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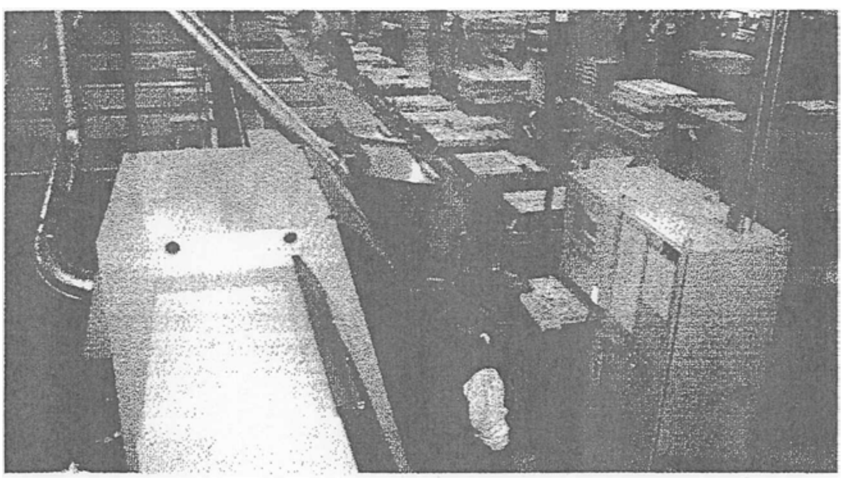
Factors that impact rough mill yield and value

Choosing the best lumber grade mix should not be a one-time event; it should be done whenever lumber prices, products, or rough mill operations change.

by Jan Wiedenbeck
jwiedenbeck@fs.fed.us



Choosing the best lumber grade mix should not be a single decision for all species and all cutting orders.

The author is Wood Products Reseal.ch Scientist at U.S. Forest Service, Princeton, W. Va. This article is an excerpt from a series of articles that will be published by the Forest Service as the new rough mill operators guide. The full text of the articles will be available on North Carolina State University's Web site at www.ces ncsu.edu/nreos/wood.

Most rough mill managers choose a particular grade mix for a cutting order based on what lumber is available, both in inventory and from suppliers, and on what grade mix is standard for the mill The standard grade mix is one that has evolved over time based on observations of what runs smoothly through the mill and produces the needed parts with an acceptable yield.

However, a standard grade mix may not be the best grade mix for a specific cutting order or for one species versus another. Even for a given cutting order, the best grade mix may change when relative lumber prices change, when the length and width of the lumber supply changes, when rough mill equipment or operator expertise changes, or when there are changes in cutting order specifics such as part pricing, sizes, and quality, numbers of parts, or turnaround time on the order.

Choosing the best lumber grade mix should not be a single decision for all species and all cutting orders (except for rough mills that focus on a particular product so that they produce the same part sizes using the same species every day.) Choosing the best lumber grade mix should not be a one-time event or a once-a-year activity - it should be done whenever lumber prices, products or rough mill operations change.

In choosing the best lumber grade mix to process, it is helpful to run frequent studies in the rough mill using" small groups of boards of a given grade (such as five boards). The basic design for these small-scale yield studies is shown on page 64.

These boards are tracked through the rough mill and the yield is calculated

rough mill

ed based on the tally at the sort station. Several five-board runs can be conducted for each lumber grade in a single day with minimum disruption. If this is done for every significant cutting order, your rough mill managers will be better able to answer the question, “What is the best lumber grade mix for this rough mill to run on this cutting order given current prices, equipment, etc.?" It also will help you answer the question, "What is the breakeven sales price for this cutting

A standard grade mix may not be the best grade mix for a specific cutting order.

order when cut from each lumber grade?"

In lieu of mill studies, computer programs can be used to estimate the optimal lumber grade mix. Two types of prograil1s can be used **least-cost lumber grade mix programs** and **lumber cut-up simulation programs.**

Least-cost lumber grade mix programs provide optimal grade mix estimates using lumber prices, part sizes and quantities, production costs and a list of available lumber grades that the user inputs. The least-cost lumber grade mix is then derived based on expected lumber yields that are contained in the programs' yield tables. Unfortunately, the yield tables are based on crosscut-first lumber processing, so predicted rip-first yields might not be reliable. The yield tables also have some *other* shortcomings. The advantage of this type of program is that it is easy to use and provides quick answers. If a rough mill manager must choose between frequent least-cost grade mix computer runs to assist in the grade mix decision and infrequent rough mill grade-based yield studies, the more frequent computer runs probably are preferred.

While several least-cost lumber grade mix programs have been developed over the years, many are difficult to obtain and/or complicated to run. The more familiar of these programs include:

- *The Furniture Cutting Program* authored, distributed and supported by Dr. Hank Huber of Michigan State University until his retirement. This program is no longer distributed by Michigan State.
- The *Rough Mill Cost-Cutter Program* authored,' distributed and supported by Dr. Philip H. Steele of Mississippi State University.
- *OPTIGRAMI V2* authored distributed and supported by Penny Lawson and others at the Forest Service research lab in Princeton, W. Va.

Lumber cut-up simulation programs are somewhat more complicated for evaluating optimal lumber grade mix, but can provide better comparisons of the relative yields and cost factors for different lumber grade mixes and cutting bills. These programs are run repeatedly with different lumber grades to determine the optimal lumber grade mix. Both rip-first and crosscut-first simulation programs are available.

The advantage of this type of computer program is that the user can pro

Periodic, five-board rough mill yield study — rip-first example

1. Randomly select five boards of a single grade and length. Measure and record surface measure, length, width and crook. Mark the ends of each board with a crayon mark.
2. Put a crayon mark along the length of the strips as they come out of the rip saw, before they advance to the crosscut saw. Do a dot count of the number of strips of each rip width that are recovered from the five boards.
3. Route all strips to the same one or two chop saws, to introduce consistency in the comparison.
4. Do a dot count of the number of parts of each length recovered from the strips. Count parts produced for each strip width (different columns on the tally sheet for each width.
5. Number of parts x part length x part width/144 = surface measure (SM) of parts of a given size recovered.
6. Add the SMs of all part sizes and divide by the SM of the boards to obtain rough yield.
7. Run the study at least three times on the same lumber grade and length and then run it on other lengths and grades.
8. Run the series of yield studies for all important cutting bills.

vide more specific information on the rough mill processing system, such as type of gang-rip saw, cutting priorities and part quality. In addition, rip-first yields are not erroneously based on crosscut-first yields, as is the case for the least-cost grade mix programs.

Lumber cut-up simulation programs can be run manually *or* tied into another program that can serve as an interface for optimum lumber grade mix runs. Currently available lumber cut-up simulation programs include:

- *CORY* authored, distributed, and supported by Dr. Charlie Brunner of Oregon State University.
- *RIP-X* authored, distributed, and supported by Dr. Philip Steele and others at Mississippi State University.
- *ROMI-RIP and ROMI-CROSS* authored, distributed, and supported by Ed Thomas at the Forest Service research lab in Princeton, W. Va.

The impact of lumber grade on yield is best measured in rough mill yield studies or using a rough mill cut-up simulator. However, general data (derived from simulations) on the degree of influence of lumber grade on part yields for a variety of cutting bills look like the example below.

When comparing simulation-derived part yields from No.1 and 2A Common lumber, the differences in yield between

Although the purchase price of higher grade lumber is higher than for lower grade lumber processing costs for lower grade lumber are usually greater than for higher grade lumber.

rip-first and crosscut-first systems for each grade appear to be significant. It is important to note that the computer simulation of the cutup process assumes an ideal, fully optimized operation. The yields from actual operations typically are lower since the potential yield gains from full optimization are difficult to achieve in practice.

The rip-first configuration produced consistently higher part yield when processing No.1 Common lumber than the crosscut-first configuration (six of seven cutting orders). The crosscut-first configuration produced higher part yield than the rip-first configuration when cutting No. 2A Common lumber into C2F (clear two face) parts, though this result was less consistent (four of seven cutting orders). When a cutting order calls for wider parts from 2A Common lumber, the crosscut-first system outperforms the rip-first system. For narrower parts (less than 3.5 inches), the rip-first system seems to perform better.

Higher lumber yields do not necessarily mean greater profits. The cost element must be weighed for every decision. Although the purchase price of higher grade lumber is higher than for lower grade lumber, processing costs for lower grade lumber are usually greater than for higher-grade lumber. For example, processing costs are greater because more cutting operations are required to isolate usable board sections from defects in No. 2A and 3A Common lumber compared to higher-grade lumber.

For FAS lumber, most of the cutting that is done is for the purpose of sizing the parts, because only a few defects need to be removed. Also, a higher percentage of the cuttings produced from upper grade lumber are primary parts rather than higher cost salvage parts. Other costs associated with processing lower

Rough mill type	Rip-First					Crosscut-First			
Lumber grade	FAS[a]	1C[b]	2C[b]	1C[b]	2C[b]	1C[b]	2C[b]	1C[b]	2C[b]
Cutting quality	C2F	C2F	C2F	C1F	C1F	C2F	C2F	C1F	C1F
Yield (%)	74	65	51	75	66	64	53	70	64

a FAS. Rip-first yields are based on simulations of 12 cutting bills. b No.1 and 2A Common yields are based on simulations of the same seven cutting bills for both the rip-first and crosscut-first mill configurations. This was a rigorous analysis that allowed direct comparison of the relative difference in yields expected for 1 C versus 2C lumber when cutting a variety of cutting 9rders.

The general impact of lumber grade on yield in both rip-first and crosscut-first rough mills can be determined from computer simulations.

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grade lumber that are difficult to quantify include higher part reject rates (due to defecting mistakes and machining defects that arise where cross-grain occurs near knots) and longer inspection times for operators as they try to make decisions concerning part placement and the importance of defect blemishes.

The number of cutting operations required to extract needed parts climbs significantly when cutting FAS versus No.1 Common versus 2A Common lumber in both gang-rip-first and crosscut-first rough mills. For a difficult cutting order, the number of chop saw cuts (in a rip-first rough mill) required per part produced is 27 percent higher for No.1 Common lumber than for FAS lumber and 53 percent higher for No. 2A Common lumber than for FAS lumber. The number of crosscuts required (in a crosscut-first rough mill) to fill the same cutting order is 70 percent higher for No.1 Common lumber than for FAS lumber and 200 percent higher for 2A Common lumber than for FAS lumber.

For the straight-line ripsaw in the crosscut-first rough mill, the number of cutting operations required to extract needed parts also goes up significantly as lumber grade is reduced. Fortunately, this increase is not as great as for the crosscut saw. The productivity of the crosscut saw and straight-line ripsaw system is less affected by a reduction in lumber grade when cutting an order that is made up of shorter and narrower parts than when cutting larger parts.

Lumber length affects part yield and value in several ways. Obviously, more boards typically will be required to obtain longer parts when cutting shorter lumber, such as 4 to 8 feet long. Where part size requirements emphasize shorter lengths, short lumber can be used. For some cutting orders, long lumber provides a higher part yield than short lumber in a crosscut-first rough mill. This is because there are more ways in which required lengths can be combined to fit a longer board. Thus, there is less potential yield loss associated with crosscut waste. Also, 2 inches of end trim on a short board represents greater yield loss than on a long board. By contrast, in rip-first operations, shorter lumber may give higher yields (typically 1 to 3 percent) than long lumber.

This is largely due to the fact that longer boards tend to have more crook (or sidebend) and, consequently, produce lower strip yields when they pass through the gang-rip saw. Lumber width also impacts rough mill yield, particularly when narrow lumber is used in rip-first rough mills. This impact is most significant for gang-rip saws with fixed arbors and when there are a limited number of part widths in the cutting order. Of course, wider parts are more difficult to obtain from narrow lumber and wider cutting orders will produce more waste when narrower boards are being processed. The impact of width on yield in a ripfirst rough mill can be so important that it dictates buying upper grade lumber for some orders.

FAS and F1F lumber is wider than selects and common grade lumber. The width differences can be large. For example, the average width of 4/4inch thick, dry, FAS and FIF red oak lumber measured in amide 1990s multi-mill study was approximately 73/4 inches. The average width of the selects grade lumber was closer to 51/4 inches. The average width of 1 Common lumber increased to approximately 7 inches but the average width of 2A Common lumber was only to 51/4 inches.

For gang-rip-first rough mills that cut parts wider than 3 inches on an occasional to frequent basis, the best strategy for keeping yield up and lumber costs down is to note differences in lumber width from one supplier to the next. Significant differences in the distribution of lumber widths among suppliers have been measured. In an unpublished 1996 Forest Service study, the percentage of dry, red oak boards at least 8 inches wide from five mills ranged from 7 to 27 percent, while the percentage of boards less than 5 inches

Least cost lumber grade mix programs

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- **OPTIGRAMI V2** authored, distributed and supported by Penny Lawson and others at the Forest Service research lab in Princeton, W. Va. 304/431-2700.

Lumber cut-up simulation programs

- **CORY** authored, distributed and supported by Dr. Charlie Brunner of Oregon State University, 541/737-4205.
- **RIP-X** authored, distributed and supported by Dr. Philip Steele and others at Mississippi State University, 662/325-8083.
- **ROMI-RIP and ROMI-CROSS** authored, distributed and supported by Ed Thomas at the Forest Service research lab in Princeton, W. Va., 304/431-2324.

boards less than 5 inches in width ranged from 8 to 26 percent. These widths were for mixed-grade lumber made up of similar percentages of uppers and No. 1, 2 and 3 common boards at each mill.

Processing efficiency is important when comparing lumber dimensions. From a material handling standpoint, it is easier to handle short and narrow lumber than longer or wider lumber in manual operations. Even so, productivity usually is greater when processing wider, longer lumber than when processing narrower, shorter lumber of the same quality. However, the difference in productivity is not as great as with automated systems.

More boards typically will be required to obtain longer parts when cutting shorter lumber.

Processing short and narrow lumber with automated systems can be more problematic and less efficient because there are fewer board feet in each piece of lumber. For many automated systems, processing gaps (space between boards passing through work stations) lead to lower machine utilization rates when processing short and narrow lumber. In a gang-rip-first rough mill, efficiency losses associated with loading the ripsaw's infeed conveyor (repositioning the fence) can be a problem when using short lumber. Similarly, narrow lumber occupying a machine that processes lumber in a linear direction is less productive on a volume-per-hour basis than when wider lumber (gang-rip saw, planer, moulder, automated chopsaw) is processed. □

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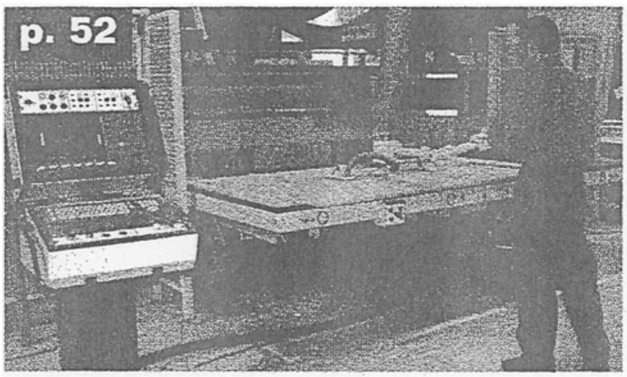

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