Manufacturing Interior Furniture Parts: A New Look at an Old Problem

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USDA FOREST SERVICE RESEARCH PAPER NE-334
1975
FOREST SERVICE, U. S. DEPARTMENT OF AGRICULTURE
NORTHEASTERN FOREST EXPERIMENT STATION
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MANUSCRIPT RECEIVED FOR PUBLICATION 13 MARCH 1975

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ABSTRACT

The yields of interior furniture parts from four manufacturing sequences were compared. In three of the sequences, gang-ripping was the first step; in the fourth, the lumber was crosscut first. Though the grade of lumber used affects the percentage yield of parts, the manufacturing sequence used does not—but it will affect the cost per part. The selection of the best method must be based on factors other than parts yield.

Keywords: Lumber yield, furniture manufacture, wood utilization.

FEW FURNITURE MANUFACTURERS have rough mill lines set up exclusively for the production of interior furniture parts. But now some manufacturers are finding that the demand for interior parts warrants the establishment of a specialized interior-parts line or mill to supply one or more assembly plants.

An interior part is a structural part of a furniture frame that is hidden from view. Its primary function is strength. It can contain any sound defect that (1) does not materially weaken the strength of the piece and (2) does not occur in the outer inch of either end where machining for joining is necessary. For a given line of furniture, almost all the interior parts have the same width and thickness; they vary only in length.

The allowance of sound defects and the constant width and thickness of parts suggest that gang-ripping of boards before crosscutting may have advantages over the conventional technique of crosscutting first. To test this, we compared four manufacturing sequences and three grades of 4/4 yellow-poplar lumber. The basis for comparison was the yield of usable parts recovered from the lumber.

Though the results showed that the grade of lumber does affect the percentage yield of parts, the manufacturing sequence used had no influence on yield. However, the manufacturing sequence used will affect the final cost of the part. Therefore the selection of the best method must be based on factors other than lumber yield.

THE STUDY

The study was conducted in two phases. In phase I, the percentage yield of parts from three rip-first manufacturing sequences was tested, using 1 Common (1C) and 2A Common (2AC) 4/4 kiln-dried yellow-poplar lumber. Phase II was conducted to check the assumption that gang-ripping would increase the yield of parts when compared to a crosscut-first production process. In phase II, the crosscut-first process was compared with what we judged to be the two best gang-rip-first sequences of phase I. Two B Common (2BC) 4/4 kiln-dried yellow-poplar lumber was used in phase II.

Cutting Order

The cutting order used (table 1) was provided by a furniture manufacturer. It is typical of the part sizes and frequency distributions the manufacturer would require in a centralized interior-parts plant.

Table 1.—Cutting order distribution for 1-11/16-inch-wide 4/4 yellow-poplar interior furniture parts

Cutting No.	Length of cutting	Frequency distribution
	Inches	*Percent*
1	73	5
2	62	7
3	56	2
4	37	6
5	36	8
6	30	3
7	24	17
8	22	3
9	16	14
10	15	32
11	13	3

This cutting order contained 11 lengths, ranging from 13 to 73 inches. The width of all parts was 1-11/16 inches. The frequency distribution in the cutting order represents percentages of the total number of parts required; that is, for every 100 parts produced, 5 should be 73 inches long, 7 should be 62 inches long, etc. The actual number of parts to be cut to meet these requirements depends upon the parts yield of a given amount of a given grade of lumber.

Design and Test of Manufacturing Sequences

Four manufacturing sequences were studied (fig. 1). For sequences 1, 2, and 3, the first operation was gang-ripping full-length lumber into strips 1-11/16 inches wide. For sequence 4, all lumber was first crosscut to lengths dictated by the cutting bill and then gang-ripped into 1-11/16-inch strips.

In phase I, we simulated the step-by-step procedures for sequences 1, 2, and 3 for gang-ripping two 500-board-foot samples of yellow-poplar to width. The entire 1,000 board feet of strips were marked for interior parts according to the steps shown in sequence 2. Then the 500-board-foot samples were physically crosscut into parts according to the steps in sequences 1 and 3.

In phase II, approximately 500 board feet of yellow-poplar lumber were physically processed according to the steps in sequences 2, 3, and 4.

DETAILS OF THE SEQUENCES

Sequence 1

The strips from the gang-ripping operation were crosscut in a conventional manner to specified lengths, using a crosscut saw equipped with a back-gage. After crosscutting, the parts were tallied.

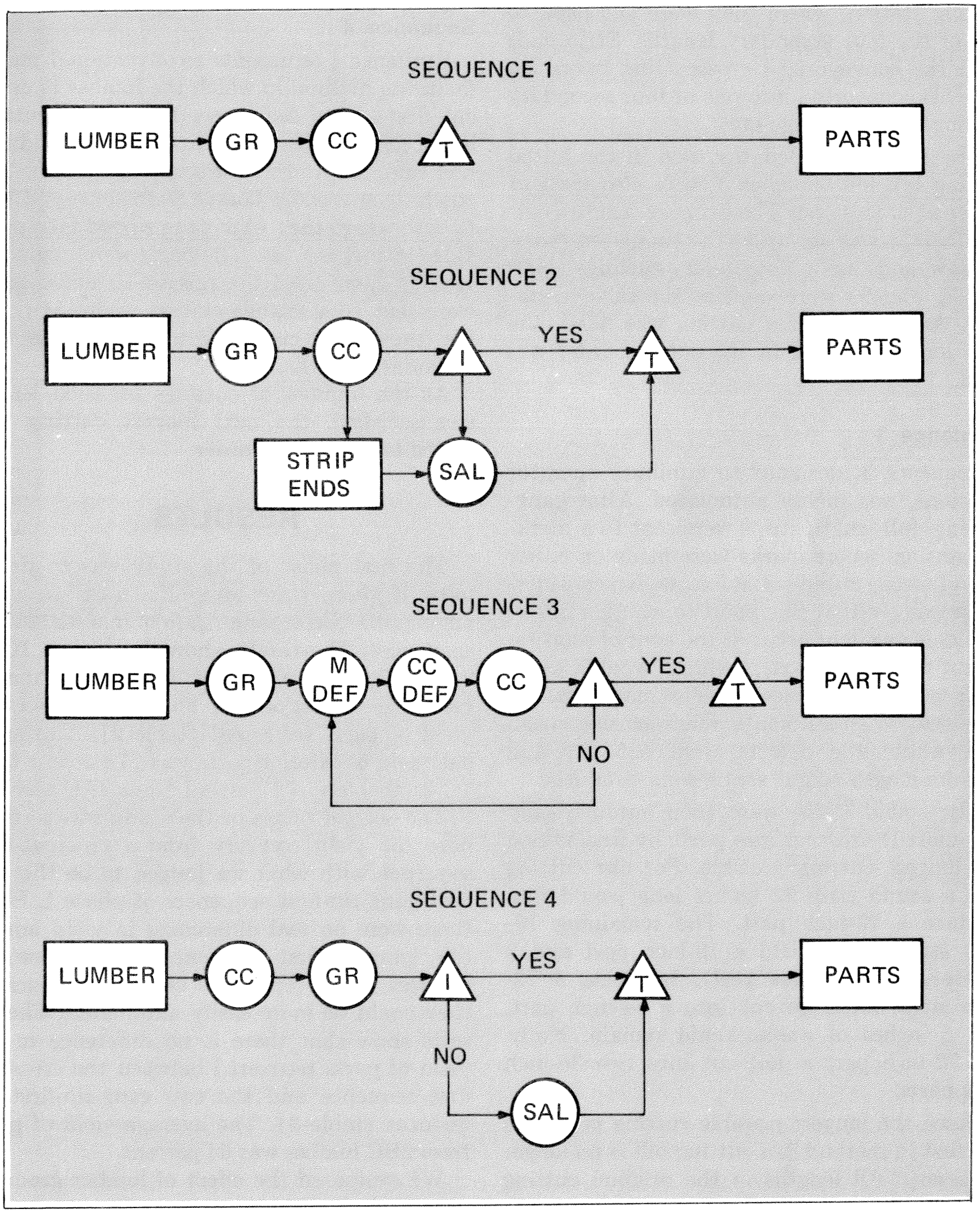
It is conventionally accepted that a crosscut saw operator cannot efficiently remember more than five different cutting lengths at one time. Therefore, we established a cutting bill of five lengths (one primary and four secondary). Initially, this cutting bill included cuttings 1, 3, 5, 7, and 9 from the original cutting order (table 1). The primary length was the longest of the five. When the required numbers of a given length were cut, the next longest cuttings in the original cutting order were made. This procedure was repeated until the required numbers of the 11 lengths in the original cutting order were sawed.

Sequence 2

Sequence 2, recommended by a manufacturer of interior parts, was an effort to introduce more automation into the process. As with sequence 1, a cutting bill (one primary and four secondary cuttings) was used. But an important difference occurred at the crosscutting station. Here strips were crosscut to the primary length, regardless of defect location, with a conveyorized crosscut saw (simulated in this study). Such a saw would automatically cut the strips to the primary length

Figure 1.—Flow diagrams of four manufacturing sequences for producing interior furniture parts.

GR = Gang-ripping station, where lumber is ripped into 1-11/16-inch strips.
CC = Crosscutting station, where lumber or strips are cut to specified lengths.
M DEF = Defect-marking station.
CC DEF = Mark-sensing crosscutting station, where defects are cut out.
SAL = Salvage station, where rejected pieces are cut to shorter usable lengths.
I = Inspection station.
T = Tally station, where parts produced are counted.



as they passed continuously, end-to-end, along a conveyor.

Since the conveyorized crosscut saw automatically cut the strips to the length of the primary cutting with no consideration for defect location, it was necessary to inspect all cuttings coming from this saw. All rejected primary cuttings were sent to a salvage crosscutting station, where they were cut back to one of the four secondary lengths. Strip ends from the conveyorized crosscutting operation were also converted into one of four secondary cuttings at the salvage saw.

The five cutting lengths used in the initial cutting bill for sequence 1 were also used at the start of this test. The primary length (cutting No. 1) was set up at the simulated crosscut saw, and the four secondary cuttings (Nos. 3, 5, 7, and 9) were used at the salvage station. As the bill for a cutting was filled, the next longest cutting in the cutting order was used.

Sequence 3

Sequence 3, designed to minimize operator decisions, was highly automated. After gang-ripping, full-length strips were sent to a marking station, where marks were made on either side of strength-reducing defects. No consideration was given at this point to whether allowable defects might occur at the ends of soon-to-be-cut-to-length parts, which would cause these parts to be rejected. The marked strips were sent to an automatic mark-sensing cutoff saw, where the defects were cut out and random-length sound strips were produced.

The sound strips were then automatically (simulated) crosscut into parts by first taking the longest cutting possible. For our cutting bill, a sound strip 92 inches long would first produce a 73-inch part. The remaining 19-inch strip would yield a 16-inch part and 3 inches of waste (less kerf). Likewise, a 72-inch strip would be cut into a 64-inch part, and 8 inches of waste would remain. Note: the 72-inch part is not cut into two 36-inch long parts.

Since the longest possible cutting is always cut first in method 3, a cutting bill is no longer necessary. All lengths in the original cutting order can be set up at the crosscutting station. As the required number of parts of any length is satisfied, that length is simply removed from the setup.

All parts coming from the cut-to-length station were inspected, and any parts having defects in their ends were rejected and returned to the defect-marking station for further processing.

Sequence 4

Sequence 4 represents a conventional manufacturing method in which the lumber is crosscut first. As in sequences 1 and 2, a cutting bill of five lengths (1 primary and 4 secondary) was required at the crosscutting station. The cut-to-length short boards were conveyed to a ripsaw, where they were gang-ripped into parts 1-11/16 inches wide. The parts were inspected as they came from the ripsaw. Rejected parts were sent to a salvage station where, if possible, they were cut back to one of the four secondary lengths.

As the number of cuttings for each length was satisfied, the next longest cutting was added to the cutting order.

RESULTS

The first phase of the study was to determine if there were any differences in yield among the three gang-rip-first manufacturing sequences. The results show that, when 1C or 2AC yellow-poplar lumber is used, the manufacturing sequence has no influence on the yield of parts recovered (table 2). The average yield of interior parts was 77 percent from 1C lumber and 72 percent from 2AC lumber.

The second phase of the study was to compare the yield recovery from a crosscut-first sequence with what we judged to be the two best gang-rip-first sequences of phase I. Since there were no real differences in yield among the gang-rip-first sequences, we chose sequences 2 and 3 for the comparison because they could be more easily automated. The results show that there is no difference in the yield of parts recovered between the crosscut-first sequence and the two gang-rip-first sequences (table 3). The average yield of parts from 2BC lumber was 64 percent.

We evaluated the effect of lumber grade on parts yield by using the results from sequences

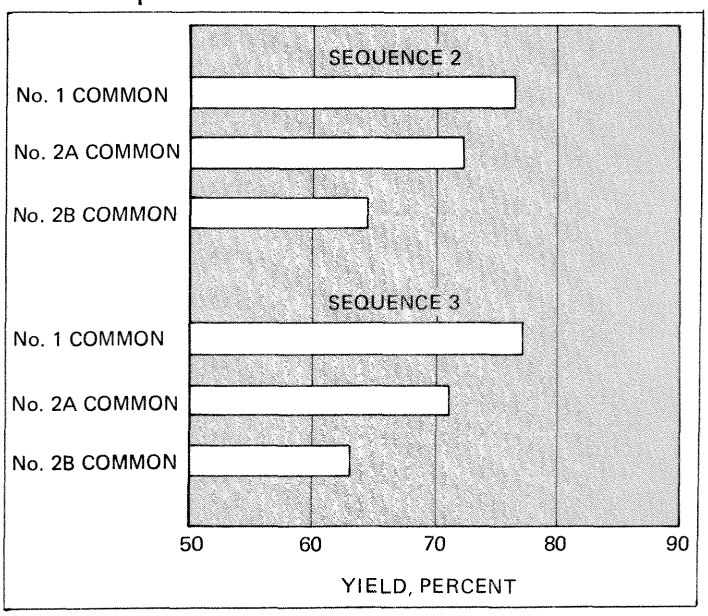
Table 2.—The yield of interior parts from 4/4 yellow-poplar lumber, by manufacturing sequence and lumber grade: phase I

Manufacturing sequence	Lumber grade	Lumber volume	Parts yield	
		Bd. ft.	*Bd. ft.*	*Percent*
1	1C	500	385	77
2	1C	1000	758	76
3	1C	500	383	77
1	2AC	500	366	73
2	2AC	1000	722	72
3	2AC	500	354	71

Table 3.—The yield of interior parts from 4/4 2BC yellow-poplar lumber, by manufacturing sequence: phase II

Manufacturing sequence	Lumber volume	Parts yield	
	Bd. ft.	*Bd. ft.*	*Percent*
2	487	314	64
3	487	307	63
4	485	317	65

Figure 2.—The effect of lumber grade on the yield of interior furniture parts in manufacturing sequences 2 and 3.



2 and 3 (fig. 2). The results show that there is no practical difference in yield between 1C and 2AC for either manufacturing sequence. However, there was a major difference in yield between 1C and 2BC for both manufacturing sequences.

DISCUSSION

Within a given grade of lumber, the yield of interior parts is not affected by any of the sawing methods tested. However, this does not mean that there is no best way to process any one grade of lumber into interior parts. Though the yield of parts is not affected, the cost per part may be. Therefore the selection of the best method must be based on criteria other than parts yield.

Consider the effect of lumber grade on parts cost. There is no practical difference in parts yield between 1C and 2AC lumber. But there is a real difference in price between 1C and 2AC. In 1974, 2AC averaged 34 percent less in price than 1C. So, 2AC is the least-cost lumber choice for producing interior parts.

In comparing 2AC and 2BC, the choice is not as clear-cut as it might first appear. Though the yield of parts from 2AC is 8 percent greater than the yield from 2BC, 2AC costs 43 percent more than 2BC in 1974. On the other hand, the appearance of the 2AC parts was far better than that of the 2BC parts, the difference in appearance being due primarily to the greater number and size of defects in the parts produced from 2BC. Even though appearance is not a grading factor for interior parts, manufacturers might want to consider how the finished product would look to a customer who pulls out drawers or otherwise looks into product construction.

Reductions in the total cost of manufacturing can often be achieved through automation. By increasing the number of steps done automatically, we reduce the chances for operator error. In sequences 1, 2, and 4, cutting bills are used, and the chance of error occurs between the tally station and the worker carrying the cutting bill in his head. Also, problems can occur when the cutting bill is changed, particularly if this is done frequently.

The two most highly automated sequences

are 2 (conveyorized crosscutting) and 3 (automatic cutting to length). The technology required for these sequences is available. A drawback to sequence 2 is the high percentage of primary parts rejected. Fifteen percent of the primary parts were rejected when cutting 1C lumber, and 21 percent and 41 percent of the primary parts were rejected when cutting 2AC and 2BC lumber. Though this did not reflect adversely on the total yield, it does require extra handling of the rejected parts to and from the salvage station.

The marking and defect-removal operations in sequence 3 overcome the problem of rejecting large numbers of cut-to-length parts. Though it is possible that prohibitive defects might occur in the ends of the cut-to-length parts, this did not occur in our tests. Therefore we believe that the number of rejected parts will be small.

Sequence 3 has a further advantage in that operator involvement is kept to a minimum. The marking of prohibitive defects is the only operator decision necessary. As cutting to length is done automatically, and all lengths in the cutting bill are considered, there is no overrun or shortage in any length.

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