Recognizing interactions among lumber grading rules, gang-ripping technology, and industry needs could increase the use of No.2 Common lumber

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Abstract

Recognizing the interactions among lumber grading rules, gang-ripping technology, and the parts needs of the furniture and cabinet industries could increase the use of No. 2 Common lumber as a raw material. The minimum piece size used in establishing the No.2 Common grade is 3 inches by 2 feet. Industry often needs shorter and narrower pieces than this. No.2 Common often contains areas that contribute to total yield but cannot be used to establish the grade. Results from an analysis of the effects of crook on yield when gang-ripping narrow boards show that both No.1 and No.2 Common yield more long lengths and fewer short lengths than are required by industry. A discussion of computer-generated versus human-generated yields is included and a practical illustration of parts yields from gang-ripping No.1 and No.2 Common lumber is presented.

For many years, we have been saying that No.2 Common hardwood lumber is a suitable raw material for furniture and cabinet manufacturing. This recommendation is based on our research results showing the needs of the industries (1) and what could be gained from processing the lower grades (4,5,8). Is this just an academic exercise? Are critics of these ideas correct? In this paper, I present some of the ideas behind the argument that No.2 Common is suitable because of the interactions among three factors: 1) lumber grading rules; 2) the technology used to process the lumber; and 3) the rough dimension parts needs of the industry.

The overall guidelines are these. Lumber is processed by gang-ripping first to parts with glueline quality edges. Further, processing is to fixed-length cutting bills that represent the needs of the industry.

The construction of the grades

The main features of the lumber grades that pertain to this discussion are the number and sizes of cuttings allowed in the determination of the percentage of the clear-face cutting area required for each grade, as defined by NHLA (9). Focusing on No.1 and No.2 Common lumber, the grades are summarized in Table 1. Overall, it can be seen that No.1 Common is better than No.2 Common because it generally requires a larger clear-face surface area in fewer cuttings of a larger size.

But, what do the grading requirements have to do with the way the boards will be used? Very little. Fully 25 percent of the clear quality solid wood furniture parts are 21 inches or shorter and 55 percent of the interior parts are 18 inches or shorter (1). This is less than the 2 foot minimum length required in establishing the No. 2 Common grade. There are two questions that must be considered: How well do the parts yields from No.2 Common match up with the parts needs of industry? And, how easily and economically can we get the needed parts out of a board?

The technology used to process the lumber

Years ago we learned that there were long lengths to be gained from No.2 Common lumber when crosscutting first. Using conventional rough mill procedures, where a crosscut is the usual first processing step, fully one-third of the surface area of the yield can be in parts 40 inches and longer (8). Almost 20 percent can be 60 inches long. When gang-ripping first is used, more than half of the surface area of cuttings will be lengths of 40 inches and longer (4,5). Thus, the practice of limiting considerations of part length yields from No.2 Common (3,6,7) to no more than 40 inches is called into question and has been rejected by us. Our approach is to develop yields based on longest length

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TABLE 1. - *Important grading rules for No. 1 Common and No.2 Common lumber.*

No.1 Common[a]			No.2 Common[a]		
Surface measure	Percent in clear-face cuttings[b]	No. of cuttings	Surface measure	Percent in clear.face cuttings[c]	No. of Cuttings
(ft.)	(%)		(ft.)	(%)	
1	100		1	66-2/3	1
2	75	1	2 and 3	50	1
3 and 4	66-2/3	1	4 and 5	50	2
5 to 7	66-2/3	2	6 and 7	50	3
8 to 10	66-2/3	3	8 and 9	50	4
11 to 13	66-2/3	4	10 and 11	50	5
14 and up	66-2/3	5	12 and 13	50	6
			14 and up	50	7

[a]Board widths = 3 inches and wider; board lengths = 4 to 16 feet.
[b]Minimum. 3 feet to 10 feet surface measure will admit one additional cut to yield 75 percent clear face. Minimum cutting sizes are 4 inches by 2 feet or 3 inches by 3 feet.
[c]Minimum. 2 feet to 7 feet surface measure will admit one additional cut to yield 66.2/3 percent clear face. Minimum cutting size is 3 inches by 2 feet.

TABLE 2. - *Most commonly needed lengths* (4/4 *lumber) of clear quality (ClF and C2F) rough dimension parts by furniture type.*

Furniture type	15	18	21	25	29	33	38	45	50	60	75	100
	Length class in inches (%)											
Solidwood	6	10	10	10	10	10	10	13	3	7	6	5
Veneered wood	7	13	9	14	6	7	9	7	5	8	9	6
Upholstered	6	--	13	18	17	25	--	--	--	--	9	12
Kitchen cabinets	12	10	11	20	14	14	4	3	5	2	2	3

first. While any lengths can be studied, we are currently using 75 inches as the maximum length from No.2 Common.

One of the reasons gang-ripping first will work with No.2 Common is that no final part length decision is made because of the gang-ripping. Boards are reduced by gang-ripping to narrow strips that can be easily handled and crosscut to the needed lengths. Widths not usable directly from the gang saw will be glued up to needed wider panels.

A reason sometimes mentioned for not using gang-ripping is the excessive loss of clear wood in kerf and edge preparation. This argument may have had some merit before gang-ripsaws could produce glueline quality edges and some machining after ripping was needed. Even with glueline quality edges directly from ripping, there might be a concern. If a 6-inch-wide board has a l/4-inch cleanup on both edges and a 1/4-inch rip, then a 3/4-inch width loss occurs at the beginning. This argument has little merit as the outside cleanup will occur somewhere along the processing line anyway as will probably at least one rip.

In processing lumber that is essentially random width and random length to wide, edge-glued panels or individual dimension parts, raw material losses will be suffered regardless of whether one crosscuts first or gang-rips first. And, total yields will be about the same depending on the number .of lengths required and the smallest piece allowed in salvage operations. In the lower grades, gang-ripping first will allow easier processing with less salvage work and will produce long-length cuttings. So it is really a question of when, not whether, raw material losses will occur.

The needs of the industry

In 1982, the results of a study of the commonality of part sizes among 20 furniture manufacturers and 12 kitchen cabinet companies were published (1). The various parts were grouped into length classes such that all needed parts could be cut with no more than an average 10 percent end trim loss from any class. Losses were almost always far less. For 4/4 lumber, percentage requirements for each length class in clear-quality parts are shown in Table 2. These length classes are used in our current yield studies. Most of the needs are 45 inches and shorter.

The effects of lumber grade, processing, and parts needs on yield

The maximum possible clear area of a board is 100 percent. Any processing will reduce this amount by at least the saw kerf. When a fixed length cutting bill is used, an additional reduction in potential yield is introduced. The amount will depend on how well different combinations of lengths can fit into the length of the board. But the point is we can never get 100 percent yield from a clear board if we do anything to it at all.

Within the upper grades, the chances are that the usable portions of the boards will be contained mostly within the cuttings area used to grade the boards. The minimum sizes of cuttings for Firsts and Seconds (F AS) and Selects are large at 4 inch by 5 foot or 3 inch by 7 foot in comparison to the lower grades. Further, the number of cuttings allowed to establish the grades are small. For example, an F AS board that is 12 feet long and 11 inches wide contains 11 feet surface measure. Only two cuttings are allowed to get the clear-face surface area for grading purposes. If the clear-face area is, say, 85 percent and it takes two cuttings to get this 85 percent, then one or both cuttings must be considerably larger than the minimum allowable sizes.

Because of kerf and end trim losses, the total surface area of all of the furniture cuttings sawed from a high grade board may be less than the area of the clearface cuttings used to determine the board grade. However, one should not conclude that this is a trend that will continue in the lower grades.

With No.2 Common, the situation is different. No. 2 Common is 2 Common because it does not contain sufficient area in few enough clear-face cuttings of sufficient size to be 1 Common. The normal 2 Common yield range is 50 to 66-2/3 percent. It is sometimes possible to exceed the 66-2/3 percent upper limit of 2 Common and still not be 1 Common. This occurs when more cuttings are needed to get the grading surface area than are allowed for No.1 Common and/or one or more cuttings is below the 3 inch by 3 foot or 4 inch by 2 foot minimums of the No.1 Common grade.

When the maximum number of grading cuttings are used for No.2 Common, there may still be other areas almost as large that cannot be considered in determining the grade. These areas contain small parts that add to the yield but do not contribute to the establishment of the grade. While these areas may be found in all grades, our experience is that their effects on yield are more important in No.2 Common than in the higher grades, because there are more defects present in No. 2 Common to delineate these areas.

There is an additional factor in the construction of the grades that can contribute to higher parts yields from No.2 Common than might be expected in comparison with No.1 Common. For No.1 Common, an additional cutting is allowed in boards with 3 to 10 feet surface measure provided the clear-face yield is at least 75 percent. This is in the middle of the normal No.1 Common range. For No.2 Common, an extra cutting is allowed in boards with 2 to 7 feet surface measure when the clear-face yield is at least 66-2/3 percent. This is at the top of the normal No.2 Common range. Thus, anytime an extra cutting is used to grade a board No.2 Common, that board has a clear-face yield in the No.1 Common range. Expert lumber graders who have reviewed this paper suggest that the practice of edging and trimming No.2 Common boards to smaller No.1 Common boards of much higher net value will reduce the occurrence of this factor in the marketplace.

In a study currently in progress, we are examining the effect of crook or board side bend on yield when gang-ripping narrow boards. Twenty-nine No.1 Common and 32 No.2 Common boards from 10 to 16 feet long and 5 to 8 inches wide (mostly 5 to 6 in.) are being processed with computer simulation. Crook amounts vary from 1/2 inch to more than 2 inches in each sample. When determining grades, diagonal cuttings are not permitted. Because of this exclusion, a crooked board can be of a lower grade than it would be if straight because of the number of cuttings required to determine the clear-face yield. All No.1 Common boards were within the normal No.1 Common clear-face range of 67 to 83 percent. For No.2 Common, 8 of the 32 boards had grading surface areas of67 to 74 percent. Two boards in the 70 to 74 percent range required the extra cutting rule to be used to determine the grade.

The crooked boards were divided into four groups depending on the amount of crook (1/2, 3/4, 1 and 1-1/4, and 1-1/2 in. and greater - Table 3). Because crook is a deviation from the norm, there should be more boards in the 1/2-inch class than in the 3/4-inch class, more in the 3/4-inch class than in the I-inch class, and so on.

The summary results presented here are for gang-ripping with a fixed arbor such that the saw spacing and kerf will cover the entire width of each board plus the crook. Individual saw spacings varied from 1-1/2 inches to 3 inches in 1/4-inch increments. Regardless of the combinations used, the widest spacing was used first. A 1/4-inch cleanup rip was used on each edge and a 1/4-inch kerf was used for sawing within boards. For example, a 5-1/2-inch-wide board with 1-1/4 inches of crook would be fed through saws with a total spacing of 6-3/4 inches. The saw spacings used in this simulation and for all 6-3/4-inch totals of board width plus crook were 2.25, 1.50, and 2.00 inches. To this is added 1 inch of kerf (two 1/4-in. edge cleanup kerfs and two 1/4-in. internal rip kerfs).

Defect data and board measurements were recorded for the full-length crooked boards and gang-ripping was simulated. The boards were then crosscut into two or three pieces to eliminate or greatly reduce the effects of crook. Defect data and crosscut piece measurements were recorded and the gang-rip simulation was repeated. Additional details for this procedure and information on other gang-ripping procedures being studied will be included in the report on the study "The Effect of Crook on Yield When Gang-Ripping Narrow Boards" that is currently in progress. It can be said in general, however, that total yields were similar for most of the procedures. Important differences do occur in length and width distributions of parts and whether the parts come directly from crosscutting the ripped strips (primary cuttings) or must be obtained with additional crosscuts and/or rips (secondary cuttings).

The parts yields results in Table 3 were for the fixed arbor gang-ripping procedures previously described and the part lengths shown in Table 2. All of the No.1 Common groupings have less parts surface area than grading surface area. A major dropoff occurred when gangripping boards with 1-1/2 inches of crook or more. For No.2 Common, the parts surface area was greater than the grading surface area except for the 1-1/2- inch and greater crook grouping. But, the reduction here was far less for No.2 Common than for No.1 Common.

Overall totals for the fixed arbor procedure with widest saw spacing first are given in Tables 4 through 7. These tables are the distributions of clear-two-face cuttings and all of the cells in each table add to 100 percent when rounding errors are ignored.

The total yield for the No, 1 Common full-length

TABLE 3. - *Grading yields and parts yields for some crooked No.1 Common and No.2 Common boards.*

Amount of crook	No. of boards	Grading yields	Parts yields
(in.)	------ (%) ------		
No.1 Common			
1/2	8	75.4	71.7
3/4	6	77.7	68.9
1 and 1-1/4	7	76.7	72.5
1-1/2 and greater	8	76.9	66.3
No.2 Common			
1/2	9	61.8	65.3
3/4	6	57.4	65.3
1 and 1-1/4	10	58.9	67.0
1-1/2 and greater	7	67.5	63.4

TABLE 4. - *Distribution of yield of parts surface area from full-length No. 1 Common crooked boards.* [a]

Part length	Part width (in.)							
	1.0	1.5	1.75	2.0	2.25	2.5	3.0	Total
(in.)	------ (%) ------							
15	1.0	0.4	0.1	0.8	0.6	0.7	0.7	4.3
18	1.3	1.2	1.2	1.2	1.1	1.2	2.0	9.2
25	0.9	0.4	0.5	0.8	0.9	0.3	0.4	4.3
29	0.7	0.9	0.0	1.2	0.4	0.4	0.5	4.2
33	0.7	1.6	0.9	0.4	1.2	0.4	1.6	6.8
38	1.3	2.5	0.7	0.8	0.5	0.0	3.7	9.4
45	0.6	0.4	1.3	1.5	0.6	0.0	0.7	5.0
50	1.6	2.8	0.5	2.2	1.8	1.5	0.8	11.1
60	1.5	7.3	2.8	1.3	2.9	0.0	0.0	15.8
75	4.2	13.4	1.4	7.3	2.7	1.0	0.0	29.9
Total	13.7	30.8	9.4	17.4	12.6	5.6	10.5	100.0

[a]Percent of total parts yield = 69.8. Percent of total parts yield in primary parts = 62.8. Percent of total parts yield in secondary parts = 37.2. Some rows and columns may not add to totals because of rounding errors.

TABLE 5. - *Distribution of yield of parts surface area from No.1 Common boards with crook crosscut out..*

Part length	Part width (in.) 1.0	1.5	1.75	2.0	2.25	2.5	3.0	Total
(in.)	(%)							
15	0.4	0.7	0.4	0.5	0.3	0.6	1.6	4.5
18	0.5	0.4	0.1	1.1	1.2	0.5	2.2	6.0
25	0.3	0.9	0.0	1.5	0.6	0.0	2.6	5.9
29	0.0	0.7	0.0	1.7	0.6	0.0	0.9	3.9
33	0.3	1.0	0.6	0.7	0.4	0.0	3.4	6.4
38	0.0	1.4	1.7	1.1	0.0	0.0	5.7	9.9
45	0.0	0.3	0.8	0.4	3.0	0.0	2.7	7.3
50	0.0	1.6	0.9	1.5	2.8	0.7	6.0	13.4
60	0.4	2.2	2.6	1.8	2.0	0.0	5.4	14.5
75	0.0	2.8	4.6	4.5	5.1	0.0	11.2	28.2
Total	1.9	12.0	11.7	14.8	16.1	1.8	41.7	100.0

[a]Percent of total parts yield = 74.0. Percent of total parts yield in primary parts = 91.7. Percent of total parts yield in secondary parts = 8.3. Some rows and columns may not add to totals because of rounding errors.

TABLE 6. - *Distribution of yield of parts surface area from full-length No. 2 Common crooked boards..*

Part length	Part width (in.) 1.0	1.5	1.75	2.0	2.25	2.5	3.0	Total
(in.)	(%)							
15	1.9	0.9	0.3	1.3	0.7	0.4	0.9	6.4
18	1.5	2.1	1.3	2.1	1.2	1.1	1.3	10.6
25	0.3	0.7	0.4	1.2	0.8	0.3	1.5	5.3
29	1.0	1.5	1.3	1.2	1.0	1.0	1.7	7.6
33	1.3	1.2	1.1	1.3	0.7	0.4	2.0	8.0
38	2.5	2.3	0.3	1.9	1.3	1.5	0.0	9.8
45	0.0	2.0	0.4	1.3	1.0	0.0	0.0	4.7
50	2.2	4.1	0.9	2.0	1.1	1.3	1.5	13.1
60	0.4	5.4	0.5	1.8	3.3	1.6	0.9	13.9
75	3.4	6.7	0.6	8.2	1.7	0.0	0.0	20.6
Total	14.5	26.9	7.1	22.3	12.8	6.6	9.8	100.0

[a]Percent of total parts yield = 65.4. Percent of total parts yield in primary parts = 59.1.Percent of total parts yield in secondary parts = 40.9. Some rows and columns may not add to totals because of rounding errors.

TABLE 7. - *Distribution of yield of parts surface area from No.2 Common boards with crook crosscut out..*

Part length	Part width (in.) 1.0	1.5	1.75	2.0	2.25	2.5	3.0	Total
(in.)	(%)							
15	1.1	0.4	0.9	0.8	0.2	0.4	1.4	5.2
18	1.3	0.4	1.9	1.3	0.4	0.0	4.9	-10.2
25	0.1	1.1	1.3	1.0	0.8	0.0	4.2	8.6
29	0.3	0.7	0.3	1.5	1.3	0.8	2.2	7.0
33	0.2	0.5	0.6	1.7	1.5	0.0	4.0	8.4
38	0.9	1.7	1.0	1.2	1.3	0.0	2.3	8.3
45	0.0	0.3	1.6	0.9	1.5	0.0	3.4	7.8
50	0.2	1.9	0.9	4.0	2.8	0.0	7.6	17.5
60	0.0	2.7	1.1	4.2	2.0	0.0	5.4	15.5
75	0.0	2.3	2.0	0.8	0.8	0.0	5.7	11.5
Total	4.2	12.1	11.5	17.2	12.8	1.2	41.0	100.0

. Percent of total parts yield = 66.3. Percent of total parts yield in primary parts = 85.9. Percent of total parts yield in seCondary parts = 14.1. Some rows and columns may not add to totals because of rounding errors.

crooked boards was 69.8 percent with 62.8 percent of this total in primary cuttings and 37.2 percent in secondary cuttings (Table 4). After crosscutting to eliminate crook, the total No.1 Common yield was 74.0 percent with 91.7 percent in primary and 8.3 percent in secondary cuttings (Table 5). Gang-ripping the full-length boards resulted in more long pieces than the needs shown in Table 2. Crosscutting out the crook resulted in two major changes. The amount of parts obtained simply by crosscutting the ripped strips (primary) increased almost 30 percent and the amount of narrow pieces was greatly reduced. Part of this reduction was due to the saw spacings used in processing the crosscut pieces. It is also considered important that the length distributions did not change much as a result of crosscutting.

For No.2 Common, the pattern of results was similar. The total yields were approximately the same, with 65.4 percent from the gang-ripped, full-length boards with crook (Table 6) and 66.3 percent from pieces resulting from crosscutting out the crook (Table 7). Of the full-length board total yield, 59.1 percent was in primary parts and 40.9 percent was in secondary parts. After crosscutting out the crook, 85.9 percent of the yield was in primary parts and 14.1 percent was in secondary.

As with No.1 Common, crosscutting out the crook resulted in fewer narrow cuttings. Unlike No.1 Common, however, there was a 9 percent reduction in the 75-inch cuttings surface area. Most of this was distributed in the 45-, 50-, and 60-inch length classes. In any event, as with No.1 Common, not enough surface area in the shorter lengths and too much surface area in the longer lengths were produced when compared to the needs of Table 2.

Are the reported yields realistic?

The reported parts yields are computer-derived maximums that may one day be achieved by automated defect-sensing and processing. It is highly unlikely that human operators alone can obtain these yields. Saw spacings on a single arbor will not always equal the full width of the board plus its crook. Eighteen saw-spacing combinations were used to obtain the yields reported here. Even if there were enough combinations, inaccurate feeding of the boards would reduce yields. The effects of these saw-spacing and operator factors will mostly be to reduce width yields. The ease with which the ripped strips can be handled at a cut-to-length saw should minimize any effects on length distributions, particularly if a back gauge is used.

Lumber users who purchase from producers who remanufacture lower grade boards to smaller, higher grade boards will probably not find as many No.2 Common boards with high percentages of grading yields as we have in our sample. These users will get lower yields than those having access to all No.2 Common and better boards as they come from the log.

While human-derived yields for both No.1 and No. 2 Common lumber will probably turn out to be less than those achieved with computer simulation, the relationships between the gang-ripped yields should remain the same. When the needs of the furniture and cabinet industries are considered, No.2 Common should give yields close to those from No.1 Common. While there will be less yield in the longest lengths, No.2 Common will still provide more long lengths than needed and not enough shorter lengths. Crosscutting out crook will increase the yields of primary parts from either grade.

A practical illustration

In Figure 1, a straight board with 7-foot surface measure has been constructed to illustrate the interactions of grades, gang-ripping, and part lengths. In Pair A, a board with two

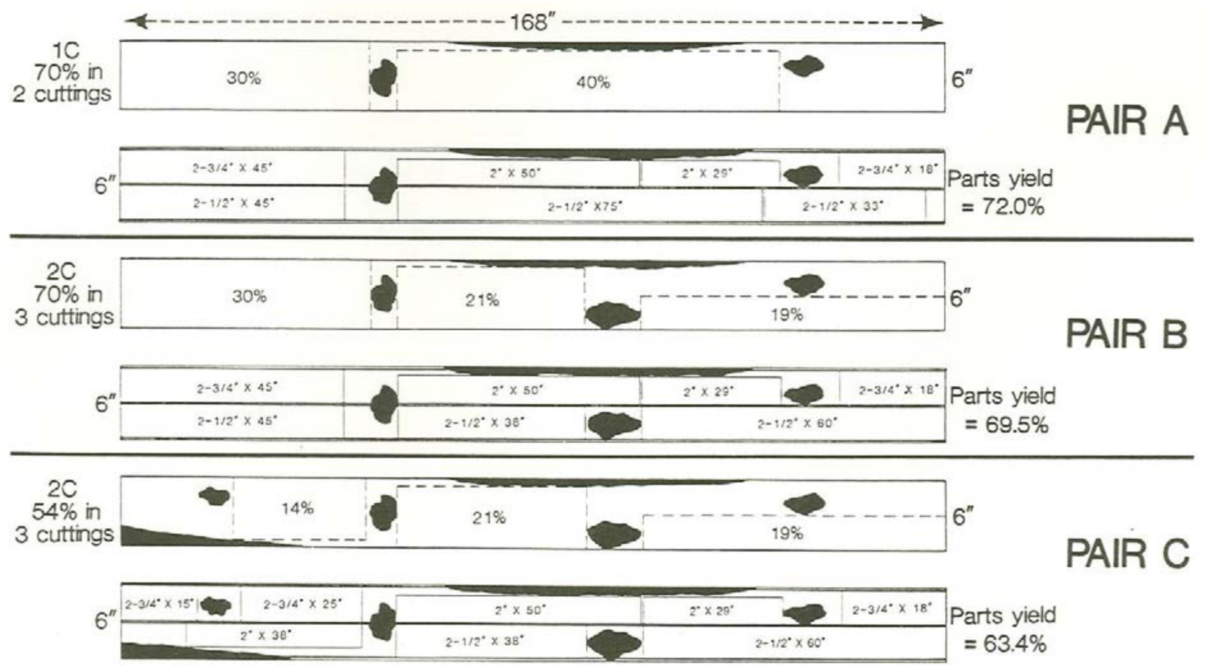

Figure 1. - Examples of the effects of decreasing grade on the yields from gang-ripping No.1 and No.2 Common lumber. Additional defects were added to Pair A to get the Pair B and Pair C boards. Drawing is approximately to scale.

large knots and some wane is graded No.1 Common because two cuttings of the minimum size or larger give a yield of 70 percent. When gang-ripped as shown, the parts yield is 72 percent.

In Pair B, an additional large knot is added, By chance, the clear-face surface area of 70 percent is the same as in Pair A, and all cuttings are larger than the minimum sizes for No.1 Common. But, because no two cuttings add to 66-2/3 percent and the total of the three cuttings is not 75 percent, the board must be graded No, 2 Common. The parts yield is 69.5 percent.

In Pair C, we add another knot and some additional wane to the Pair B board. The result is a No.2 Common board with 54 percent clear-face area in 3 cuttings, but a much higher 63 percent yield in needed parts, On a percentage basis, there is far more cuttings area in 38, 50, and 60 inches than is needed by the industry. This No. 2 Common board is not considered to be atypical.

The furniture or cabinet parts are produced with minimum machine operator decisions. The gang-ripped strips can easily be cut to length with the use of a back gauge, Two-thirds of the yield in Pair C is obtained simply by crosscutting the strips. The salvage yield can be readily recognized and there really are no choices to make. Some skill may be required in setting the width on the salvage ripsaw,

Summary

To some manufacturers for whom the cost of wood is a very small percentage of end-product value, the gang-ripping of lower grades of lumber may not seem worthwhile in comparison to the impact of changes in production sequences. But to those for whom the cost of raw material is a significant concern, the price differences among the grades may make a change in procedure worth looking into. In May 1988, the cost of air dry, 4/4 Appalachian red oak was $670 per MBF for No, 1 Common and $290 per MBF for No.2 Common (2), The interactions among grade construction and grade price, the parts needed by furniture and cabinet makers, and processing by gang-ripping first should enhance the value of No.2 Common lumber.

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