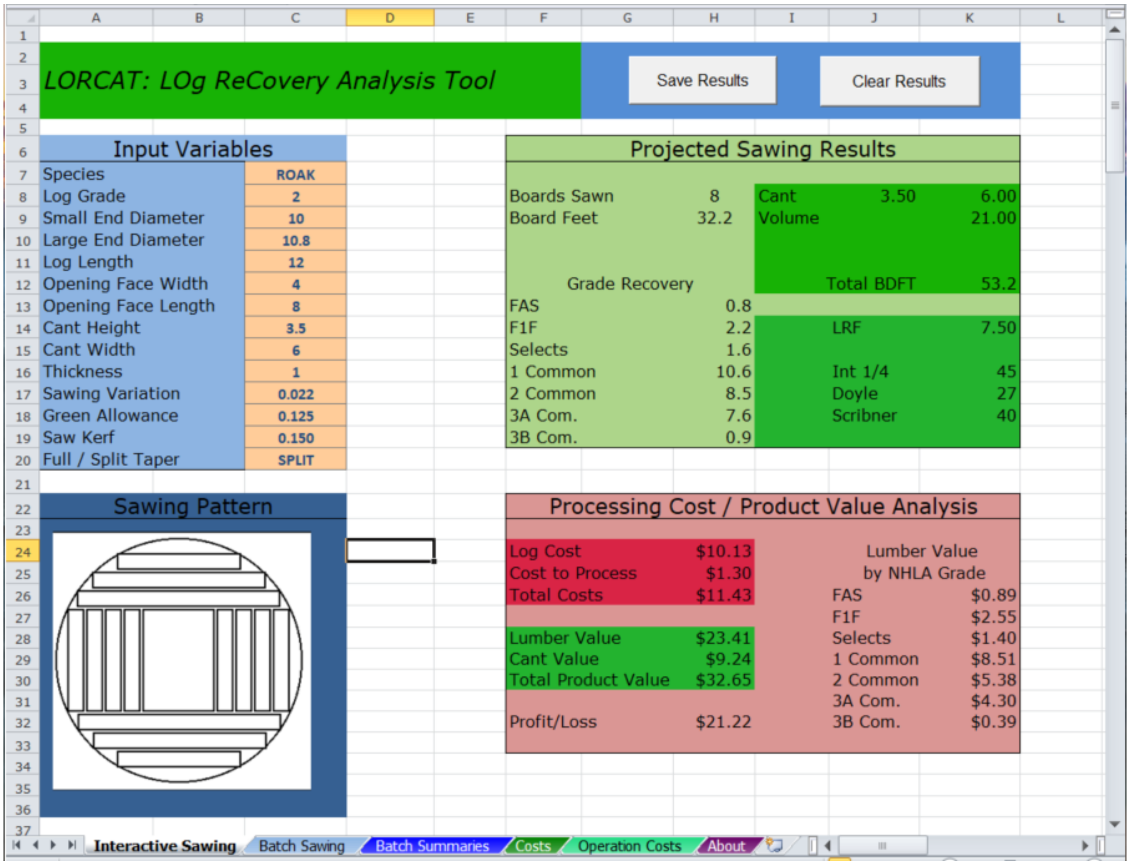


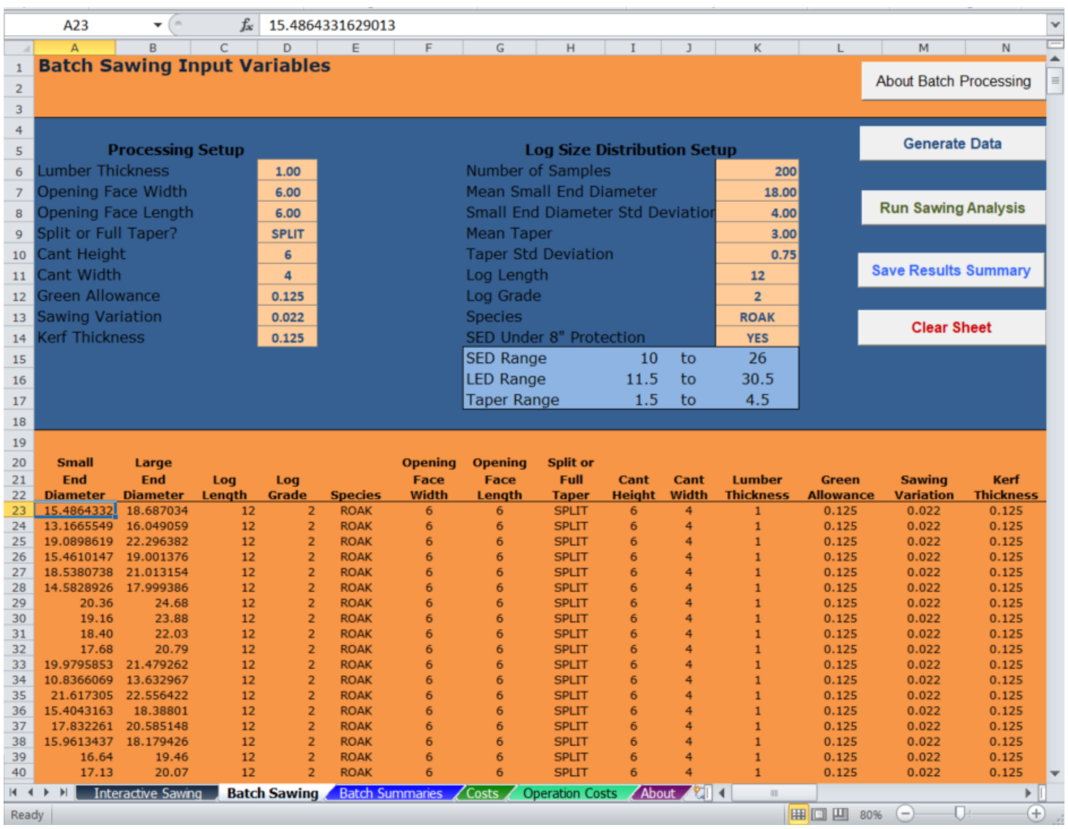
Figure 2. LORCAT: Log Recovery and Analysis Tool main window.

The light blue box in the upper left corner of the screen controls the analysis. Here you enter the specifics of the log being sawn as well as the lumber, cant and sawing parameters. The cells shaded light maroon indicate cells where you can enter/change data. The generic sawing pattern displayed in the lower left corner labeled "Sawing Pattern" shows a symbolic representation of the sawing pattern used given the current setup specified in the "Input Variables" section above. For example, entering zero into “Cant Height” and “Cant Width” in the "Input Variables" of LORCAT, will change the symbolic picture from “Sawing to a specified cant size (Figure 1a)” to “live sawing (Figure 1c).” Sawing results are displayed in the green box in the upper right corner labeled "Projected Sawing Results." It reports the expected volumes of the resulting lumber and cant, as well as the expected grade mix of the lumber produced according to NHLA lumber grading rules. The red box in the lower right corner labeled "Processing Cost / Product Value Analysis," reports the profitability of the sawing operation. The lumber values, log and processing costs are all based on user entered costs in the “*Costs”* and “*Operation Costs”* worksheets accessible in the tabs at the bottom of the spreadsheet. If users want to analyze the results from sawing multiple logs, they need to activate the “*Batch Sawing*” worksheet by clicking on this tab, which allows users to generate samples consisting of hundreds of logs.

Draft: 16-September-21

An Example

As a bandsaw owner, you might wonder if you should invest in thinner kerf blades or not? You can use LORCAT to conduct a series of simulations to examine the yield implications of four band mill kerf thicknesses available: 0.125, 0.111, 0.096, and 0.084-inch. After you have downloaded and opened LORCAT on your computer (no installation necessary as LORCAT consists of a spreadsheet file), you assemble a sample of 200, 12-foot-long logs with a total volume of 4,220 ft^3. The International ¼-inch scale volume (USDA Forest Service 2006) for those 200 logs was 26,070 board feet (bdft) and the Doyle scale volume (Cassens 2011) was 21,605 bdft. You decide to use a minimum opening face (minimum size of first board removed from a log face) of 6-inches wide and 6 feet long. You also decide that if the taper is 1 inch or greater, split-taper sawing is to be used. Also, you set the simulation up so that the sawing process simulates sawing the logs to produce a 6-inch cant that then is sawn into 6-inch wide boards (Figure 1b). You set the target thickness to 1-inch plus a green thickness allowance of 0.125-inch plus sawing variation of 0.022-inch. The details and the results of the first simulation run for band kerf thickness of 0.125-inch of your scenario analysis is shown in Figure 3.



Small End Diameter	Large End Diameter	Log Length	Log Grade	Species	Opening Face Width	Opening Face Length	Split or Full Taper	Cant Height	Cant Width	Lumber Thickness	Green Allowance	Sawing Variation	Kerf Thickness
15.4864332	18.687034	12	2	ROAK	6	6	SPLIT	6	4	1	0.125	0.022	0.125
13.1665549	16.049059	12	2	ROAK	6	6	SPLIT	6	4	1	0.125	0.022	0.125
19.0898619	22.296382	12	2	ROAK	6	6	SPLIT	6	4	1	0.125	0.022	0.125
15.4610147	19.001376	12	2	ROAK	6	6	SPLIT	6	4	1	0.125	0.022	0.125
18.5380738	21.013154	12	2	ROAK	6	6	SPLIT	6	4	1	0.125	0.022	0.125
14.5828926	17.999386	12	2	ROAK	6	6	SPLIT	6	4	1	0.125	0.022	0.125
20.36	24.68	12	2	ROAK	6	6	SPLIT	6	4	1	0.125	0.022	0.125
19.16	23.88	12	2	ROAK	6	6	SPLIT	6	4	1	0.125	0.022	0.125
18.40	22.03	12	2	ROAK	6	6	SPLIT	6	4	1	0.125	0.022	0.125
17.68	20.79	12	2	ROAK	6	6	SPLIT	6	4	1	0.125	0.022	0.125
19.9795853	21.479262	12	2	ROAK	6	6	SPLIT	6	4	1	0.125	0.022	0.125
10.8366069	13.632967	12	2	ROAK	6	6	SPLIT	6	4	1	0.125	0.022	0.125
21.617305	22.556422	12	2	ROAK	6	6	SPLIT	6	4	1	0.125	0.022	0.125
15.4043163	18.38801	12	2	ROAK	6	6	SPLIT	6	4	1	0.125	0.022	0.125
17.832261	20.585148	12	2	ROAK	6	6	SPLIT	6	4	1	0.125	0.022	0.125
15.9613437	18.179426	12	2	ROAK	6	6	SPLIT	6	4	1	0.125	0.022	0.125
16.64	19.46	12	2	ROAK	6	6	SPLIT	6	4	1	0.125	0.022	0.125
17.13	20.07	12	2	ROAK	6	6	SPLIT	6	4	1	0.125	0.022	0.125

Figure 3. LORCAT "Batch Sawing" tab with simulation set-up for your first test run with kerf thickness 0.125-inch.

Results from your scenario analysis are shown in Table 1. Lumber recovery increased from 28,887 bdft when the kerf is 0.125 inches, to 30,113 bdft when the kerf is 0.084 inches, an increase of roughly 4 percent. In the example, each reduction in kerf resulted in an approximate increase of 400 bdft, with a total overall improvement of 1,226 bdft between the widest and the thinnest kerf. Sixty-nine percent of the total improvement, 850 bdft, was realized with the 0.096-inch thick kerf. You now must estimate if the additional costs from using a thinner kerf are less than the additional profit resulting from the extra yield obtained. Realize that being able to tailor the log size distribution as well as the cost information to your specific operation, will give you the most meaningful results.

Table 1. LORCAT analysis and scale results for a sample of 200, 12-ft-long logs having an average small-end diameter of 16 inches and variable amounts of taper.

Kerf	Lumber Recovery Factor	Recovery	Doyle Overrun	Int 1/4-inch Overrun
(inches)		(bdft)	(per-cent)	(percent)
0.125	6.845	28,887	33.70%	10.80%
0.111	6.946	29,311	35.70%	12.40%
0.096	7.047	29,737	37.60%	14.10%
0.084	7.136	30,113	39.40%	15.50%

Summary

The ability to easily examine potential interactions among log characteristics, processing configurations, and resulting products allows sawmill managers to determine the most effective and efficient strategy for their mill. LORCAT's yield predictions are sensitive to small changes in input material and process configuration, allowing the detection of seemingly small changes in a mill's operation. In our processing example, a 0.012-inch difference in kerf thickness resulted in recovery difference of roughly 4 percent. The ability to repeat simulations using the same log data sample eliminates sample variation that often confounds traditional mill studies by masking true recovery differences. LORCAT is available free of charge from:

https://www.nrs.fs.fed.us/tools/lorcat

or

https://www.woodproducts.sbio.vt.edu/lorcat

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