

## DECIDING BETWEEN CROSSCUT VS. RIP-FIRST PROCESSING

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There are good reasons why the question “Should we be crosscutting or ripping first in our rough mill?” still exists for many mills. This layout decision depends on many factors and some of the more important ones are subject to change from day to day or at least year to year. There are at least 12 factors that affect the layout decision:

1. lumber grade
2. lumber width
3. lumber length
4. defect types
5. lumber straightness and drying stresses
6. part length and width needs
7. part quality needs
8. number of different parts
9. part volume requirements
10. available capital
11. gluing requirements and furniture design specifics
12. labor skills

Factors 1-5 are lumber characteristics, factors 6-9 are requirements specified by the cutting bill, and factors 10-12 relate to general business characteristics. Because the lumber characteristics and cutting bill requirements can change on a daily basis, if a mill must select between crosscut or rip-first processing the decision will be tenuous at best. This is why some rough-mill managers are opting to design “either-way” mills or to maintain dual processing capabilities when modernizing.

For mills that lack the capital resources or floor space to build and operate an either-way mill, the decision should be based not only on current operating conditions but also on the anticipated average operating state over the next 10 years. Thoughtful consideration must be given to whether lumber grade, species, or size changes might be forthcoming. Will workforce turnover rates change? How will product sizes, quality specifications, and quantities change? Will greater emphasis be placed on increasing production levels? Will kiln drying operations improve? Are shifts in furniture design specifications being planned?

Whether you are making the processing layout decision for the future of your rough mill or considering how to optimally distribute boards between the crosscut and rip-first lines in your either-way mill, the following lumber characteristics are important in the processing decision:

Grade – The intermediate grades of lumber (e.g., 1C & 2A Common) produce a higher yield of longer parts when gang-ripped-first compared to crosscut-first processing (2). In fact, some rough-mill managers have reported that adopting gang-rip-first processing reduced their grade mix and thus lumber costs such that the savings paid for the capital investment almost immediately (5). This effect is more evident when crosscut-saw operators or optimizing crosscut-saw markers are less experienced. Deciding which

defects to remove on the crosscut saw and which to leave for removal at the ripsaws and salvage operation is difficult for even the most experienced operator.

There also is a productivity consideration when processing lower grade lumber. Generally, gang-rip-first operations can process 20% more lumber than crosscut-first operations per hour of labor input. When gang ripping, there are two relatively minor productivity concerns related to lumber grade: 1) FAS and F1F grade lumber usually is somewhat wider on average than 1C, 2AC, and 3AC lumber; wider lumber leads to greater machine productivity, and 2) lower grade boards may break up in the machines more often than higher grade boards, causing downtime. By contrast, there is a large productivity impact related to lumber grade in a crosscut-first mill: the crosscut saw must make 70% more cuts when processing 1C compared to FAS and 200% more cuts when cutting 2AC versus FAS!

Width – Wider lumber typically yields a higher part volume when cut in a rip-first system than in a crosscut-first system largely because of the difficulty associated with optimizing the crosscut decision when wider boards are processed. For lumber narrower than 4.5 inches, the decision on how to optimally cut up a board becomes relatively easy for the crosscut saw operator or lumber marker (2). Thus, a mill that processes a large amount of narrow lumber can be efficient with crosscut-first processing, and a narrow board in an either-way rough mill can be sent to the crosscut-first line. Also, the negative yield impact of edgings is greater for narrow lumber when ripping first, especially when a fixed-arbor gang saw is used. If a significant portion of the wider parts in the rough mill cutting order are required to be solid, nonglued-up parts, crosscut-first processing of wider boards may be required to fill orders.

Considering rough mill productivity, the board footage of lumber processed per hour in automated systems in which the lumber runs linearly through a high-speed saw (e.g., gang rip saw or automated crosscut saw) is higher for wider boards. Since gang-rip-first mills tend to be more automated, this supports the recommendation that wider lumber benefits from being gang-ripped first. By contrast, when wider boards are processed in a manual crosscut-first rough mill, the size and weight of the wider lumber can slow processing so that the productivity gains associated with having more volume per lineal foot of lumber are diminished or eliminated.

Length – The advantage of crosscutting-first versus gang-ripping-first based on lumber length is ambiguous. Longer lumber (>11 foot) produces relatively higher yields than shorter lumber (<9 foot) in both rip-first and crosscut-first systems (3, 4, 6) *if the lumber is straight*. Lumber that is crooked (sidebend) is better cut in a crosscut-first operation (or at least cut into two pieces with a pop-up saw) rather than a rip-first operation (2). Lumber that is on the shortest end of the length spectrum (4-7 feet) can produce slightly higher yields than 8-foot-long and longer lumber in a gang-rip-first cut-up system, but the yield gains seldom will compensate for the negative production effects that arise when short lumber is processed (6).

If your lumber is predominantly shorter than 10 feet and you are cutting part orders that demand a high percentage of longer parts, rip-first processing will yield a greater

proportion of the long parts you need. If you are focused on a species that tends to end-check and you experience numerous end-checks in your dry lumber, rip-first processing usually is the better choice regardless of lumber length and part length requirements. More wood is lost when short lumber is crosscut across the entire board width to eliminate end-checks than when strips that are produced by the rip saw are end-trimmed. Thus, some strips need not be trimmed as severely as others since the end checks will vary in length. There is one exception: gang-rip-first mills that operate automatic strip chopping lines that are set up to end trim 1-inch from each strip may produce parts with checks when longer checks are encountered. Thus, part reject rates could increase. Manual rather than automated cutting operations are the better option (for trimming full-width boards or strips) when longer checks are common.

Another consideration relates to the handling of lumber. If your crosscut-first system entails manual handling of lumber (at the saw or at the marker station), shorter lumber offers certain processing advantages -- it is lighter, less bulky, and easier for the person who is making defecting decisions to evaluate and optimize quickly and accurately. However, when short lumber is processed in an automated rip-first rough mill, processing inefficiencies can be expected (similar to those associated with processing narrow boards). Processing gaps (i.e., space between boards) lead to lower machine utilization. This is a critical cost factor when the rough mill is using expensive, automated equipment.

Defect Types – A basic principle of rough mill defecting is to attempt to isolate defects in a single strip or crosscut section in the initial cutting stage (rip or crosscut ) so that the number of additional cutting operations required to remove the defects from the strips or crosscut sections are minimized. Therefore, defects that run along the length of the board are more easily isolated and removed with rip-first processing; defects that run across the board or that are clustered are suited for crosscut-first processing.

For either-way mills, boards with wane, splits/shake, pith, and stain are candidates for the gang-rip-first saw. Boards with spike knots, knot clusters, large face knots, clustered worm or pin holes, decay zones, and crook are candidates for the crosscut-first saw.

For mills considering switching to a crosscut-first system or to a rip-first system, defect type must be evaluated in a broader sense. Lower grade lumber (e.g., 1C, 2AC, and 3AC) has more defects of every kind, but the length of the wane zones and the occurrence of pith and pith-related checks and small knots point to gang-rip-first processing. Species considerations may be important for the rough mill that specializes (and will continue to specialize) in one or two species. Some species are more prone to splits and checks (e.g., red oak) and therefore, might be best suited to gang-rip-first processing. Tree species with minimum taper (e.g., yellow poplar) produce fewer wane boards in the sawmill. Thus, a furniture rough mill that specializes in this species may do well using a crosscut-first system. Species that tend to retain limbs (e.g., white pine) produce a lot of knotty boards. Processing these species in a crosscut-first rough mill might be a good option if knots are to be removed as defects. In all cases, the grade and size of the lumber and the quality and size requirements of the needed parts must be considered (and usually given more weight) along with defect type and species.

Lumber Straightness and Drying Stresses – As mentioned earlier, lumber with crook or sidebend should be crosscut-first. A study in the early 1990's (3) showed that crosscutting boards before ripping when ½ inch or more crook is present produces rough mill yields that are on average 3% greater than those when gang-ripping-first without crosscutting for crook. Of the red oak lumber processed in eastern U.S. rough mills, 75% appear to have minimal crook (less than ½ inch), while about 7% have crook in excess of 1 inch. Depending on the drying quality of the lumber processed by the rough mill, this may be one of the more important factors to consider when deciding between crosscut-first and gang-rip-first processing.

Although cupped boards are less common today due to the prevalence of relatively narrow lumber, they should be ripped-first when encountered. Also, boards that contain drying stresses due to inadequate equalizing and conditioning at the end of the kiln-drying cycle will crook and twist more if gang-ripped-first into long, narrow strips than if crosscut into wider pieces before being ripped.

The following factors also are important when evaluating crosscut-first versus gang-rip-first as they are related to the criteria for parts specified in the cutting bills:

Part Length and Width Needs – The lengths and widths of your rough mill's part requirements are an especially important factor to consider when deciding whether to crosscut or gang-rip-first. Many experts have advised that gang-rip-first processing typically yields more long-length parts from a given grade of lumber than crosscut-first processing. If your mill's orders tend to run toward longer lengths, gang-rip-first processing should be considered. On the other hand, if your orders demand a high percentage of wider parts (i.e., wider than 3 inches) crosscut-first processing usually will produce a higher yield.

For the either-way rough mill, it follows that more of the long-part requirements be set up for cutting on the gang-rip-first side of the rough mill and more of the wider part requirements be scheduled on the crosscut-first side. Maintaining a range of cutting sizes (short to long and narrow to wide) on both sides of the mill is necessary to optimize yield for each processing line and for the total rough mill.

Part Quality Requirements – From a yield standpoint, it is generally better to process cutting orders that call for Clear 1-Face (C1F) parts or Character-Marked (CM) parts or a combination of part qualities (e.g., C1F and C2F) in a gang-rip-first rough mill. Whether the crosscut-first rough mill is manual or optimizing with a defect marking station, discriminating between acceptable and unacceptable defects on two faces of a full-width board is much more difficult than making the same judgment on a narrower width strip. This dependence on human judgment in cutting lumber to length is the key issue related to part quality when deciding between crosscut-first and rip-first processing. In addition, computer simulations have shown that when cutting CM parts out of both 1C and 2AC lumber, gang-rip-first processing tends to produce slightly higher yields than crosscut-first processing (1). As attempts are made to expand markets for CM parts and furniture, this finding could become more important to rough mill managers.

Number of Different Parts – Optimizing yield by cutting many more sizes and qualities of parts in the rough mill is possible with a gang-rip-first system with optimizing chopsaws or with optimizing crosscut-first sawing. However, a mill that cuts more types of parts at a time must be able to efficiently sort and handle larger varieties of parts. This is easier to do with a gang-rip-first system than a crosscut-first system. Crosscutting 20 different part lengths that are then sorted and moved to different ripping stations is more complex than chopping 20 different part sizes (after ripping) that need only be stacked off onto carts and moved to storage or the machine room.

Part Volume Requirements – For rough mills with high part-volume requirements, automated systems (particularly gang-rip-first) are more productive (based on input lumber volume) per 1,000 hours of labor input. Conversely, when significant capital investments are made in automated and/or optimizing sawing systems, high throughput and utilization rates are needed to offset the added depreciation expense so that the manufacturing cost per unit can be maintained or improved.

Available Capital – The decision to switch to an automated gang-rip-first system from a manual crosscut system is a capital-intensive one. The rough mill must have sufficient market volume, sufficient upstream capacity (lumber supplier, dry kiln, and lumber storage) and sufficient downstream capabilities (sorting, storage, machining, etc.) to accommodate the changeover.

Gluing Requirements and Furniture Design Specifics – Quality edges suitable for gluing from gang-ripsaws are the norm for fixed-arbor saws and for most moveable-blade saws in 2001. The gluing consideration that remains then is whether glue lines are acceptable in wider furniture/cabinet pieces such as drawer fronts, tabletops, etc. A high demand for wider “solid” parts calls for crosscut-first processing of higher-grade lumber. A second design factor that affects the crosscut versus rip-first decision is the degree of color and grain matching required in the secondary product. It is easier to match color and grain with less handling and reinspection when the lumber is crosscut-first. Parts recovered at the straight-line rip saw from a given board section will have relatively similar color and grain compared to strips that are mixed together coming out of the gang rip saw.

Labor Skills – Defect recognition, decision-making skills, and mill savvy are necessary traits for a crosscut-first saw operator to possess if a crosscut-first rough mill is to operate near its profit potential. The same is true for board markers and to a lesser extent, for strip markers. For rough mills that operate in a competitive labor market that experiences high turnover rates, including the more experienced and higher paid employees, gang-rip-first processing generally requires less experienced personnel.

Of the many factors that affect the crosscut versus gang-rip-first rough mill layout decision, lumber grade, part size requirements, part volume requirements, availability (or lack) of skilled labor, and furniture design requirements should be given the most weight. Many of the other lumber factors (width, length, straightness) are presented for consideration by the either-way rough mill with the flexibility to process specific boards through a gang-ripsaw or a crosscut saw to derive the maximum yield from each board. Table 1 is a simplistic framework for comparing some of the factors discussed in this paper.

**Table 1 - Comparison matrix for factors that affect the crosscut versus rip-first decision.**

	Lower grade lumber	Narrow lumber	Longer lumber	Lumber with crook	Long parts required	Wide parts required	Check-prone species	Waney lumber	Varied part qualities	Experienced labor
<b>Rip-first</b>	+	-	+	-	+	-	+	+	+	?
<b>Crosscut-first</b>	-	+	?	+	-	+	-	-	-	+

**Literature Cited**

1. Buehlman, U., J.K. Wiedenbeck, and D.E. Kline. 1999. Character-marked furniture: potential for lumber yield increase in crosscut-first rough mills. *Forest Products Journal* 49(2):65-72.
2. Gatchell, C.J. 1987. Rethinking the design of the furniture rough mill. *Forest Products Journal* 37(3):8-14.
3. Gatchell, C.G. 1991. Yield comparisons from floating blade and fixed arbor gang rip-saws when processing boards before and after crook removal. *Forest Products Journal* 41(5):9-17.
4. Hamner, P.C., B.H. Bond, and J.K. Wiedenbeck. The effects of lumber length on part yields in gang-rip-first rough mill operations. *Forest Products Journal* (in review).
5. Mullin, S. 1990. Why switch to rip first? *Furniture Design and Manufacturing* 1990(9): 36, 38, 40, 42.
6. Wiedenbeck, J.K. 1992. The potential for short length lumber in the furniture and cabinet industries. Ph.D. dissertation. Virginia Polytechnic Institute and State University, Blacksburg, VA pp. 102-122.

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