INCREASING SOFTWOOD DIMENSION YIELD FROM SMALL LOGS—— Best Opening Face

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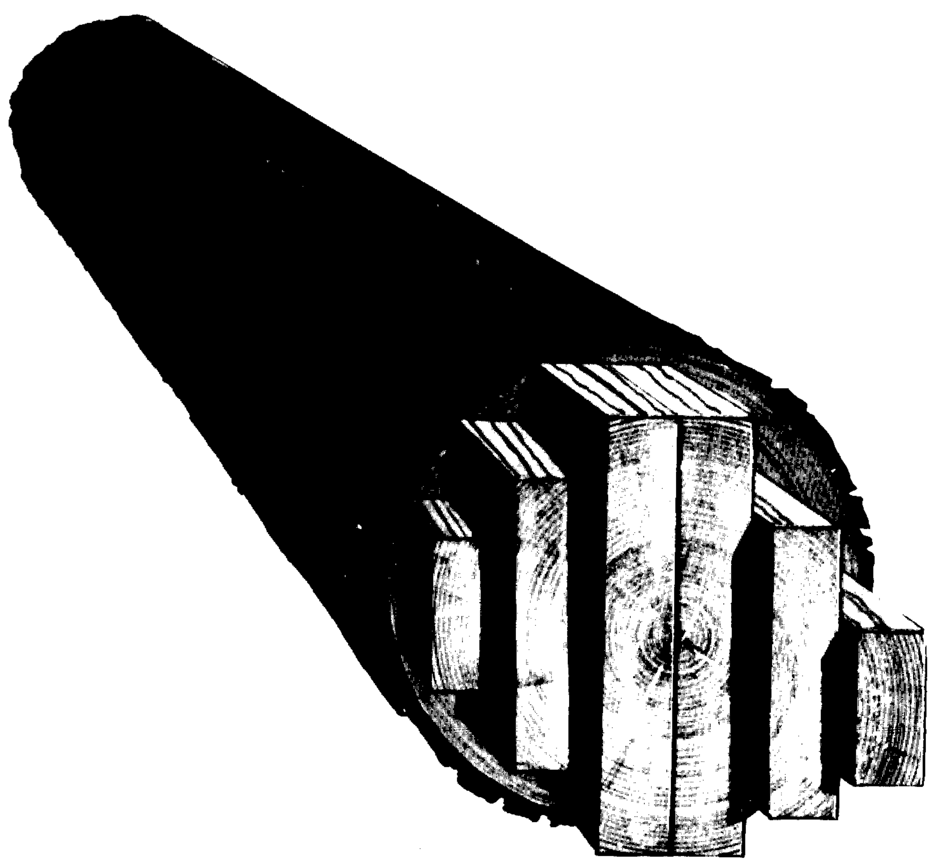

INCREASING SOFTWOOD DIMENSION YIELD FROM SMALL LOGS——Best Opening Face

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SUMMARY

Production of lumber, especially from small logs, is in essence the fitting of rectangles into a circle. For any given set of conditions the sizes of the lumber and the size of the log are fixed. Maximization of yield becomes a geometrical problem with the key being width of the opening face. This paper presents a system called BOF for Best Opening Face width which makes it possible to precisely locate the opening face.

An example is presented for the five common log breakdown methods with logs of a diameter range of 4.6 to 20.5 inches, by 0.l-inch-increments. Three of these methods have the possibility of varying opening face width. The average difference in yield for the best and poorest opening for these three methods are 27, 21, and 8 percent. If it is assumed industry practices are midway between the best and poorest points, substantial industry increases may be possible.

This research makes possible an automated mill system through the use of presently available precise diameter- measuring equipment, numerically controlled log positioning equipment, a minicomputer, and the opening face data available from the BOF program.

The BOF program also makes possible precise comparison of the potential yields of each of the five sawing methods. Of these, the variable-opening-face live sawing method is shown to be consistently the best.

LOCATING THE OPENING FACE

The softwood dimension industry is being forced to obtain an increasing percentage of its cut from small-diameter second- and third-growth logs. These small diameters further compound the age-old problem of where to make the opening cut in a log to get maximum yield.

Sawing involves the removal of rectangular lumber, of specified sizes, from cylindrical logs. The problem of lumber yield thus basically involves fitting rectangles into a circle. The opening cut is the key one, as the resulting face fixes the position of all other faces or sawlines in the same plane.

For a given set of conditions the rough green lumber thicknesses and widths are fixed, and each of these lumber items has a definite scale. The

[1] Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

total yield is, of course, the summation of those items which can be fitted in the log diameter being examined. Shifting the saw lines back and forth across the face of the log end results, in almost all cases, in substantial differences in lumber yield because of the geometrical interrelation involved.

Knowledgeable people in the sawmilling field have long known that the yield of lumber from a given log is related to the width and position of the opening face. What was not known or appreciated was the magnitude of variation which exists between the yields resulting from the best and poorest width of opening face. It has not previously been possible to precisely define this factor.

Solution of this overall problem requires a mathematical model for each of several generally recognized sawing methods. These models can be manipulated to theoretically saw logs of various diameters, each differing by very small increments, with a range of opening faces.

Previous Research

Limited work has been done on this problem Hallock[2] in his mathematical investigation of the effect of kerf width and lumber sizing on lumber yield from small logs found indications that geometry played a very important role. The actual effect of the opening face, however, was not investigated. Taylor and Garton[3] investigated the effect of cant size and log diameter in relation to yield by a transparent overlay procedure. They concluded that best yields from a given diameter resulted when the largest cant possible was developed. Juvonen[4] investigated the effect of kerf width and lumber oversizing on yield with a computer routine for various sawing patterns. His analysis did not include evaluation of the width of the opening face. McAdoo[5] developed a series of mathematical sawing models and manipulated them to investigate yields from small logs by four chipping headrig sawing systems. Opening face widths were not examined as a variable factor.

Our Approach

A computer program, "BOF," for width of Best Opening Face has been developed and is reported in this paper. In addition to determining the best opening face, it analyses all factors involved in producing dimension lumber from logs. Although basically designed to analyze the diameter range of 5 to 20 inches (4.6 to 20.5), extension of this range is possible.

This program makes two basic assumptions for its mathematical analysis: that the lumber includes no wane and that the log is cylindrical. Adjustments for a specified amount of wane could be included. Additional 4/4 lumber recoverable from the taper outside the cylinder can be reasonably assumed to be somewhat constant between related sawing methods when the dimension yield by each system has been maximized and a reasonable range of diameters is included.

COMPUTER PROGRAM

To make this program as flexible as possible and suitable for analyzing any set of conditions found in any sawmilling setup, the following variables may be assigned any value actually existing or desired.

1. The thickness of the dry finished lumber (American Lumber Standard or other optional size).
2. The width of the dry finished lumber (American Lumber Standard or other optional size).
3. Planing allowance (this value can be hypothetical or it can be actual from mill data).

[2] Hallock, H. A mathematical analysis of the effect of kerf width on lumber yields from small logs. U.S. Forest Prod. Lab. Rep. No. 2254. 1962.

[3] Taylor, F. W., and Garton, M. W. The systematic evaluation of a pine sawmilling operation. Res. Rep. No. 9, Mississippi State University. 1970.

[4] Juvonen, Kauko. Influence of saw kerf and oversize allowance on the economy and recovery of sawmilling operation. Finnish Pap. & Timber No. 4. 1968.

[5] McAdoo, J. C. Computer Simulation of Small-Log Mill Processing. Forest Products J. 19(4): 34-35. (April) 1969.

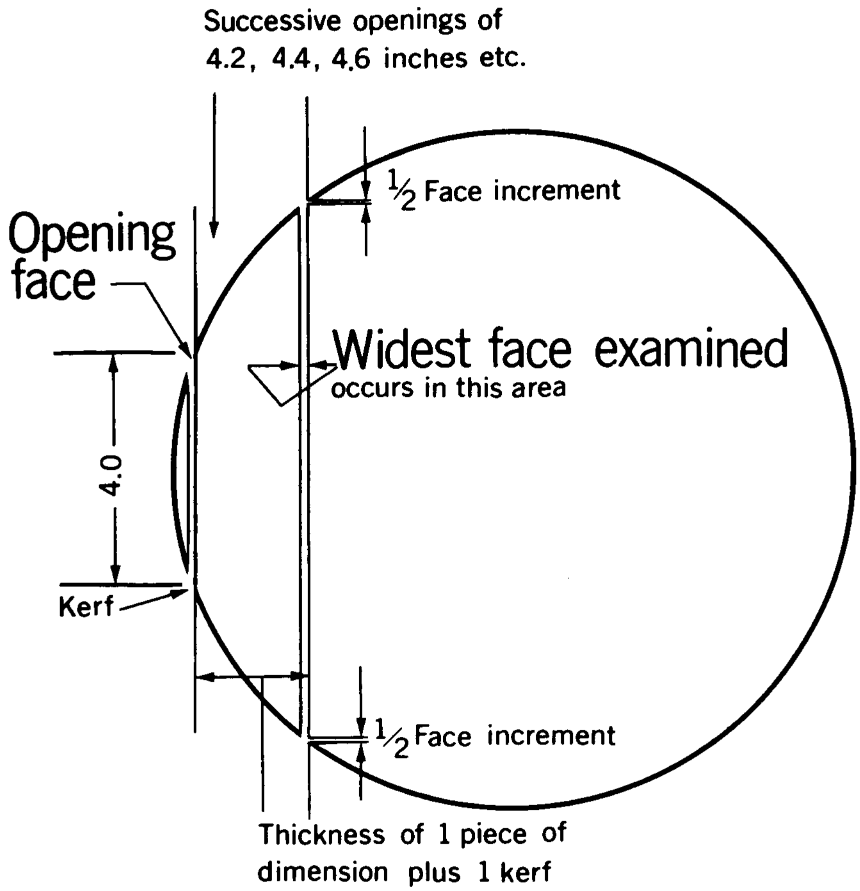

Figure I.--Procedure followed to determine the initial opening face and subsequent trial opening faces for each log diameter.

4. Shrinkage during drying (any value maybe used but a 95 pct. exclusion value is most realistic).

5. Sawing variation (this value may be hypothetical but for mill analysis should be the scant or negative variation, which will exclude only 2.5pct. of the lumber).

6. Saw kerf width (actual for the mill or hypothetical if desired).

7. Log diameter range (minimum and maximum diameters of the diameter range to be analyzed).

8. Log diameter increment (the increase between successive log diameters which will be analyzed; for instance, 0.1 in.--5.0, 5.1, 5.2, etc.).

9. Opening face increments (the increase between successive face openings; for instance, 0.2 in---4.0, 4.2, 4.4, etc.). The program then examines a series of openings at the selected increment. Basically all openings are examined until the outside initial slab is thick enough to resaw into a 2 by 4 (fig. 1).

Opening faces on sawing the cants are limited to nominal widths of 4, 6, 8, 10, and 12 inches. The width values actually used are calculatedly the program from the variables listed above.

The program then theoretically saws all logs into dimension lumber by five sawing methods (fig. 2).

Live Sawing Methods

In the three live sawing methods used, all sawlines are parallel and in a single plane:

1. Centered-flitch method. --This method is typical of round log gangs in which the log is approximately centered in the carriage or feed trough and the center flitch tends to contain the geometric center of the log at its center. By

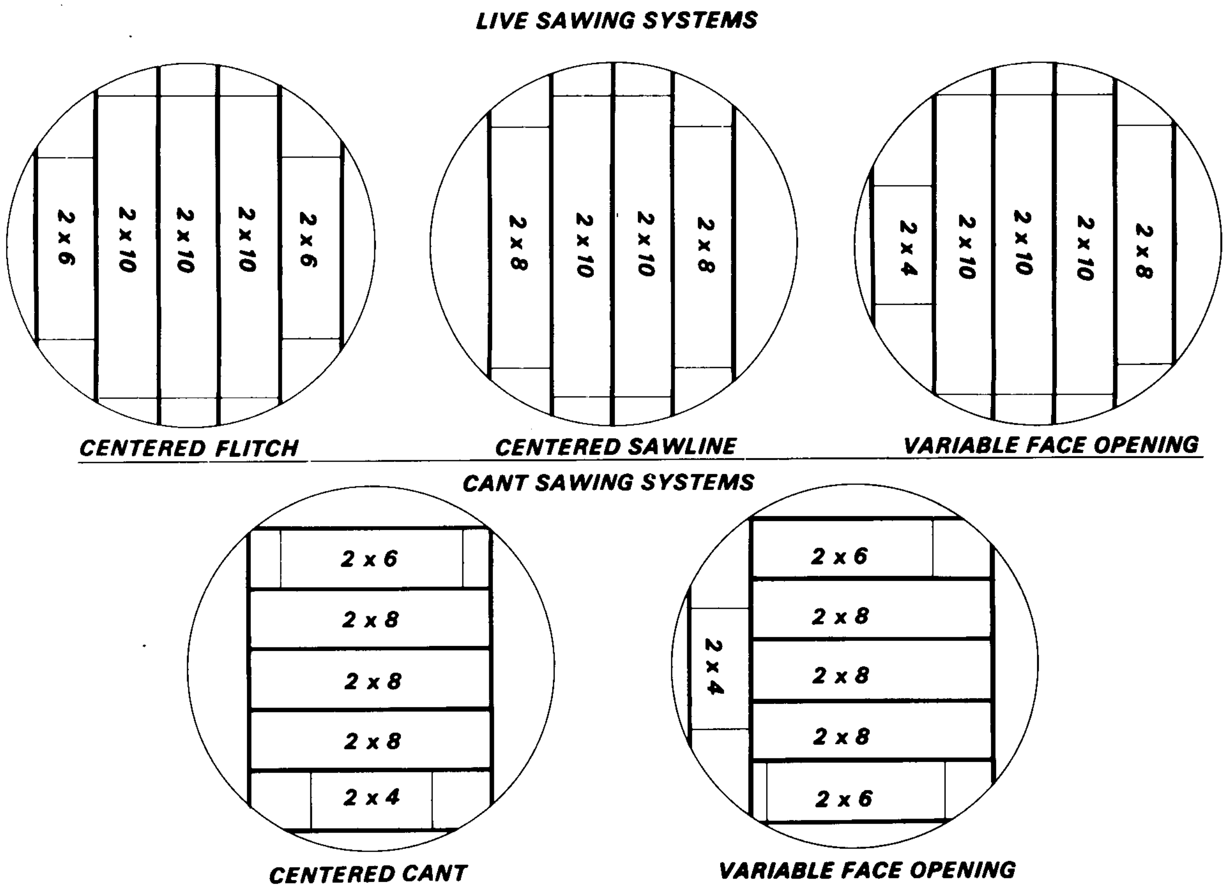

Figure 2.--Five common sawing methods for producing 8/4-inch dimension lumber from softwood logs. M 139 699

chance, logs can be sawn this way on a conventional carriage with circular or band headsaw. Several multiple tandem bandmills also produce this sawing pattern, especially in smaller logs.

2. Centered-sawline method.--Multiple tandem bandmills followed by a splitter resaw to divide the center flitch (a double) usually sawlogs in this manner. By chance the conventional carriage and headrig may also saw a log by this pattern.

3. Variable-face-opening method. --The conventional carriage and headrig generally cuts by this method even though small logs maybe split and sent to a resaw or larger logs flitched in doubles or quadruples and sent to the resaw. Results could be easily accomplished on any other sawing system by controlling the position of the log.

Cant Sawing Methods

In the cant sawing methods a cant and possible side lumber are produced by sawlines in one plane and the cant is subsequently sawn in a second plane 90° from the first:

1. Centered-cant method. --This method is typical of all Scragg systems whether band or circular. It is also typical of the two-gang system in which the first gang produces flitches and a centered cant which in turn is sawn by the second gang. By chance, the conventional carriage headrig system may also saw a small percentage of its output this way. The centered cant itself may be sawn centered or by variable face opening.

2. Variable- face-opening method. --This is the normal system for the conventional carriage and headrig combination. Flitches and a cant are

produced on the headrig. The cant maybe sawn on the headrig or by circular or sash gang secondary equipment. This method could be accomplished in all other systems by controlling the log and cant positions.

Analysis

The program analyzes all possible combinations of face openings for both log and cant for all diameters and sawing methods. However, it outputs only those opening faces, within each diameter increment and sawing method, which produce a maximum or a minimum yield solution. The full information which is provided as output is shown in figure 3 and includes:

(a) All opening face widths which result in the maximum lumber yield, their distances from the center of the log, and the associated closing or last face and its location.

(b) All opening face widths which result in minimum lumber yield, their distances from the center of the log, and the associated closing face and its location.

(c) In addition, for each entry in (a) and (b) this information is shown:

(1) The number of pieces of lumber of each nominal size.
(2) The total cumulative width of all lumber.
(3) The percent volume of the green log which is represented in the dry dressed volume of the finished lumber.
(4) The total lumber tally in board feet based on a 12-foot log length.

(d) A summary for the whole run shows, for each 0.l-inch and 1.0-inch diameter, the maximum and minimum lumber tally for each of the five sawing methods.

In most diameters and sawing methods the maximum yield can result from more than one opening face. In many cases there is more than one mix of lumber items which results in the same maximum yield. It is then possible to select the mix which most nearly meets the mill's normal market demand.

An example of this can be seen by referring to figure 4. An opening face of 10.6 inches results in one 2 by 4, two 2 by 6's, and seven 2 by 10's. On the other hand an opening face of 9.6 inches yields one 2 by 4, one 2 by 6, two 2 by 8's, and six 2 by 10's. Both openings yield a 12-foot lumber tally of 172 board feet, so the choice of which face to use depends on the anticipated need.

WHAT THE RESEARCH SHOWS

One complete analysis has been made by this Laboratory using values for the variables which in our opinion reflect fairly realistic limits for the better segment of the sawmilling industry. The values used were as follows:

1. American Lumber Standard lumber thickness (dry)
2. American Lumber Standard lumber width (dry)
3. 2/32 inch per face planing allowance
4. 5 percent shrinkage
5. 3/32-inch sawing variation for nominal 2-inch thickness, 4/32-inch sawing variation for nominal 4-inch width, and 5/32-inch sawing variation for nominal 6-inch and wider
6. 5/32-inch saw kerf
7. 4.6-inch to 20.5-inch log diameter range
8. 0.l-inch increment of log diameter
9. 0.2-inch increment of opening face

Effect of Opening Face on Lumber Yield

In two of the sawing methods (live sawing centered-flitch, and live sawing centered- sawline) there is no possibility of controlling or varying the opening face because, by definition, the opening is a direct function of log diameter, kerf width, and flitch thickness. For the other three methods where control of the opening face is possible, a substantial spread usually existed between the yield from the best (BOF) width and the poorest.

For the variable-face-opening live sawing method when l-inch-diameter classes are considered, the maximum yield exceeds the minimum yield by 6 to 90 percent (fig. 5) and averages approximately 21 percent.

When the centered-cant sawing method with opening face controlled only on the cant is evaluated, the maximum exceeds the minimum by a range of 0 to 8 percent and averages about 4 percent (fig. 6).

If the opening faces in both sawing planes of the variable-face-opening cant sawing method are controlled, the maximum exceeds the minimum by a range of 12 to 100 percent and averages about 27 percent (fig. 7).

LOG DIAMETER 12.4 IN.		NUMBER OF PIECES 2X4	2X6	2X8	2X10	2X12	TOTAL WIDTH (IN.)	PERCENT OF LOG USED	LUMBER TALLY 12 FT. BASIS	OPENING FACE SIZE (IN.)	OPENING FACE DISTANCE FROM CENTER (IN.)	CLOSING FACE SIZE (IN.)	CLOSING FACE DISTANCE FROM CENTER (IN.)
LIVE SAWN - CENTERED FLITCH													
		0	2	0	2	1	40.75	50.6	88	7.791	4.823		
LIVE SAWN - CENTERED SAWLINE													
		2	0	2	2	0	40.00	49.7	88	4.363	5.803		
LIVE SAWN - CONTROLLED FACE													
MAXIMUM		0	1	1	2	1	42.50	52.8	92	6.800	5.185	8.610	4.462
		0	1	1	2	1	42.50	52.8	92	7.000	5.118	8.469	4.529
		0	1	1	2	1	42.50	52.8	92	7.200	5.048	8.317	4.599
		0	1	1	2	1	42.50	52.8	92	7.400	4.975	8.153	4.671
		0	1	1	2	1	42.50	52.8	92	7.600	4.899	7.975	4.747
		0	1	1	2	1	42.50	52.8	92	8.000	4.737	7.573	4.909
		0	1	1	2	1	42.50	52.8	92	8.200	4.651	7.344	4.996
		0	1	1	2	1	42.50	52.8	92	8.400	4.561	7.092	5.086
		0	1	1	2	1	42.50	52.8	92	8.600	4.467	6.814	5.180
MINIMUM		1	0	2	2	0	36.50	45.3	80	4.800	5.717	9.591	3.930
		1	0	2	2	0	36.50	45.3	80	5.000	5.674	9.520	3.973
		1	0	2	2	0	36.50	45.3	80	5.200	5.628	9.444	4.018
		1	0	2	2	0	36.50	45.3	80	9.600	3.924	4.774	5.722
CANT SAWN - CENTERED CANT													
MAXIMUM	FLITCH	0	0	0	0	0	.00	.0	0	9.542	3.960		
	CANT	2	0	4	0	0	36.00	44.7	80	3.941	5.879	4.744	5.728
	TOTAL						36.00	44.7	80				
MINIMUM	FLITCH	0	0	0	0	0	.00	.0	0	9.542	3.960		
	CANT	0	1	4	0	0	34.50	42.9	76	6.077	5.404	7.919	4.242
	CANT	0	1	4	0	0	34.50	42.9	76	7.919	4.771	7.660	4.876
	TOTAL						34.50	42.9	76				
CANT SAWN - CONTROLLED FACE													
MAXIMUM	FLITCH	0	1	0	0	0	5.50	6.8	12	6.200	5.369	8.508	4.511
	CANT	2	0	4	0	0	36.00	44.7	80	3.941	5.879	4.744	5.728
	TOTAL						41.50	51.5	92				
	FLITCH	0	1	0	0	0	5.50	6.8	12	6.400	5.310	8.381	4.570
	CANT	2	0	4	0	0	36.00	44.7	80	3.941	5.879	4.744	5.728
	TOTAL						41.50	51.5	92				
	FLITCH	0	1	0	0	0	5.50	6.8	12	6.600	5.249	8.244	4.631
	CANT	2	0	4	0	0	36.00	44.7	80	3.941	5.879	4.744	5.728
	TOTAL						41.50	51.5	92				
	FLITCH	0	1	0	0	0	5.50	6.8	12	6.800	5.185	8.096	4.695
	CANT	2	0	4	0	0	36.00	44.7	80	3.941	5.879	4.744	5.728
	TOTAL						41.50	51.5	92				
	FLITCH	0	1	0	0	0	5.50	6.8	12	7.000	5.118	7.940	4.762
	CANT	2	0	4	0	0	36.00	44.7	80	3.941	5.879	4.744	5.728
	TOTAL						41.50	51.5	92				
	FLITCH	0	1	0	0	0	5.50	6.8	12	8.000	4.737	6.926	5.143
	CANT	2	0	4	0	0	36.00	44.7	80	3.941	5.879	4.744	5.728
	TOTAL						41.50	51.5	92				
	FLITCH	0	1	0	0	0	5.50	6.8	12	8.200	4.651	6.662	5.229
	CANT	2	0	4	0	0	36.00	44.7	80	3.941	5.879	4.744	5.728
	TOTAL						41.50	51.5	92				
	FLITCH	0	1	0	0	0	5.50	6.8	12	8.400	4.561	6.370	5.319
	CANT	2	0	4	0	0	36.00	44.7	80	3.941	5.879	4.744	5.728
	TOTAL						41.50	51.5	92				
MINIMUM	FLITCH	0	1	0	0	0	5.50	6.8	12	7.400	4.975	7.584	4.905
	CANT	0	1	3	0	0	27.25	33.8	60	7.919	3.700	7.693	3.986
	TOTAL						32.75	40.7	72				

Figure 3.--An example of the computer output for all sawing methods and the 12.4-inch-diameter class log are shown here.

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LOG DIAMETER 16.5 IN.		NUMBER OF PIECES 2X4	2X6	2X8	2X10	2X12	TOTAL WIDTH (IN.)	PERCENT OF LOG USED	LUMBER TALLY 12 FT. BASIS	OPENING FACE SIZE (IN.)	OPENING FACE DISTANCE FROM CENTER (IN.)	CLOSING FACE SIZE (IN.)	CLOSING FACE DISTANCE FROM CENTER (IN.)
							CANT SAWN - CONTROLLED FACE						
MAXIMUM	FLITCH	0	0	2	0	0	14,50	10.2	32	9,000	6,915	8.632	7.031
	CANT	1	1	0	6	0	64,50	45.2	140	3,941	8.011	6.800	7.517
	CANT	1	1	0	6	0	64,50	45.2	140	6,077	7,670	5.026	7.858
	TOTAL						79,00	55.4	172				
	FLITCH	0	0	2	0	0	14,50	10.2	32	9,200	6,849	8.412	7.097
	CANT	1	1	0	6	0	64,50	45.2	140	3,941	8,011	6.800	7.517
	CANT	1	1	0	6	0	64,50	45.2	140	6,077	7,670	5.026	7.858
	TOTAL						79,00	55.4	172				
	FLITCH	0	0	2	0	0	14,50	10.2	32	9,400	6,780	8.178	7.165
	CANT	1	1	0	6	0	64,50	45.2	140	3,941	8,011	6.800	7.517
	CANT	1	1	0	6	0	64,50	45.2	140	6,077	7,670	5.026	7.858
	TOTAL						79,00	55.4	172				
	FLITCH	0	0	2	0	0	14,50	10.2	32	→ 9,600 ←	6,710	7,926	7.236
	CANT	1	1	0	6	0	64,50	45.2	140	3,941	8,011	6.800	7.517
	CANT	1	1	0	6	0	64,50	45.2	140	6,077	7,670	5.026	7.858
	TOTAL						79,00	55.4	172				
	FLITCH	0	1	0	1	0	14,75	10.3	32	10,200	6,485	7.042	7.461
	CANT	1	1	0	6	0	64,50	45.2	140	3,941	8,011	6.800	7.517
	CANT	1	1	0	6	0	64,50	45.2	140	6,077	7,670	5.026	7.858
	TOTAL						79,25	55.6	172				
	FLITCH	0	1	0	1	0	14,75	10.3	32	10,400	6,405	6.693	7.541
	CANT	1	1	0	6	0	64,50	45.2	140	3,941	8,011	6.800	7.517
	CANT	1	1	0	6	0	64,50	45.2	140	6,077	7,670	5,026	7.858
	TOTAL						79,25	55.6	172				
	FLITCH	0	1	0	1	0	14,75	10.3	32	→ 10,600 ←	6,322	6.308	7.623
	CANT	1	1	0	6	0	64,50	45.2	140	6,077	7,670	5.026	7.858
	TOTAL						79,25	55.6	172				
MINIMUM	FLITCH	1	0	0	1	0	12,75	8.9	28	4,800	7,893	11.212	6.053
	CANT	1	0	1	5	0	57,00	40.0	124	10,025	5,733	5.170	7.835
	TOTAL						69,75	48.9	152				
	FLITCH	1	0	0	1	0	12,75	8.9	28	5,000	7,862	11.145	6.084
	CANT	1	0	1	5	0	57,00	40.0	124	10,025	5,765	5.360	7.803
	TOTAL						69,75	48.9	152				
	FLITCH	1	0	0	1	0	12,75	8.9	28	5,200	7,830	11.073	6.116
	CANT	1	0	1	5	0	57,00	40.0	124	10,025	5,798	5.549	7.769
	TOTAL						69,75	48.9	152				

Figure 4.--An example of the option for alternate products. Face openings of 9.6 and 10.6 both yield the same volume, 172 board feet, but different lumber mixes. M 139 7

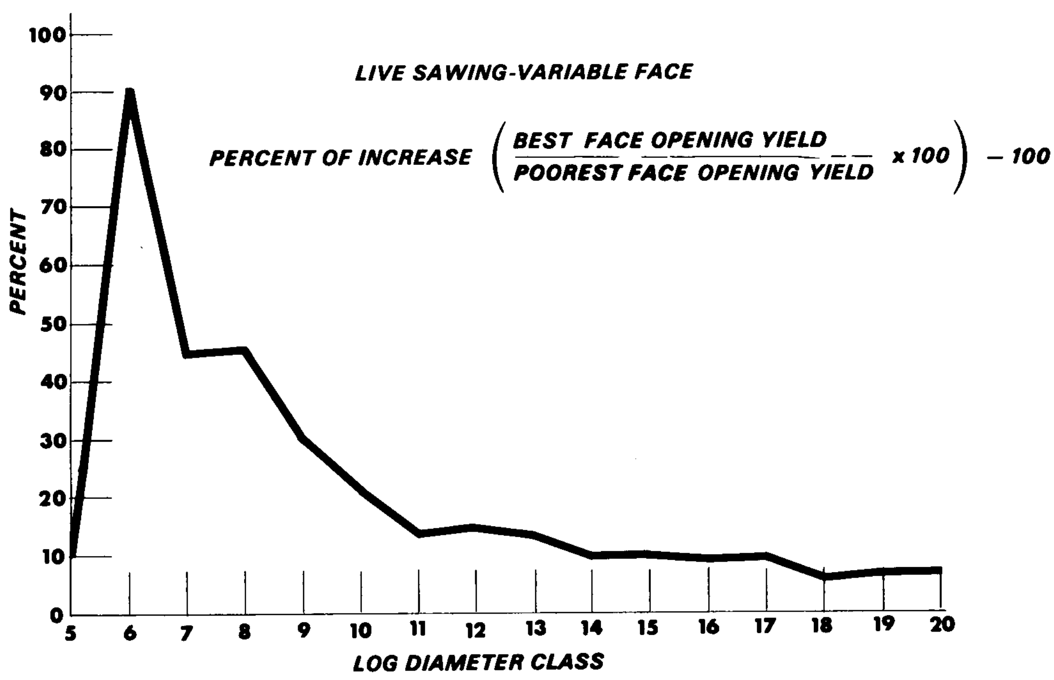

Figure 5.--Difference in yield between the best (BOF) and the poorest opening faces for the variable-face-opening live sawing method. M 139 697

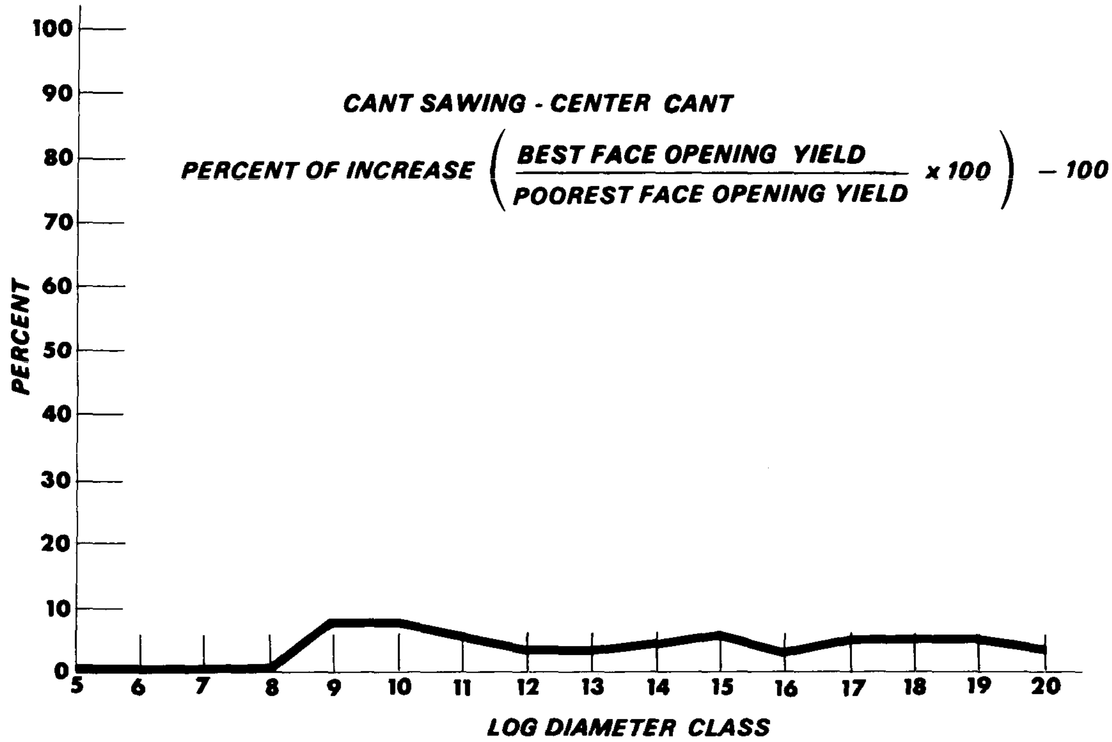

Figure 6.--Difference in yield between the best (BOF) and the poorest opening faces (on the center cant) for the centered-cant sawing system. M 139 694

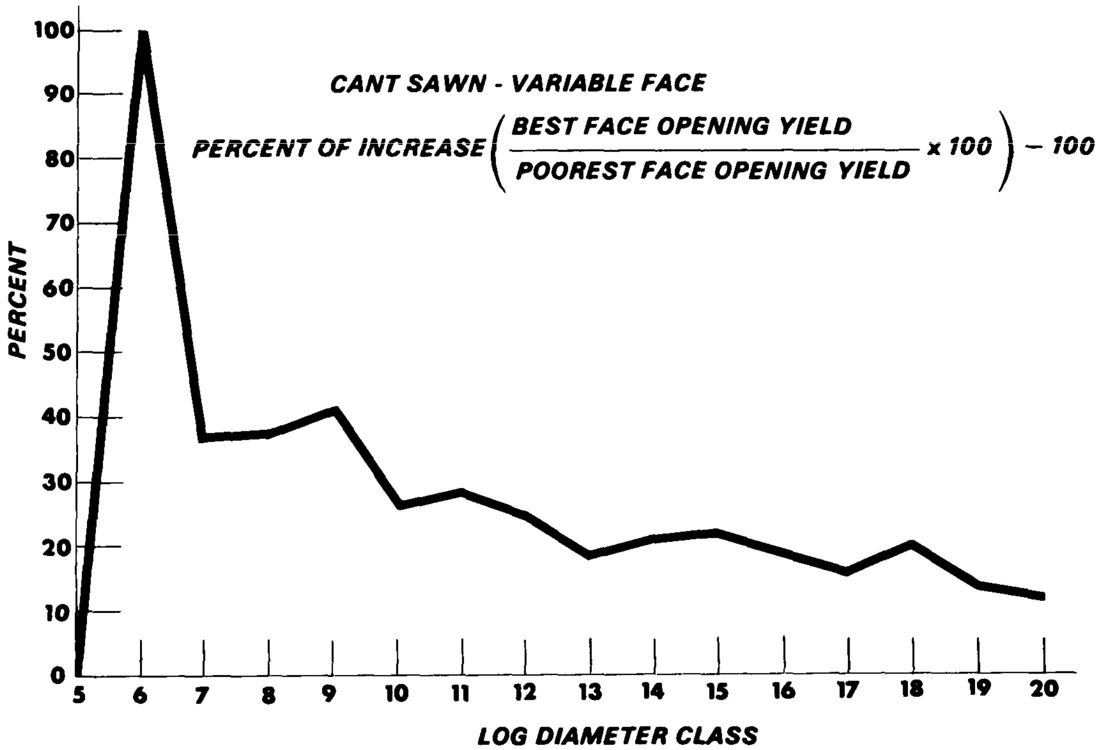

Figure 7.--Difference in yield between the best (BOF) opening face on both flitch and cant and the poorest for the variable-face-opening cant sawing method. M 139 696

The above averages are the arithmetic mean of all 1.0-inch-diameter classes. The probable effect of a normal small log diameter distribution would be to increase the average, as the percent increase tends to decrease with increasing diameter.

Effect of Opening Face on Log Utilization Percentage

Sawing a log with the best opening face by either the variable-f ace-opening live sawing method or the variable-face-opening cant sawing method will result in increased percentages of the green log volume being converted to dry dressed lumber. This increase over the poorest opening face approximates 10 percent in the first case and nearly 14 percent in the second case.

What About Thin Slabs and Narrow Face Openings?

A rather surprising result of this study is the lack of any real indication that thin slabs and narrow face widths consistently result in maximum log utilization for lumber. An example (fig. 8) is the 12.4-inch-diameter class for the live-sawn variable-face method in which the 7.6-inch opening results in a lumber scale of 92 board feet and a utilization percent of 52.8, compared to an opening of 5.2 inches which yields 80 board feet and a utilization percentage of 45.3. Conversely it can also be said that the very widest opening faces rarely result in maximum yields.

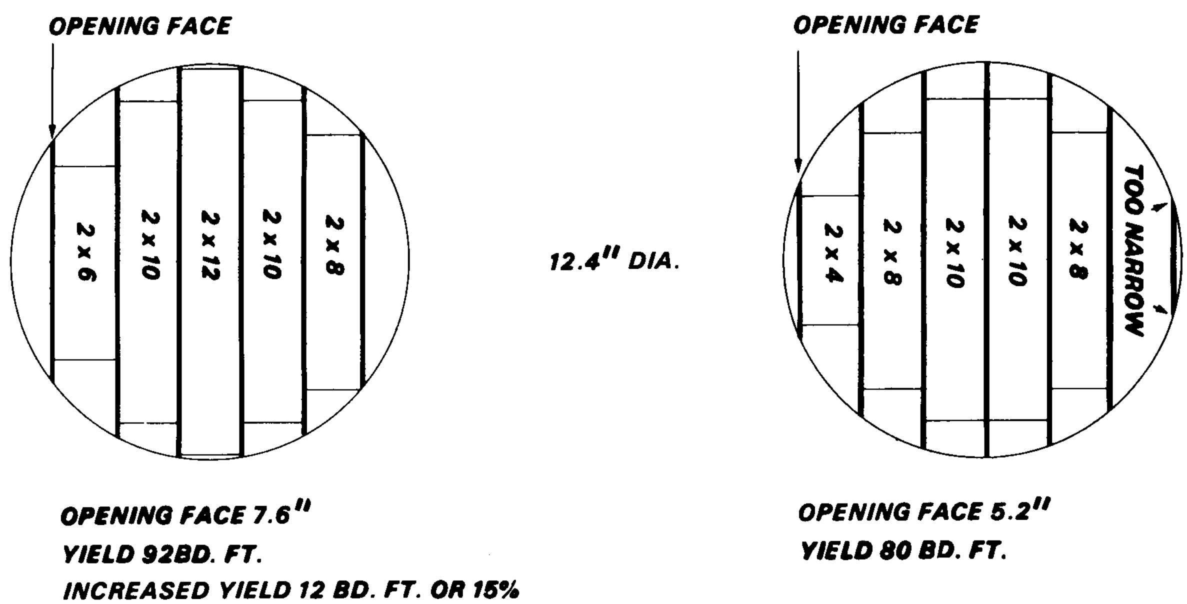

Figure 8.--The effect of two different opening faces on lumber yield for logs in the 12.4-inch-diameter class. M 139 695

Which Sawing Method is Best?

That there is a diversity of opinion regarding the best sawing system based on yield is evidenced by the current widespread use of five systems. It is now possible to evaluate the yield potential of each system in relation to each other.

Yields of lumber in the log diameters examined by each of five sawing methods are shown in table 1 and figure 9. There is little doubt that live sawing variable-face-opening gives consistently the best results and that cant sawing with variable-face-opening is second best. The other three methods give somewhat lower yields but their relative order would appear to be influenced by the diameter mix of logs sawn.

If the assumption is made that one log of each 0.1-inch-diameter class is sawn and the yield of live sawn variable-face-opening is given a value of 100 percent, then the other methods have the following percentage yield values: Cant sawn variable-face-opening, 97.63 percent; live sawn centered-flitch, 95.30 percent; live sawn centered-saw-line, 94.63 percent; and cant sawn centered-cant, 94.24 percent. On this basis a mill currently using a Scragg-type system to produce a centered cant could expect approximately a 6.1 percent increase in yield by converting to a live sawn system with optimum variable-face-opening.

APPLICATION OF THIS RESEARCH

A completely automated system for sawing softwood dimension requires: (1) Numerically controlled and precise sawing equipment; (2)

Table 1.--Yields[1] of dimension lumber from logs theoretically sawn by five sawing methods (12 ft. length basis)

Diameter	Live sawn type: Centered flitch	Live sawn type: Centered sawline	Live sawn type: Variable Face: Maximum	Live sawn type: Variable Face: Minimum	Cant sawn type: Centered cant: Maximum	Cant sawn type: Centered cant: Minimum	Cant sawn type: Variable face: Maximum	Cant sawn type: Variable face: Minimum
	Bd. ft.	Bd. ft.	Bd. ft.	Bd. ft.	Bd. ft.	Bd. ft.	Bd. ft.	Bd. ft.
5.0	8.0	1.6	8.8	8.0	0.0	0.0	0.0	0.0
6.0	8.8	16.0	16.0	8.4	16.0	16.0	16.0	8.0
7.0	21.6	19.2	24.8	17.2	20.8	20.8	20.8	15.2
8.0	31.2	24.0	33.6	23.2	24.0	24.0	30.8	22.4
9.0	40.0	44.8	47.6	36.8	40.8	38.0	44.0	31.2
10.0	49.6	54.4	56.8	47.2	47.6	44.4	53.6	42.4
11.0	68.8	66.4	72.4	63.6	66.0	62.4	71.6	56.0
12.0	86.0	76.8	86.8	75.6	77.2	74.8	86.8	69.6
13.0	96.8	104.8	107.2	94.4	102.8	99.6	104.4	88.0
14.0	116.4	117.6	122.4	111.6	118.0	112.8	120.8	100.0
15.0	140.8	136.8	145.2	132.8	143.0	134.4	143.6	118.0
16.0	163.2	156.0	166.0	152.0	162.0	158.0	163.6	137.6
17.0	179.2	189.6	192.4	176.0	184.4	175.6	189.2	163.2
18.0	205.2	208.0	212.4	200.8	210.0	200.0	210.8	176.4
19.0	239.2	230.4	241.6	226.4	233.2	222.0	239.2	210.4
20.0	264.4	260.8	270.0	253.2	255.2	246.8	266.0	238.4

[1] The yields shown for these diameters are the arithmetic mean for all 0.1-in. diameters in each 1.0-in. class. Maximum yields for each diameter class are underlined.

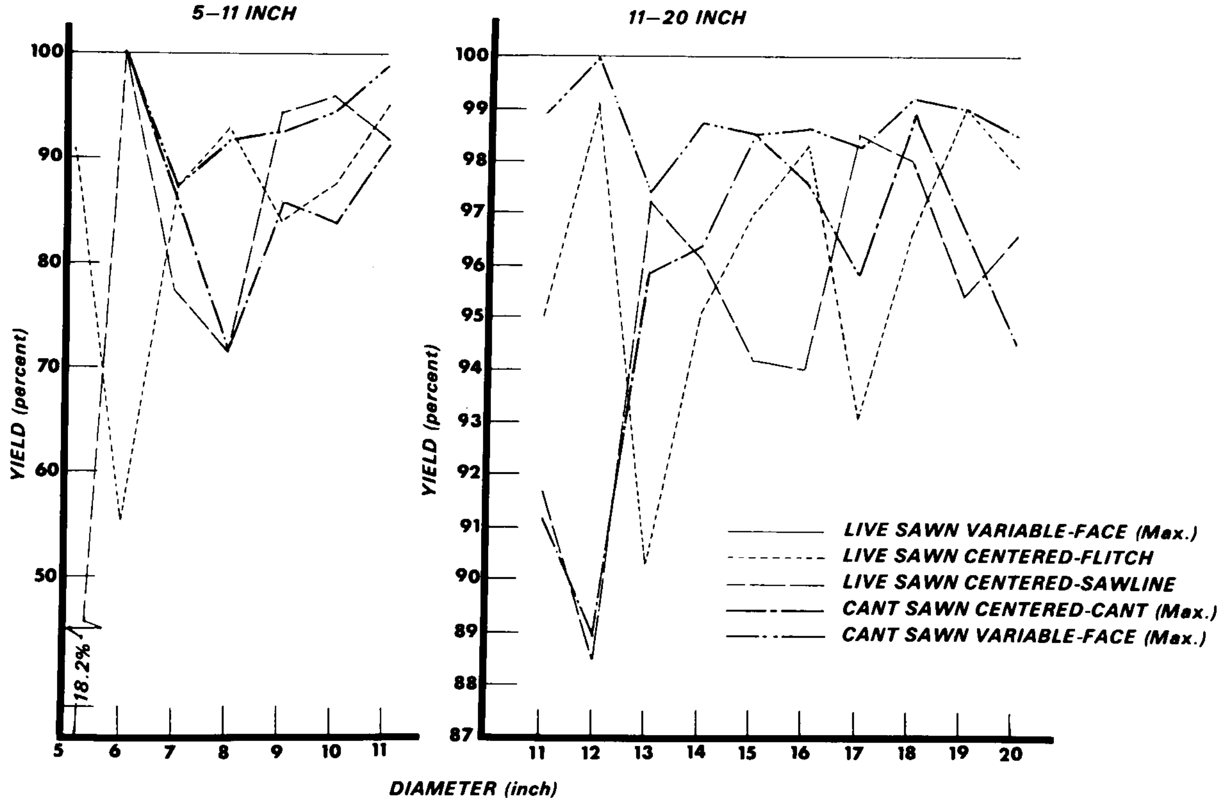

Figure 9.--Relative yields by five sawing methods. Live sawing variable-face has been set at 100 percent for all diameters and the other methods are shown as a percentage.

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equipment to automatically measure log diameters accurately to fractions of an inch; (3) a minicomputer; and (4) information on optimum opening faces for these increments of diameter.

The first three of these ingredients are already available. The present research completes the list by furnishing a method for obtaining the information on optimum opening faces for the computer memory system.

To use this system for a specific operation, it would first be necessary to define all the variables in the input and then to calculate the opening face information by running the program on a computer of suitable capacity. From this output an opening face and location can be chosen--one for each diameter increment--which will maximize yield and optimize the product mix This information will then be stored in the memory of the minicomputer.

Although the actual mechanisms for the different sawing equipment would differ, the principle would be the same regardless of whether the conventional carriage and headrig, the round log gang (single or double), or the Scragg system (circular or band) were used.

Basically the log would first be precisely measured and this information would be transmitted to the minicomputer. The minicomputer would already have stored in its memory the opening face width and its distance from the center of the log. The log would then be shifted to a position which coincides with the stored information. Sawing would then proceed in the normal manner. For the cant sawing methods a second alinement of the cant would also be accomplished from the original diameter information. Ideally, the alinement and edging of the flitches from any of the systems would be accomplished under the control of the minicomputer.

Another direct application of the computer program is in precisely evaluating the effect that changes in any of the variables, such as kerf width, oversizing, and lumber sizes, have on lumber yields.