UNDERSTANDING THAT RED OAK LUMBER HAS A BETTER AND WORSE END

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ABSTRACT

We have found that the majority of red oak boards generally have one end that is distinctly better than the other and believe this finding applies to hardwoods, in general. Application of this knowledge can have important implications for lumber processing, particularly in gang-rip-first operations. The better ends produce better overall yield, more primary yield, less salvage yield, and more yield in longer and wider cuttings.

It is generally believed that defects in hardwood lumber are randomly distributed. We have found this not to be so for red oak lumber. If it were true, yields from the left end of a board would usually be the same as the yield from the right end when the ends are subjected to the same processing. We have found that, in general, red oak lumber has a better and a worse end and believe this to be true for hardwood lumber in general.

Defect locations are not entirely random. Defects such as pith or bark generally occur only in the center or outside of the log. Sound knots usually occur near the pith, and unsound knots usually occur near the bark. The location of knots along the board length is determined, in part, by the growth rate of the tree and how much natural pruning has occurred.

The effects of humans on defect locations also must be considered. Logs are usually bucked at the edges of major defects. Boards from these logs will start with relatively clear ends. At the sawmill, the sawyer will usually turn the log and select the depth of cut to maximize the yield of high-grade lumber. One objective is to group defects in as few boards as possible. Following sawing, boards are edged and trimmed. If the first several feet of a board produce a quality at the high end of a grade, the trimmer operator may leave attached additional, less valuable wood until the lower end of the grade is reached. This may occur more frequently as computerized electronic grading systems are used.

This report is part one of a two-part examination. Using the 1992 Data Bank for Red Oak Lumber (4) and the Advanced GAng RIp Simulator (AGARIS 1.0) computer program (6), several hundred red oak boards, 8 feet and longer in the FAS, No.1 Common, and No. 2A Common grades (5) were gang-ripped with arbors that produced narrow or wide strips. These boards represented the full range of quality within these grades. We then crosscut the original boards in half and repeated the gang-rip analysis. We found that the lower the grade, the more pronounced was the difference in overall quality from one end of the board to the other. Even in FAS boards, where there is little apparent difference in total yields, the difference in part-length distributions between the better and worse ends may have important processing implications.

In part two of the study, boards with 10 percent or greater end-to-end yield differences will be manually divided into two or more pieces based on defect location to evaluate some of the practical implications of this new knowledge.

THE STUDY

There were 198 FAS, 465 No.1 Common, and 537 No. 2A Common boards (4), 8 feet and longer, that were gang-ripped full-length in the computer. The same boards also were sawn in half within the computer, and the halves were gang-ripped to the same specifications. The purpose of the study was to determine whether important yield differences exist between ends and to compare these "yields" to those from full length boards.

Two arbor setups were used: one to produce primary cutting widths from 2 to 5 inches and another to produce primary cutting widths from 1.25 to 2.75 inches. Fixed part lengths, from 15 to 72 inches, were produced using two crosscutting (chopping) methods. The 1-length method always took the longest possible cutting between two defects. The 3-length method fitted the three lengths that gave the greatest primary yield between the two defects.

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TABLE 1. - Better and worse half-board yield comparisons from all 8-foot and longer full-length boards.

Grade and no. of boards	Arbor setup	Better ends (all lengths) Primary	Salvage	Total	Worse ends (all lengths) Primary	Salvage	Total
		- - - - - - - - - - - - - - (% of lumber input surface)- - - - - - - - - - - - - -					
FAS	3.0 * 2.0	**82.2**[a]	**3.0**	**85.2**	**75.6**	**5.1**	**80.7**
(n = 198)		*88.0*[b]	*1.7*	*89.7*	*79.1*	*5.7*	*84.8*
	1.5 *1.25	**78.7**	**1.1**	**79.8**	**73.9**	**2.6**	**76.5**
		83.6	*0.8*	*84.4*	*78.0*	*2.6*	*80.6*
No. 1 Common	3.0 * 2.0	**71.6**	**6.8**	**78.4**	**56.0**	**11.4**	**67.4**
(n = 465)		*75.4*	*6.0*	*81.4*	*57.9*	*11.2*	*69.1*
	1.5 * 1.25	**72.0**	**2.7**	**74.7**	**60.8**	**4.0**	**64.8**
		75.7	*2.5*	*78.2*	*63.6*	*3.8*	*67.4*
No. 2A Common	3.0 * 2.0	**60.5**	**11.2**	**71.7**	**44.3**	**14.3**	**58.6**
(n = 537)		*62.9*	*10.5*	*73.4*	*45.2*	*14.4*	*59.6*
	1.5 * 1.25	**65.5**	**3.9**	**69.4**	**52.9**	**4.6**	**57.5**
		68.4	*3.5*	*71.9*	*54.8*	*4.5*	*59.3*

[a] Boldface numbers are the values for the 1-length method (longest single length between two defects is taken out first).

[b] Italic numbers are the values for the 3-length method (three-length combination giving highest surface area in primary parts between two defects is taken).

TABLE 2. -Amount of yield differences between better and worse halves of full-length boards.

Grade and no. of boards	Arbor setup	Percent difference in primary yields between better and worse ends 0 to 4	5 to 9	10 to 14	15 to 19	20 to 29	30 to 39	40+	Total
		- (% of boards) -							
FAS	1.5 *1.25	**55.1**[a]	**26.8**	**13.6**	**3.5**	**1.0**	- -	- -	**100**
(n = 198)		*55.6*[b]	*25.3*	*12.6*	*4.5*	*2.0*	- -	- -	*100*
	3.0 * 2.0	**34.3**	**26.8**	**16.7**	**9.6**	**10.6**	**2.0**	- -	**100**
		36.9	*24.3*	*14.1*	*12.1*	*10.1*	*2.5*	- -	*100*
No. 1 Common	1.5 *1.25	**24.5**	**22.6**	**17.6**	**14.0**	**15.5**	**4.9**	**0.9**	**100**
(n = 465)		*21.9*	*23.2*	*16.1*	*14.9*	*16.8*	*6.2*	*0.9*	*100*
	3.0 *2.0	**16.3**	**16.6**	**12.5**	**13.1**	**18.3**	**11.0**	**12.2**	**100**
		14.0	*15.7*	*13.3*	*13.6*	*17.0*	*12.0*	*14.4*	*100*
No. 2A Common	1.5 *1.25	**25.1**	**18.3**	**18.1**	**10.8**	**16.8**	**7.0**	**3.9**	**100**
(n = 537)		*23.3*	*18.1*	*15.4*	*13.6*	*16.6*	*8.7*	*4.3*	*100*
	3.0 * 2.0	**17.7**	**14.0**	**14.5**	**11.7**	**16.8**	**12.1**	**13.2**	**100**
		16.8	*11.5*	*14.7*	*11.2*	*17.7*	*12.5*	*15.6*	*100*

[a] Boldface numbers are the values for the 1-length method (longest single length between two defects is taken out first).

[b] Italic numbers are the values for the 3-length method (three-length combination giving highest surface area in primary parts between two defects is taken).

UNDERSTANDING GANG-RIP ARBOR SETUPS AND SIMULATIONS

We used the fixed arbor with movable outer blade option of the AGARIS 1.0 computer program (6). In this simulation, a combination of fixed and random width strips is used to eliminate edgings. A single fixed width is repeated until the outer edge of the board is approached. When the board remainder is less than the fixed width, but equal to or greater than a specified minimum width, the computer moves the outside saw to the edge of the board and the narrow strip is taken. If, however, the remainder of the board is narrower than the minimum specified strip width, then the last fixed-width strip is not taken. Instead, the outer blade is moved directly to the board edge and a strip wider than the repeated width is taken. Salvage part widths within strips were in 1/4-inch increments with a I-inch minimum width.

Fixed arbor with movable outer blade setups are specified, for example, as 3.0*2.0 (3 in. by 2 in.). The range of strip widths that can be generated is 2.0 to 5.0 inches with the 10-inch width being repeated as many times as possible. When used with straight boards, this procedure produces no edging waste and allows a clearer understanding of yields. Any yields narrower than 2.0 inches (in this example) can only come from salvage operations. Any yields wider than 3.0 inches can only come from moving the outer blade. Most primary yields will be in the repeated width (3.0 in.). This allows easy comparisons of the effects of narrow and wide simulations on part-length distributions.

We used 3.0*2.0 and 1.5*1.25 simulations in this study to compare the effects of wide versus narrow strip widths on yields. Part-length specifications were based on the needs of industry as shown by Araman et al. (1). Lengths of 15, 18,25,29, 33, 38,45, 50, 60, and 72 inches were used. To obtain these lengths, program AGARIS 1.0 was operated with two crosscut methods: the single longest length method (I-length) and the three longest lengths method (3-length). In the I-length method, the longest single length between two defects is always taken even if the total yield suffers. For example, if the distance between two defects in a gangripped strip is 84 inches, the program will cut a 72-inch length and waste 12 inches. In the 3-length method, the program searches for that combination of three lengths that will give the same or greater yield than the best combination of two lengths or the longest single length. In this example, the 3-length method will yield 50-, 18-, and IS-inch strips (the best 2-length yields are 50 and 33 inches). The 3-length method should be of interest to the kitchen cabinet maker because the amount of very long lengths is reduced and yields are more uniformly spread over the length groupings.

UNDERSTANDING YIELDS

Much emphasis is often placed on total yield. However, this value fails to fully describe the conversion efficiency of a gang-rip-first operation. For greatest success, a gang-rip-first process should produce the desired part lengths with as little salvage as possible. If there is a wide range of uniformly spaced part lengths, with the shortest cutting being 10 to 15 inches long, and there is also a wide range of widths, with the narrowest being 1 inch wide, our experience shows that the total yields will be about the same no matter how the boards are processed. A procedure that gets a substantial portion of the total

TABLE 3. — Full-length lumber length-width distribution.

Grade	Standard length	Width (in.)										No. of boards
		4	5	6	7	8	9	10	11	12	13	
	(ft.)											
FAS	8	--	--	4	2	3	2	--	--	--	--	11
	9	--	--	2	1	1	4	1	--	--	--	9
	10	--	--	2	5	10	9	4	4	--	--	34
	11	--	--	--	1	1	1	--	--	--	--	3
	12	--	--	4	6	13	15	6	2	1	--	47
	13	--	--	--	--	1	1	--	2	--	--	4
	14	--	--	8	8	4	8	8	5	1	--	42
	15	--	--	--	--	--	--	--	--	--	--	--
	16	--	--	12	6	11	5	6	5	3	--	48
	Total	--	--	32	29	44	45	25	18	5	--	198
No. 1 Common	8	3	11	16	19	19	10	10	2	3	--	93
	9	--	--	4	10	3	--	--	1	1	1	20
	10	1	30	24	19	7	11	11	9	2	--	114
	11	--	6	4	0	2	--	--	--	--	--	12
	12	2	32	21	14	6	11	5	2	7	1	101
	13	1	1	--	2	--	--	--	--	--	--	4
	14	--	19	9	9	2	15	4	5	3	--	66
	15	--	--	--	--	1	--	--	--	--	--	1
	16	--	16	10	8	7	6	2	5	--	--	54
	Total	7	115	88	81	47	53	32	24	16	2	465
No. 2A Common	8	2	30	30	21	13	14	18	3	3	--	134
	9	--	3	5	5	--	--	--	--	--	--	13
	10	4	41	31	34	12	10	2	1	--	--	135
	11	--	3	1	1	--	--	--	--	--	--	5
	12	--	31	28	23	9	6	1	5	1	--	104
	13	--	5	2	1	--	--	--	--	--	--	8
	14	2	39	12	10	5	9	3	4	1	--	85
	15	1	1	--	1	--	1	--	--	--	--	4
	16	3	18	7	5	8	5	2	--	1	--	49
	Total	12	171	116	101	47	45	26	13	6	--	537

yield from salvage may not be as desirable as one that gets less overall yield when that yield comes from simply crosscutting full-width strips to length (primary parts). In this study, we emphasize the analysis of primary part yields.

Industry should be able to get most of the primary yields that our computer finds. Yields are clear-two-face parts that are full width. Salvage, however, is a different matter. The computer always places the salvage sawcuts in the defects. A human might remove more clear wood to ensure complete defect removal and, thereby, produce salvage with smaller dimensions.

Our yields are expressed as a percentage of the surface area of input lumber. Yield figures based on area will indicate, in general terms, whether there is enough yield in a given grade to satisfy cutting bill needs. Surface area percentages are summary numbers and provide easy and direct comparisons.

When total surface-area yields are similar, as in this study, certain general statements can be made. The narrower the gang-ripped strips, the greater the total number of parts produced per thousand board feet (MBF). Within an arbor setup, the 3-length method produces more parts than the I-length method. There are more primary and fewer salvage parts produced as saw spacings on the arbor are made narrower.

RESULTS

BETTER VERSUS WORSE END COMPARISONS

The computer was used to crosscut each full-length board to two pieces of equal length that were then processed with the same arbor setups and to the same length specifications as the full-length boards. Over the several hundred boards used (198 FAS, 465 No. I Common, and 537 No. 2A Common), there was a definite difference in overall yields between the ends. An overview is shown in Table 1. The worse ends contained less overall yield, less primary yield, and produced more salvage than the better ends. This was true for both 1-length and 3-length methods of operation.

There are other trends shown in Table 1. Under any conditions, FAS produced very little salvage. For the wide arbor (3.0*2.0), No. 2A Common produced more salvage and considerably less primary yield than No. I Common. These differences were not as pronounced for the narrow arbor (1.5* 1.25). Because of increased amounts of kerf, the 1.5* 1.25 setup produced less overall yield. It also produced less salvage yield.

How many boards had yield differences from end to end? The answers, based on total surface area yield of primary cuttings, are given in Table 2. The primary yield from one end of each board was compared to the other and sorted according to the amount of the difference. For narrow strips (1.5*1.25 arbor), 18.1 percent of the FAS boards had a 10 percent or greater end-to-end difference in yield. More than half of the No. I and No. 2A Common boards had 10 percent or more end-to-end yield differences. For the wider arbor

(3.0*2.0), more than 30 percent of the FAS and two-thirds of the No.1 and No. 2A Common had 10 percent or more differences in yield. In fact, a large percentage of the No.1 and No. 2A Common boards had 30 percent or more end-to-end yield differences.

Boards with 0 through 4 percent yield differences were considered to be practically the same. When processed to narrow strips (1.5*1.25 arbor), one out of two FAS boards and only one out of four No.1 or No. 2A Common boards yielded the same percentages of primary parts from either end. When wide strips were generated, this dropped to one in three for FAS and only one in six for the Common grades.

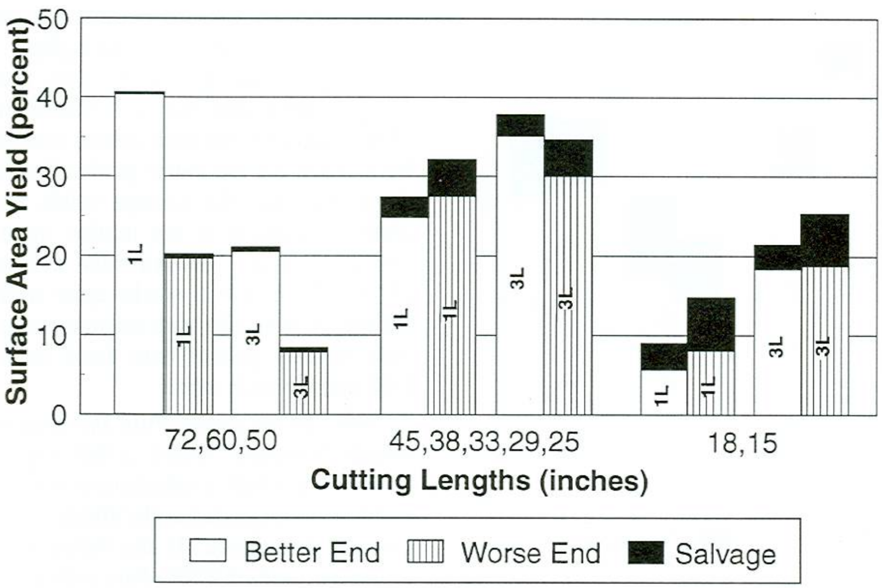

Figure 1. - Yield of short-, medium-, and long-length cuttings from the better and worse halves of 8-foot and longer boards; NO.1 Common lumber, wide arbor setup (3.0*2.0); 1 L = 1-length method of chop saw optimization; 3L = 3-length method of chop saw optimization.

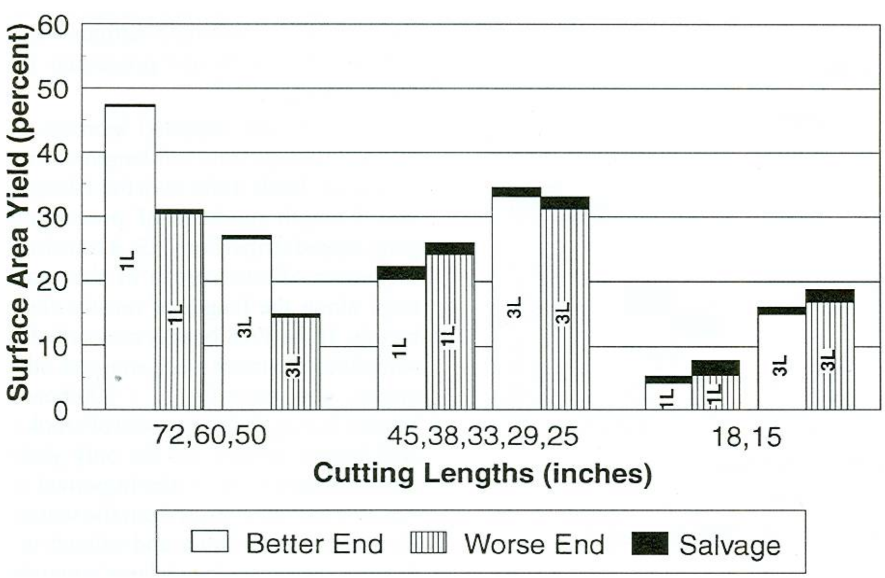

Figure 2. - Yield of short-, medium-, and long-length cuttings from the better and worse halves of 8-foot and longer boards; NO.1 Common lumber, narrow arbor setup (1.5*1.25); 1 L = 1-length method of chop saw optimization; 3L = 3-length method of chop saw optimization.

Because more defects might be expected in the lower grades, it is not surprising that there are more and bigger differences in end-for-end yields between FAS and the Common grades. What is surprising is the similarity between No.1 and No. 2A Common and the I-length and 3-length methods. The importance of these differences can best be evaluated by an analysis of the distribution of part lengths. .

For comparison, it is useful to discuss the results that could be expected from processing only clear wood. For the 1-length method, when we cut a 16-foot board to two 8-foot or 96-inch-long halves, we will take a 72-inch piece first. An 18-inch piece is all that can be taken next according to the cutting lengths used in this study. This leads to an inflation of the numbers in the 18-inch lengths and a deflation in the number of 25-inch lengths. Change the 25-inch length to, say, 23 inches, and the distribution of the shorter lengths will reverse because a 72-inch and a 23-inch piece will fit in the 96-inch-long clear piece with a higher yield than the 72- and 18-inch pieces.

Another factor affecting yields is the length distribution of the full-length boards used in the study. It is not possible to get 72-inch-long pieces when 8foot and lO-foot boards are cut in half Only 48- and 60-inch maximum lengths can be found here. Table 3 gives the length-width distribution of the boards used. Of the No.1 Common boards, 51.4 percent (239 of 465 boards) will not yield a 72-inch-long cutting when cut in half because they are less than 12 feet long. For No. 2A Common, the amount is 53.4 percent (287 of 537 boards). Only 28.8 percent of the FAS boards would not yield a 72-inch-long cutting (57 of 198 boards).

Therefore, it is important that the reader use the results mainly to compare trends, arbor setups, and relative yields from better and worse ends. The AGARIS 1.0 program and data banks are available for those who would like to try other combinations.

From this point on, we will discuss the actual yields as a percentage of the lumber input surface area. Thus, for 4/4 lumber, the surface area in square feet that can be expected from I MBF of lumber input can be determined simply by moving the decimal point one place to the right (e.g., 65.0% yield equates to 650 ft.^{2} of parts per 1 MBF). By dealing in percentages, the numbers between grades and arbor setups are directly comparable.

Grouped length distributions of primary and salvage parts for the Common grades is shown in Figures 1 through 4. Primary yields from full-length boards are compared in greater detail to better and worse-end yields for all grades in Table 4.

As expected, the 3-length method produced higher total yields, fewer longer lengths, and a more uniform distribution of parts. For both arbors (3.0*2.0 or 1.5* 1.25), the decreases in the longest lengths (50, 60, and 72 in.) were quite large between the better and worse ends for both the 1-length or 3-length results.

The magnitude of the end-to-end differences in primary yield totals as well as primary long-length yields is larger in the Common grades compared to F AS (Table 4). We consider end-to-end yield differences of 10 percent or more to be important, and the yield differences in the common grades always exceeded 10 percent.

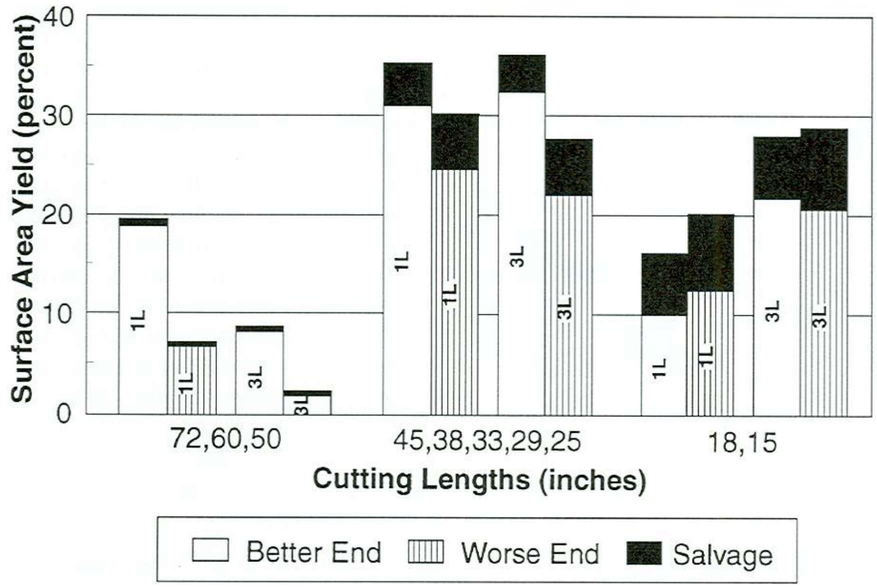

Figure 3. - Yield of short-, medium-, and long-length cuttings from the better and worse halves of 8-foot and longer boards; No. 2A Common, wide arbor setup (3.0*2.0); 1 L = 1-length method of chop saw optimization; 3L = 3-length method of chop saw optimization.

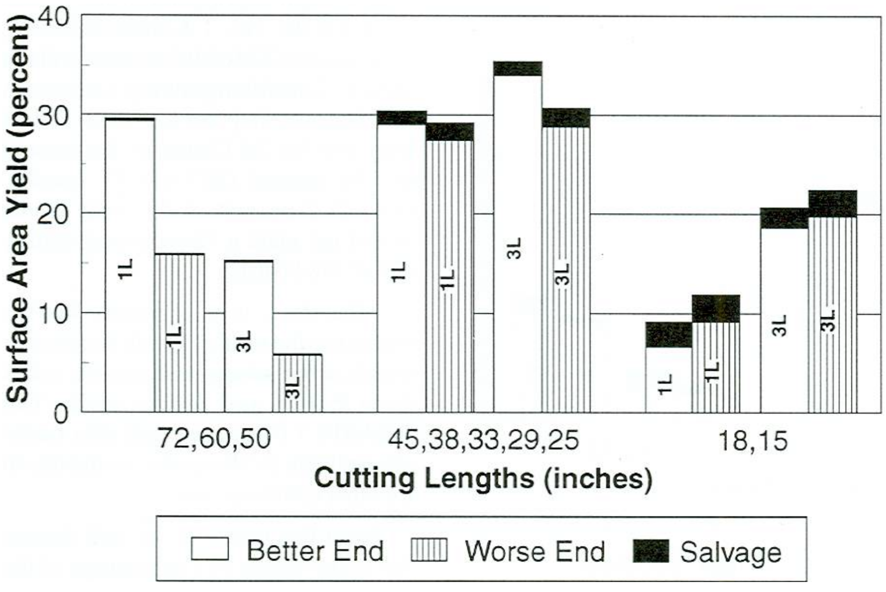

Figure 4. - Yield of short-, medium-, and long-length cuttings from the better and worse halves of 8-foot and longer boards; No. 2A Common lumber, narrow arbor setup (1.5*1.25); 1 L = 1-length method of chop saw optimization; 3L = 3-length method of chop saw optimization.

Discussing salvage from FAS lumber is probably trivial because of the small amounts found in this study. Even so, there are some differences between the better and worse ends. On the other hand, salvage yields from the Common grades are very important. The high percentages of salvage yields for the 3.0*2.0 arbor and No. 2A Common (Fig. 3) suggest that wide arbors should be avoided for the lower grades. From the worse ends, the salvage yields are about 13 percent of the lumber input surface area. The narrow arbor (1.5* 1.25), however, works quite well for the lower grades with salvage yields only slightly greater than those from FAS and the wide arbor.

How do the yields from full-length boards compare? When a full-length board is cut in half, a reduction in overall yield can be expected as the ability to fit cuttings is reduced. If the better and worse end totals in Table 4 are averaged, a 2 to 3 percent reduction in either primary totals or total yields (primary plus salvage) can generally be seen. Because cuttings begun in the better half could extend into the worse half of a full length board, one should expect to find more of the longest length cuttings when full-length boards are processed by gang-ripping.

For FAS, the expected increase in 72-inch cuttings from full-length boards did occur (Table 4) for both the I-length and 3-length methods of processing gang-ripped strips. For FAS, it is mainly a question of how best to fit clear cuttings along the length of mostly clear boards. If the FAS boards are perfectly straight (our current work suggests otherwise, with one-third of a 900-board sample having 1/2 in. or more of crook), and longest lengths are the only yield criterion, then it may not be important to separate the better ends from the worse. However, the furniture and cabinet industries do not need such large amounts of long lengths (l) and, for them, the 3-length method of obtaining yields may be more realistic. As before, the wide cutting bill

TABLE 4. - *Yield of primary cutting by length from fiill-length boards and from better and worse ends, by arbor setup.*

		3.0 * 2.0 arbor						1.5 * 1.25 arbor					
		1-length[a]			3-length[b]			1-length			3-length		
Grade	Primary length	Better ends	Full length	Worse ends	Better ends	Full length	Worse ends	Better ends	Full length	Worse ends	Better ends	Full length	Worse ends
	(in.)	- (% of lumber input) -											
FAS	72	49.3	57.9	38.1	16.0	30.9	12.2	51.4	58.8	42.7	16.7	32.8	14.4
	50,60	21.0	8.5	21.1	34.1	26.2	21.2	17.5	6.2	19.2	33.8	28.0	26.2
	38,45	4.8	8.9	7.4	12.8	11.0	13.3	3.9	9.1	5.1	12.0	9.6	12.3
	25, 29, 33	1.8	3.3	4.4	18.7	10.3	21.5	1.1	2.2	2.5	16.1	7.0	17.8
	15,18	5.3	3.3	4.6	6.4	5.8	10.9	4.8	2.8	4.4	5.0	3.7	7.3
	Primary total	82.2	81.9	75.6	88.0	84.2	79.1	78.7	79.1	73.9	83.6	81.1	78.0
	Total yield	85.2	86.0	80.7	89.7	87.8	84.8	79.8	81.1	76.5	84.4	82.9	80.6
NO.1	72	17.7	24.0	6.1	6.8	7.3	2.2	22.8	33.5	12.2	9.1	12.1	4.5
Common	50, 60	22.7	15.8	13.7	14.3	14.9	5.8	24.3	14.1	18.3	17.7	18.4	10.1
	38,45	14.8	10.6	14.3	9.8	10.1	8.3	14.1	9.0	14.1	8.9	10.6	8.9
	25, 29, 33	10.3	9.8	13.4	25.7	21.6	22.3	6.3	7.6	10.2	24.4	18.3	22.7
	15,18	6.1	5.8	8.5	18.8	15.0	19.3	4.5	4.3	6.0	15.6	12.0	17.4
	Primary total	71.6	66.0	56.0	75.4	68.9	57.9	72.0	68.5	60.8	75.7	71.4	63.6
	Total yield	78.4	75.2	67.4	81.4	77.2	69.1	74.7	71.9	64.8	78.2	74.4	67.4
No. 2A	72	4.8	8.9	1.2	2.1	2.0	0.3	10.5	19.3	4.8	4.5	5.1	1.5
Common	50, 60	14.2	13.1	5.6	6.1	6.4	1.6	18.9	14.9	11.1	10.7	11.3	4.3
	38,45	16.7	10.8	9.7	9.4	9.2	5.0	18.2	10.2	12.8	9.9	11.6	7.6
	25,29,33	14.6	12.6	15.1	23.2	20.4	17.3	11.0	10.1	14.8	24.3	20.1	21.4
	15,18	10.2	9.5	12.7	22.1	19.0	21.0	6.9	6.8	9.4	19.0	15.9	20.0
	Primary total	60.5	54.9	44.3	62.9	57.0	45.2	65.5	61.3	52.9	68.4	64.0	54.8
	Total yield	71.7	67.3	58.6	73.4	68.8	59.6	69.4	65.5	57.5	71.9	67.7	59.3

[a] In the 1-length method, the longest single length between two defects is taken out first.

[b] In the 3-length method, the three-length combination giving highest surface area in primary parts between two defects is taken.

TABLE 5. — *Primary yields from boards with 10 percent and greater end-to-end yield differences, by arbor setup.*

		3.0 * 2.0 arbor						1.5 * 1.25 arbor					
Grade	Primary length	Better ends	Full length	Worse ends	Better ends	Full length	Worse ends	Better ends	Full length	Worse ends	Better ends	Full length	Worse ends
	(in.)	- (% of lumber input) -											
		1-length[a] (n = 310)			3-length[b] (n = 325)			1-length (n = 244)			3-length (n = 254)		
No. 1	72	19.5	23.0	4.3	6.8	6.5	2.1	24.7	32.9	8.9	10.3	10.1	3.7
Common	50, 60	24.7	16.3	11.3	16.7	14.3	4.0	25.2	13.9	15.9	20.5	18.7	8.1
	38, 45	16.0	9.6	10.9	10.1	10.2	6.8	15.3	8.4	13.2	8.3	10.7	7.1
	25, 29, 33	9.3	9.5	13.6	27.1	21.9	20.0	5.7	7.5	10.9	24.3	18.3	21.3
	15, 18	5.8	6.1	9.3	18.0	14.8	19.0	3.9	4.3	6.5	14.8	12.2	17.8
	Primary total	75.3	64.5	49.4	78.7	67.7	51.9	74.8	67.0	55.4	78.2	70.0	58.0
	Total yield	78.8	74.6	66.2	81.8	76.8	67.8	76.2	70.8	61.6	79.5	73.4	64.0
		1-length (n = 366)			3-length (n = 383)			1-length (n =302)			3-length (n = 312)		
No. 2A	72	5.4	9.2	0.6	2.1	1.8	0.1	10.5	18.7	2.5	4.9	4.0	0.8
Common	50, 60	16.4	13.4	3.7	7.7	6.7	1.0	22.0	15.1	8.4	12.4	11.5	3.5
	38, 45	18.6	9.9	7.4	10.0	9.0	3.8	19.9	9.9	12.4	9.7	11.4	6.6
	25, 29, 33	14.7	11.9	13.5	24.8	19.8	14.9	9.8	9.7	14.2	25.3	19.9	18.7
	15, 18	9.6	9.0	12.1	22.5	18.7	19.3	6.2	6.3	9.2	18.8	15.6	18.9
	Primary total	64.7	53.4	37.3	67.1	56.0	39.1	68.4	59.7	46.7	71.1	62.4	48.5
	Total yield	71.7	66.6	57.0	73.7	68.2	58.1	70.5	64.2	53.7	73.0	66.4	55.4

[a] In the 1-length method, the longest single length between two defects is taken out first.

[b] In the 3-length method, the three-length combination giving highest surface area in primary parts between two defects is taken.

(3.0*2.0) requires better quality lumber for higher yields in the longer lengths.

For the Common grades, the full-length boards did not produce a much greater yield of 50-inch and longer pieces than the better ends of the boards (Table 4). For No. 2A Common, the yield patterns for the better ends and the full-length boards were quite similar. Further, cutting boards in half did not produce a great increase in the shortest lengths (15 and 18 in.).

YIELDS FROM BOARDS WITH 10% OR GREATER END-TO-END YIELD DIFFERENCES IN PRIMARY YIELDS

To achieve the results just described, some sort of vision system to perceive very small end-to-end yield differences, is required, particularly in the Common boards. But humans can easily separate boards with 10 percent or more differences. Results for these boards are given in Table 5. Note that within a grade there are different numbers of boards with 10 percent or more end differences depending on whether the 3.0*2.0 or the 1.5*1.25 arbor was used and whether the 1-length or the 3-length method of obtaining yields was used. Because yields are easier to get from narrow strips, there were fewer boards with 10 percent end-to-end yield differences for the 1.5*1.25 arbor than for the 3.0*2.0 arbor.

HOW MIGHT INDUSTRY EXPLOIT END-TO-END DIFFERENCES?

There are three reasons why gangrip-first rough mills should have the capability to crosscut lumber before gangripping. First, in the development of our lumber data banks, we have found that one-fourth of the Common boards and one-third of the FAS boards have 1/2 inch or more of crook or side bend. The negative effects of this crook on yields demand that crook be removed before gang-ripping (2,3). Second, removal of board ends with little or no potential yield should make the gang-ripping and subsequent processing of the remainder more efficient. Third, as shown by this paper, selective processing of board ends may offer an outstanding opportunity for increasing part value recovery. The better ends could be sorted for specific cutting bills or to produce hard-to-find lengths.

How much of an end-to-end yield difference should be present to warrant the extra handling costs involved in crosscutting and sorting ends for different cutting bills? This will depend on how valuable longer part lengths are to the operation and on the flexibility of the mill's handling and inventory system. A mill that frequently must run "rush" or "priority" orders for longer cutting lengths should benefit from grade sorting, end sorting, and scheduling.

In a gang-rip-first operation or a crosscut-first operation, opportunities for yield improvement may be associated with strip/lumber orientation before entering the chop and crosscut saws. Many chop or crosscut saw operators try to cut longer lengths and priority lengths from the leading end of a strip or board and only use the backgage when large defects or the trailing end of the board approach the saw. Leading with the better end should increase productivity from such operators.

Whether knowledge of the better-worse end relationship is of value may depend on many factors including lumber grades, cutting bills, arbor setups, crosscutting procedures (I-length, 3-length, or others), and operator tendencies. In part two of this study, we will examine the hundreds of boards with 10 percent or greater end-to-end differences to see the effects of manually determining the point of crosscutting according to defect locations (instead of simply cutting boards in half). Of greatest interest are the effects on productivity at the gang rip:; w.

Copies of AGAR. S 1.0 and the 1992 Data Bank for Red Oak Lumber may be obtained from the USDA Forest Service, Forestry Sciences Laboratory, Rt. 2, Box 562-B, Princeton, WV 24740.

The computer program described in this publication is available on request with the understanding that the USDA cannot assure its accuracy, completeness, reliability, or suitability for any other purpose than that reported. The recipient may not assert any proprietary rights thereto nor represent it to anyone as other than a government-produced computer program.

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