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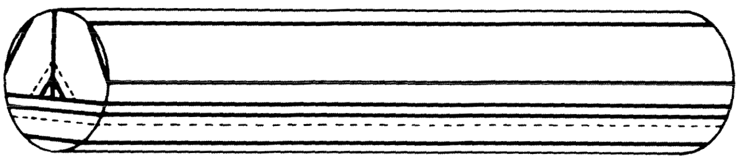
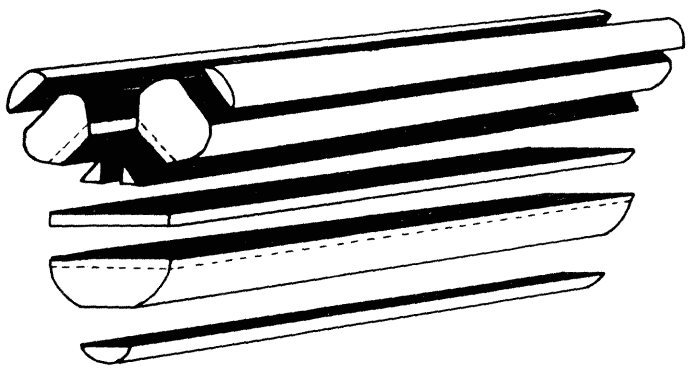
VOLUME RELATIONSHIPS IN SLICING NORTHERN RED OAK AND BLACK CHERRY LOGS

by Everette D. Rast





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Abstract

Veneer quality logs of black cherry and northern red oak from northern Pennsylvania were converted into sliced face veneer. The percentage yield of veneer for cherry was greater than oak due to tree form. Thirty-four percent of the total log volume of oak became chippable or fuel residue, but only 29 percent of cherry. Where and how this loss of material occurs in the veneering process is discussed.

INTRODUCTION

Much research has been done on veneering hardwoods, but very little work has been done on the relationship of products yielded during the veneering process, or the factors that affect these yields. In this study I have examined the volume relationship from the sawing of the log into flitches through the steaming, slicing, drying, and grading of the veneer. This is the type of information that log buyers and mill managers need to determine their recovery efficiency. It will help to estimate the percentage of yield of products as well as the portion of the log that is only used as chips or boiler fuel.

THE STUDY

Sample data

The data are from a veneer study conducted on the Allegheny National Forest in northern Pennsylvania. Samples of both black cherry and northern red oak were selected and graded using the interim Forest Service veneer-log grades as a guide (Rast et al. 1973). After felling, the veneer portion of each tree was bucked into log lengths of 8, 9, 10, or 12 feet. There were 98 cherry logs and 86 oak. The surface and ends of each veneer log were diagramed to provide a permanent record of the log defects. The length to the nearest inch and the diameter to the nearest 1/10-inch were measured and recorded. Also, a numbering system was used so that the veneer could be traced back to the flitch, log, position within the log, and the tree.

At the veneer plant, the logs were debarked and sawed into flitches. The number of flitches per log was determined by diameter specifications used at the veneer plant, but the breakdown for this study did not follow the specifications exactly—there was some overlap:

Flitches per log	*Diameter range (inches)*
2	*12 to 15*
3	*14 to 17*
4	*16+*

The flitches were heated in vats of water for about 36 hours, then end trimmed, and the faces cleaned with a hand-held rotary planer. Next, the flitches were sliced, and the veneer was dried and bound into "books."

Volume determination by categories

Figures 1a, 1b, and 1c illustrate how the logs were cut into flitches, and show the different products that resulted. During each phase of the veneer production, measurements were taken at various intervals to determine the volume of the products. All measurements (Tables 1 - 8, Appendix) are of green volume except a portion of the scrap veneer and the veneer itself, which are dry volume. Following is an explanation of the measurements and how they were obtained:

1. Volume of individual logs, in cubic feet. Diameter and length measurements were taken in the field, and the following formula was used to determine total log volume. Since these were veneer logs, there

Figure 1a.—2-flitch log.

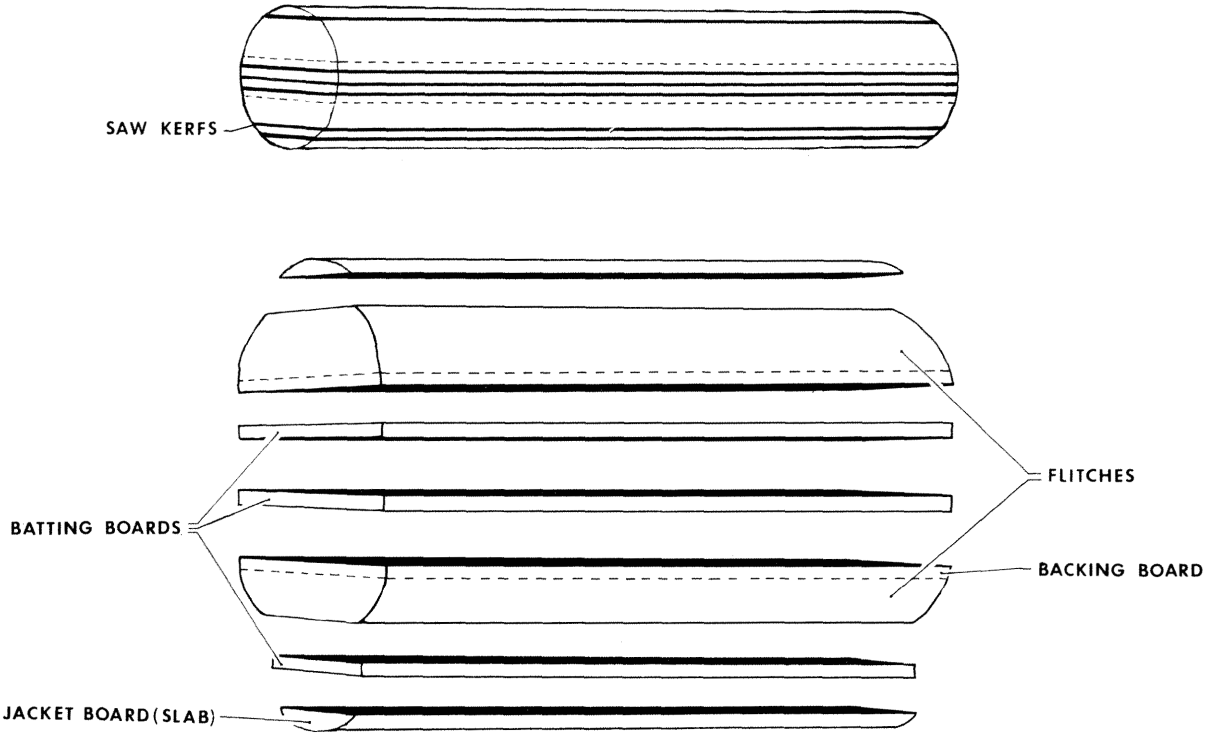


Figure 1b.—3-flitch log.

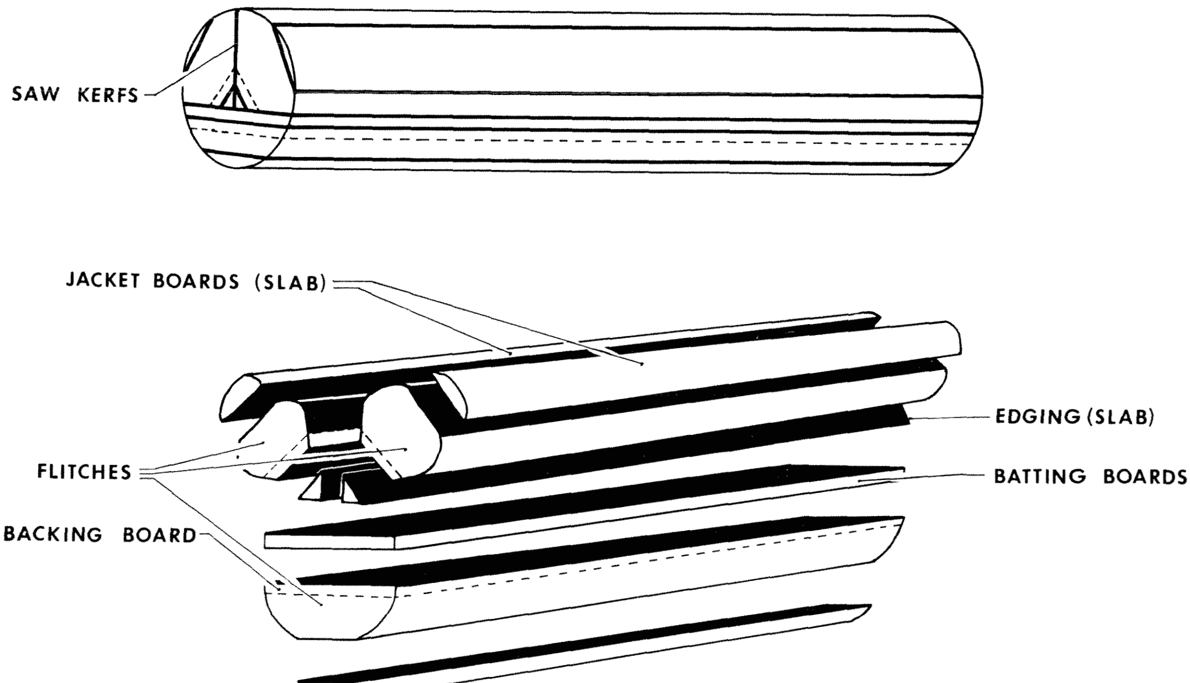
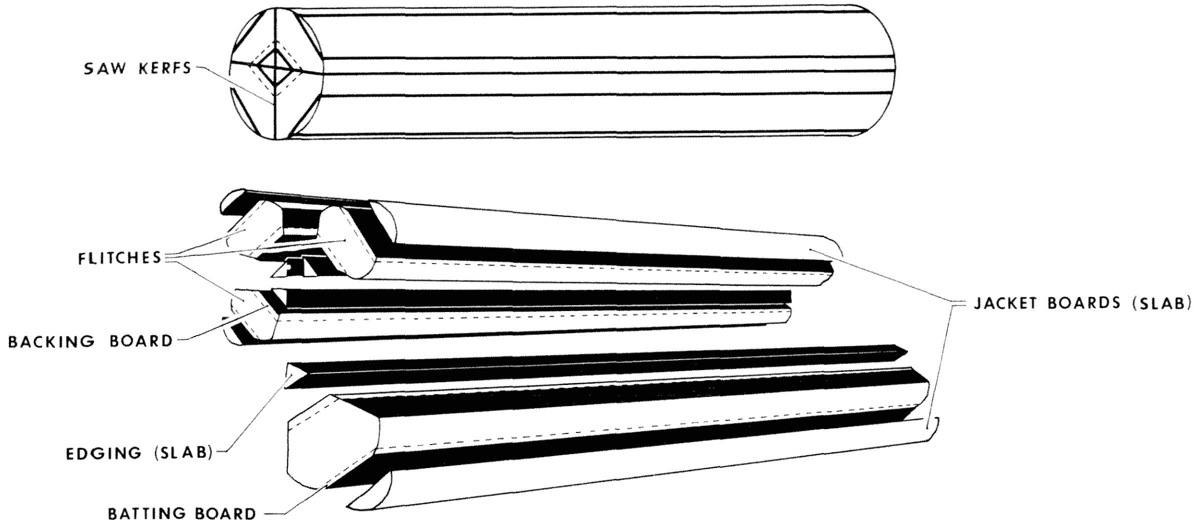


Figure 1c.—4-flitch log.



was no significant amount of volume-reducing defects for which scaling deductions had to be made.

a. Butt logs:

$V_{B1} = 0.001818\,(3.5)\,(D_S^2 + D_S D_L + D_L^2)$

$V_{B2} = 0.001818\,(L - 3.5)\,(D_S^2 + D_S D_L + D_L^2)$

b. Upper logs:

$V_U = 0.001818(L)\,(D_S^2 + D_S D_L + D_L^2)$

Where

V_{B1} = Cubic-foot volume of first 3.5 ft of butt log

V_{B2} = Cubic-foot volume of log length above first 3.5 ft of butt log

V_U = Cubic-foot volume of upper logs

L = Log length (1/10 ft)

D_S = Average small-end diameter of log inside the bark (1/10 in)

D_L = Average large-end diameter of log inside the bark (1/10 in)

2. Volume of batting board per log, in cubic feet.
Batting or batting boards are usable boards recovered during the process of sawing logs into flitches (see Figs. 1a-c). These were used as crating for the dried "books" of veneer. The thickness, width, and length of each board was recorded as it passed along the green chain.
3. Volume of individual flitches, in cubic feet.
Before the flitches were sliced, an outline of both ends of each flitch was traced on a sketch pad. These tracings were cut out and passed through an automatic area meter to obtain the end area in cubic centimeters. From the end area and the flitch length, the cubic volume was determined.
4. Volume of flitch end trim, in cubic feet.
By measuring the flitch before and after trimming, two different volumes for each flitch were obtained. Then end-trim volume was obtained by subtraction.
5. Volume of backing boards, in cubic feet.
The backing board or "dog" board is used to hold the flitch stationary during the slicing operation. After the flitch was sliced, the thickness, width, and length of the dog board was measured (Fig. 1a-c).
6. Volume of veneer, in cubic feet.
As the veneer came out of the dryers, each piece was graded and the width measured. Length was recorded only once for the entire flitch.
7. Volume of scrap veneer, in cubic feet.
Scrap veneer residue, which is produced at four different points in the veneering process, consists of:

a. The initial pieces of veneer sliced off the flitch until usable veneer is obtained.
b. Veneer pieces damaged during the slicing process.
c. The portion of the veneer clipped off the edges to even the books before drying.
d. Veneer ripped or torn when hung in the drying chain, and veneer with excessive buckling or curling caused by high heat.

The formula for volume was:

Scrap = Flitch − (Backing + Veneer)

8. Volume of slabs, shavings (from the flitches), and sawdust (S.S.S.), in cubic feet.

The formula for volume was:

S.S.S. = Log volume − (Batting + Flitch Ends + Flitch)

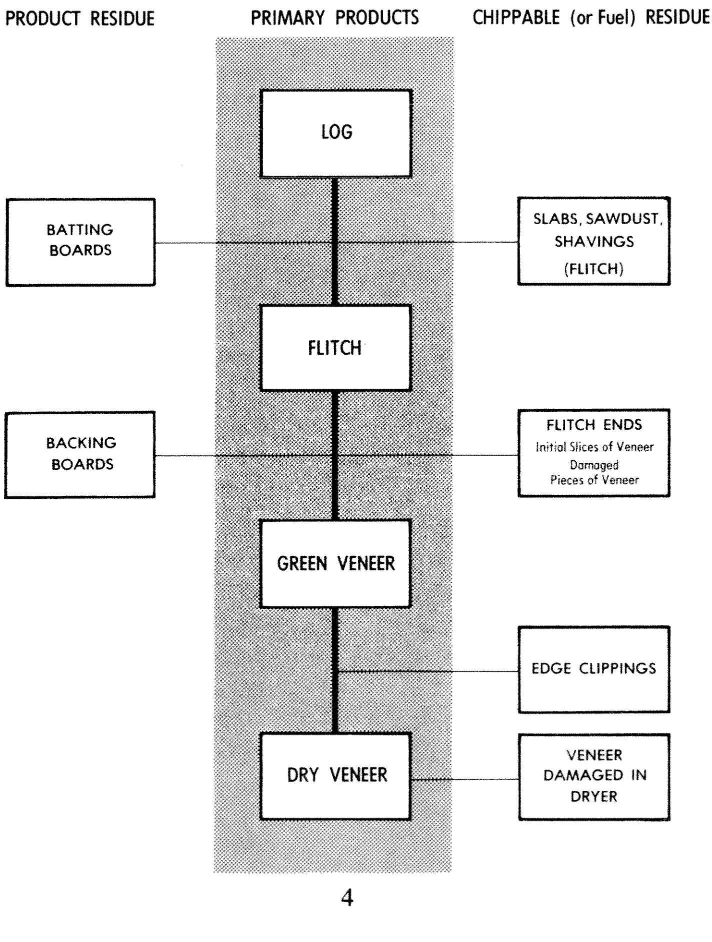
VOLUME YIELDS

The log components are grouped in three main categories (Fig. 2):

1. Primary products—log, flitch, green and dry veneer.
2. Product residue—batting and backing boards.
3. Chippable (or fuel) residue—slabs, sawdust, flitch shavings, flitch ends, initial slices of veneer, veneer damaged during slicing, edge clippings, and veneer damaged during drying.

The volume yield as a percentage of total log volume is quite different between oak and cherry for some categories. This is primarily due to the difference in the form (taper) of the butt log. Oak has considerably more butt swell than cherry. But once the flitch has been produced and the final products are compared as a percentage of flitch

Figure 2.—Breakdown of log components.



volume, there is little difference in yield between the species or within the species by these categories.

Product recovery as a percentage of total log volume

In terms of total log volume, the amount of product residue between the two species is similar. However, there is a significant difference in the amount of chippable residue produced (Figs. 3, 4). In the production of the oak flitches alone, over 25 percent of the total log volume is in chippable residue; whereas only about 20 percent of the total log volume is in this category for cherry. Continuing through the process to the final product—veneer—the percentage of chippable residue increases to 34 percent for oak and only to 29 percent for cherry. In the primary products, cherry flitch yields exceed that of oak by over 6 percent and cherry veneer yields exceed oak by over 4 1/2

Figure 3.—Black cherry log components as a percentage of total log volume.

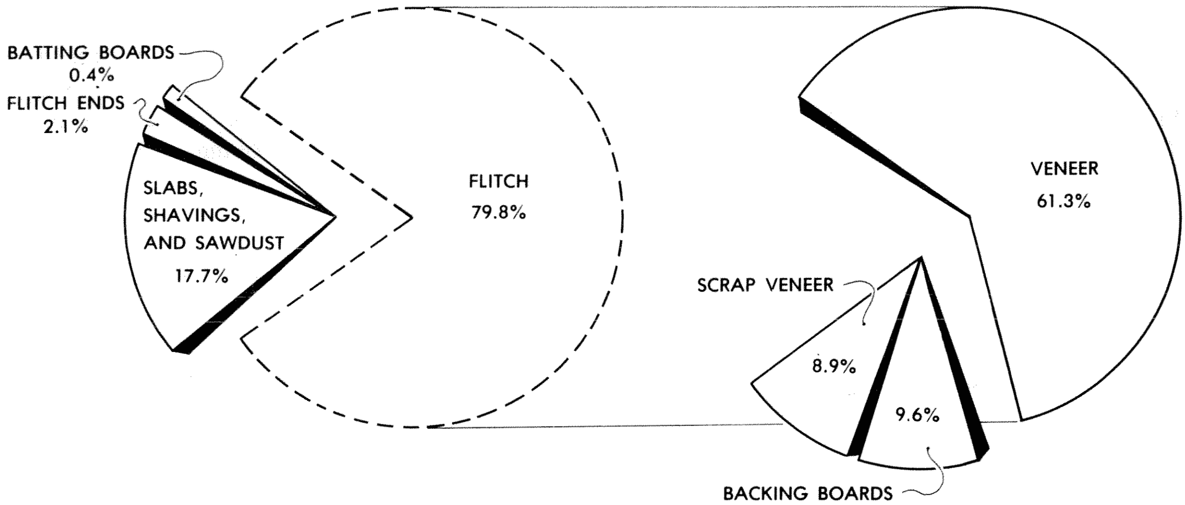
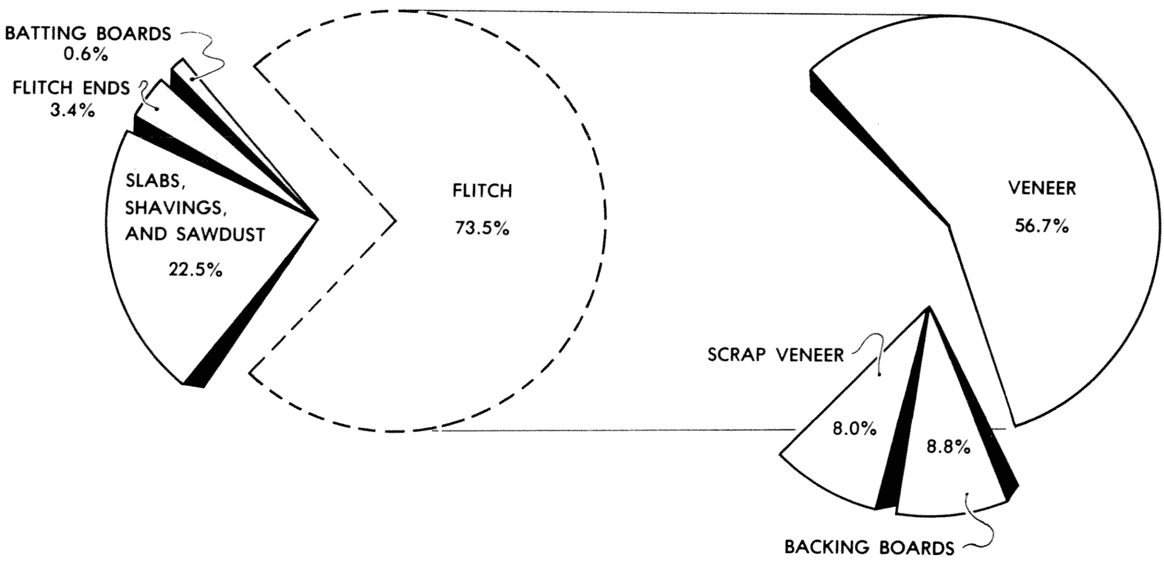


Figure 4.—Northern red oak log components as a percentage of total log volume.



percent. When the product residue is included, the total percentage of the log that is utilized, other than as fuel, is 66 percent of oak and 71 percent for cherry.

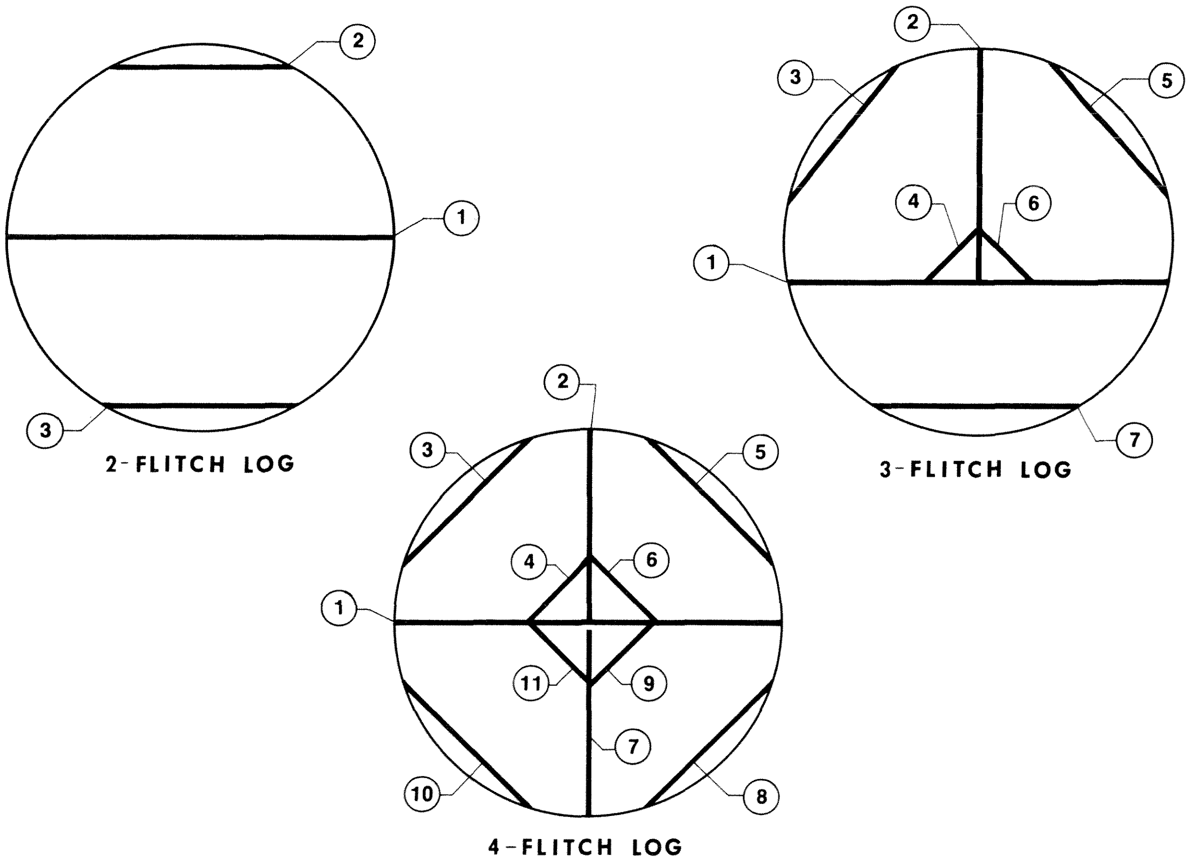
By dividing the logs of each species into groups of butt and upper logs (Table 1), it is quite obvious that the major differences between and within the species are in the butt logs. In fact, the volume percentages for the upper logs of oak and cherry are almost identical. Within the species, the difference between butt and upper logs for oak is much greater than for cherry.

The percentage of primary products plus product residue in the upper logs exceeds that of the butt logs. Two principal reasons account for this. One is that with the additional taper of the butt logs, the total log volume is increased more than the volume of the primary products and product residue. Second, butt logs contain a higher percentage of 4-flitch logs (Table 2). The percentage yield of primary product plus product residue from these logs is less than that of the 2- or 3-flitch logs (Table 3) because the percentage of batting and backing boards decreases as the number of flitches increases. One of the factors contributing to the inverse ratio between number of flitches and the percentages of primary product plus product residue is the number of saw cuts required to produce the flitches. The minimum number of saw cuts required by number of flitches (Fig. 5) is:

Flitches per log	*Saw cuts required*
2	3
3	7
4	11

Of course, if any batting boards are produced as the flitches are cut, then the number of saw cuts increases and volume is further reduced. Another factor is the change in the volume of product resi-

Figure 5.—End view of logs showing location and minimum number of cuts to produce 2, 3, or 4 flitches per log.



due among 2-, 3-, and 4-flitch logs. The backing board of the 2-flitch log is from the widest portion of the flitch whereas the backing board of the 4-flitch log is from the narrowest portion (see Figs. 1a and 1c). The volume of the 3-flitch log falls about halfway between the other two because of the location and number of cuts (Fig. 5).

From the mill owner's or manager's standpoint, the most important aspect of the breakdown by number of flitches (Table 3) is the increased yield of veneer as the number of flitches increases. This should be investigated further to determine if the cutoff points between the 2-, 3-, 4-flitch logs could be lowered to take advantage of this increase without lowering the total value of the veneer produced.

When log length is considered as a factor that affects yield, it becomes apparent that the same holds true for sawing and slicing veneer logs as for sawing logs for standard lumber—that is, as log length increases, the percentage of yield decreases (Table 4). As length increases, the taper normally increases, which results in an increase in slab volume and a decrease in the yield of the primary products. In this study, as in most log-grade studies, the butt logs tended to be longer:

Log length (feet)	*Butt logs*	*Upper logs*
8	21	61
9	10	9
10	37	31
12	12	3

Therefore, the additional taper of the butt logs compounds the taper problem, and results in a further decrease in the percentage of yield.

The breakdown by diameter cannot be adequately analyzed because there are not enough logs per diameter cell. The general trend indicates a decrease in yield of primary products as diameter increases.

Product recovery as a percentage of flitch volume

The previous data have all been based on the percentage of yield of the total log, and many differences were apparent. Now, if you consider the product yields based on flitch volume, you get a different perspective. When oak and cherry are compared (Table 5), the two are almost identical in the yield of backing boards, veneer, and scrap veneer. Also, there is little or no difference between butt and upper logs within or between species (Table 6). However, when the comparisons are made by number of flitches (Table 7), it becomes apparent that the yield of backing boards is inversely proportional and the yield of veneer is directly proportional to the number of flitches. The reason for the inverse proportion can be seen when you compare the width of the backing boards of the 2-, 3-, and 4-flitch logs (Fig. 1a-1c). The backing board comes from the widest portion of the flitch for the 2-flitch log and from the narrowest portion of the 4-flitch log. The 3- flitch log falls about halfway between because it is composed of one flitch that is a little less than one-half of the log, and each of the other two are a little larger than one-fourth of the log. Even though the volumes of both backing boards and veneer vary, the decrease in one is almost exactly offset by the increase in the other. The percentage of scrap and backing plus veneer both verify this.

Log length, according to these data, has little or no effect on the yields as a percentage of flitch volume (Table 8).

Even though the number of logs per cell is small, as previously stated, it can be seen that diameter has the same inverse relationship with backing boards and direct relationship with veneer as does the number of flitches. This is to be expected, since the number of flitches is almost perfectly correlated with diameter.

SUMMARY

The primary purpose of this study is to show the relationships between the various components that are produced when logs are processed into sliced veneer.

Since the veneer logs utilized in this study were virtually free of volume-reducing defects, the main cause of volume difference between logs of equal scaling diameter is attributed to taper. The analysis of differences between butt and upper logs support this. The comparison by species shows that form (or taper) is quite different between oak and cherry. Figures 3 and 4 give an overall view of the breakdown of components by species.

Of spécial interest to mill owners or managers is that the yield of veneer increases as the number of flitches increases (Table 3). Also, there are four stages in production that I feel should be closely examined to determine ways to reduce the loss of material that could become veneer. The percentages of residue are:

Residue	*Oak*	*Cherry*
Batting boards	0.6	0.4
Backing boards	8.8	9.6
Flitch ends	3.4	2.1
Scrap veneer	8.0	8.9
Total	20.8	21.0

These figures show that if these residue products could be reduced by 50 or even 25 percent, then this could result in a 5 to 10 percent increase in veneer volume.

ACKNOWLEDGMENTS

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Appendix

Table 1.—Percentage of total log volume of butt and upper veneer logs, by species, products, and residue.

Species	No. of logs	Products residue		Chippable (or fuel) residue				Primary products		Total products residue + veneer
		Batting Boards	Backing Boards	Flitch ends	Slabs, shavings, sawdust	Scrap veneer	Total fuel residue	Flitch	Veneer	
					BUTT LOGS					
Oak	39	0.4	7.9	3.9	28.4	7.0	39.3	67.3	52.4	60.7
Cherry	41	0.4	9.1	1.7	20.8	8.1	30.6	77.1	59.9	69.4
					UPPER LOGS					
Oak	47	0.9	10.0	2.7	15.4	9.2	27.3	81.0	61.8	72.7
Cherry	57	0.5	10.1	2.4	14.8	9.6	26.8	82.3	62.6	73.2

Table 2.—Percentage of flitches from butt and upper logs, by species.

Log position	2-flitch		3-flitch		4-flitch	
	No. of logs	Percent	No. of logs	Percent	No. of logs	Percent
			OAK			
Butt	11	28	5	13	23	59
Upper	10	21	13	28	24	51
			CHERRY			
Butt	9	22	6	15	26	63
Upper	15	26	10	18	32	56

Table 3.—Veneer log products and residue as a percentage of total log volume, by species and number of flitches.

No. of flitches	No. of logs	Products residue		Chippable (or fuel) residue				Primary products		Total products residue + veneer
		Batting boards	Backing boards	Flitch ends	Slabs, shavings, sawdust	Scrap veneer	Total fuel residue	Flitch	Veneer	
					OAK					
2	21	2.4	12.8	5.6	20.0	7.0	32.6	72.0	52.2	67.4
3	18	1.0	10.5	2.9	19.7	8.1	30.7	76.4	57.8	69.3
4	47	0.2	7.5	3.0	23.8	8.1	34.9	73.0	57.4	65.1
					CHERRY					
2	24	1.9	14.4	4.7	11.9	8.6	25.2	81.5	58.5	74.8
3	16	0.4	12.0	2.2	15.8	8.8	26.8	81.6	60.8	73.2
4	58	0.1	8.2	1.5	19.2	9.0	29.7	79.2	62.0	70.3

Table 4.—Veneer log products and residue as a percentage of total log volume, by species and log length.

Log length (feet)	No. of logs	Products residue		Chippable (or fuel) residue				Primary products		Total products residue + veneer
		Batting boards	Backing boards	Flitch ends	Slabs, shavings, sawdust	Scrap veneer	Total fuel residue	Flitch	Veneer	
					OAK					
8	34	0.9	9.5	2.6	18.3	8.8	29.7	78.2	59.9	70.3
9	9	0.5	8.3	1.7	27.3	6.5	35.5	70.5	55.7	64.5
10	36	0.6	8.9	3.6	22.9	7.8	34.3	72.9	56.2	65.7
12	7	0.1	7.3	6.3	27.4	8.0	41.7	66.2	50.9	58.3
					CHERRY					
8	48	0.1	9.5	2.0	17.4	8.8	28.2	80.5	62.2	71.9
9	10	0.6	12.0	0.9	14.6	9.0	24.5	83.9	62.9	75.5
10	32	0.5	8.8	2.1	17.8	9.5	29.4	79.6	61.3	70.6
12	8	1.2	11.9	3.6	21.7	6.4	32.7	73.5	55.2	68.2

Table 5.—Flitch components as a percentage of total flitch volume, by species.

Species	No. of logs	Component			Backing + veneer
		Backing board	Veneer	Scrap veneer	
Oak	86	12.1	77.1	10.8	89.2
Cherry	98	12.1	76.8	11.1	88.9

Table 6.—Flitch components as a percentage of total flitch volume, by species and log position.

Log position	No. of logs	Component			Backing + veneer
		Backing boards	Veneer	Scrap veneer	
			OAK		
Butt	39	11.8	77.9	10.3	89.7
Upper	47	12.3	76.3	11.4	88.6
			CHERRY		
Butt	41	11.8	77.7	10.5	89.5
Upper	57	12.2	76.1	11.7	89.3

Table 7.—Flitch components as a percentage of total flitch volume, by species and number of flitches.

No. of flitches	No. of logs	Component: Backing boards	Component: Veneer	Component: Scrap veneer	Backing + veneer
			OAK		
2	21	17.8	72.5	9.7	90.3
3	18	13.7	75.7	10.6	89.4
4	47	10.3	78.6	11.1	88.9
			CHERRY		
2	24	17.7	71.8	10.5	89.5
3	16	14.7	74.5	10.8	89.2
4	58	10.4	78.3	11.3	88.7

Table 8.—Flitch components as a percentage of total flitch volume, by species and log length.

Log length (feet)	No. of logs	Component: Backing boards	Component: Veneer	Component: Scrap veneer	Backing + veneer
			OAK		
8	34	12.2	76.6	11.2	88.8
9	9	11.7	79.1	9.2	90.8
10	36	12.3	77.1	10.6	89.4
12	7	11.1	76.9	12.0	88.0
			CHERRY		
8	48	11.8	77.3	10.9	89.1
9	10	14.3	75.0	10.7	89.3
10	32	11.0	77.0	12.0	88.0
12	8	16.1	75.1	8.8	91.2

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