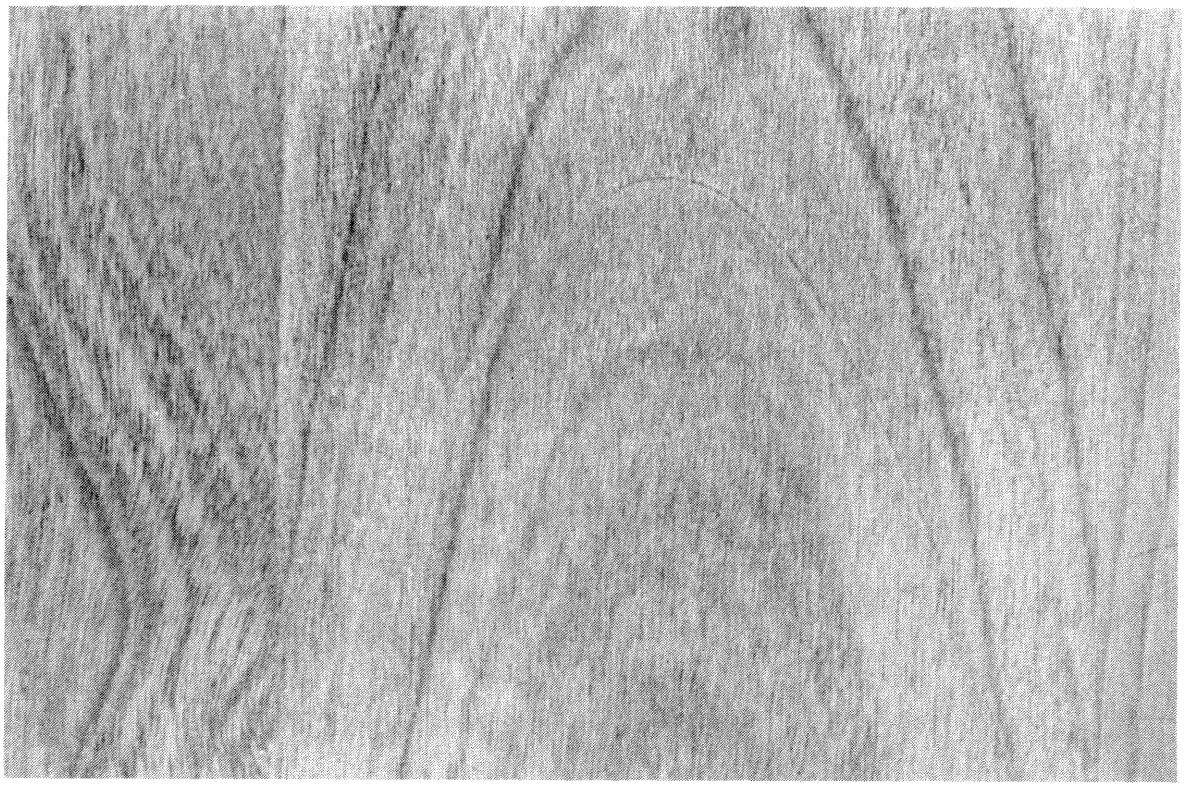
ODC 824.7--014

SERPENTINE END MATCHING: A TEST OF VISUAL PERCEPTION



by Bruce G. Hansen and Charles J. Gatchell

FOREST SERVICE RESEARCH PAPER NE-408
1978
FOREST SERVICE, U.S. DEPARTMENT OF AGRICULTURE
NORTHEASTERN FOREST EXPERIMENT STATION
370 REED ROAD, BROOMALL, PA. 19008

The Authors

BRUCE G. HANSEN is an associate economist at the Northeastern Forest Experiment Station's Forestry Sciences Laboratory in Princeton, West Virginia. He holds a B.S. degree in economics from Concord College and has done graduate study in marketing and economics at Virginia Polytechnic Institute and State University. He began his career with the Forest Service in 1968.

CHARLES J. GATCHELL received his B. S. degree in forestry from the University of Massachusetts in 1955. After a tour of duty with the U. S. Navy, he returned to the New York State College of Forestry at Syracuse University where, in 1961, he received his M.S. degree in wood-products engineering. From 1961 to 1965 he was a project scientist in the product and process development project at the U. S. Forest Products Laboratory in Madison, Wisconsin. He is now project leader of the low-grade hardwoods utilization research work unit at the Forestry Sciences Laboratory of the Northeastern Forest Experiment Station at Princeton, West Virginia.

Abstract

In tests of gross perception of Serpentine end matched (Sem) joints in oak and cherry display panels, there were no significant differences between the number of times the non-Sem panels were chosen and the number of these selections that could be attributed to chance. Results of separate tests of sensitivity of perception of Sem joints showed that the most conspicuous joints in oak and cherry panels were chosen most often, and that the least conspicuous joints were detected least often. Given proper selection of pieces to be end matched, and moderate finishing, Sem joints are difficult to detect—even by those who are well-informed about Serpentine end matching.

SERPENTINE END MATCHING (Sem) is an end joining technique that overcomes objections to straight end joints in furniture panels. The curved end joint is based on a sine wave and is machined with precision by a numerically controlled router. Sem is a new way to joint short pieces of low-grade lumber.

When well-matched pieces of wood are end joined, the joints are difficult—often nearly impossible—to see with the naked eye. The question then arises: how much matching of grain and color is necessary to make the joints imperceptible? The answer is important in defining the potential of Serpentine end matching (Fig. 1).

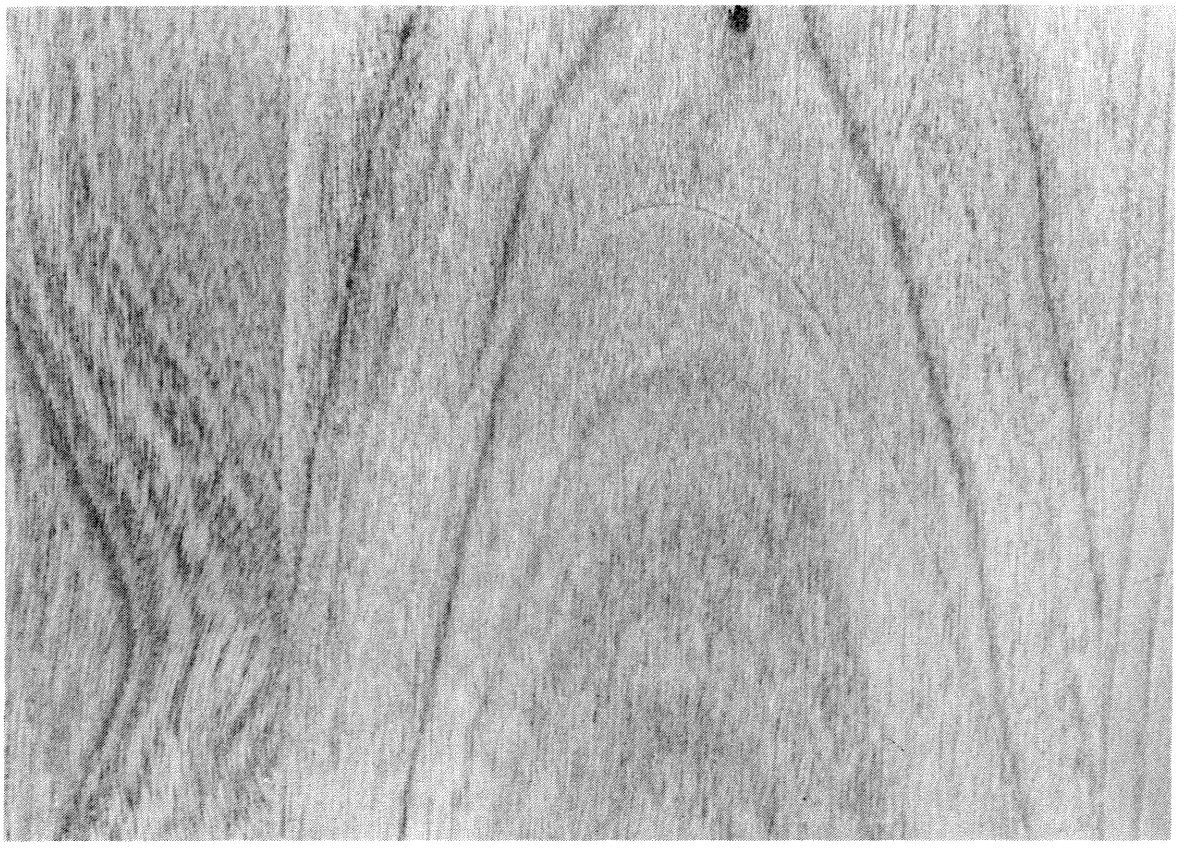
PERCEPTION TEST

To evaluate perceptions of Sem joints, a two-part test was given to participants of the 5th Annual Meeting of the Hardwood Research Council. Most of these participants were dimension producers, furniture manufacturers, design consultants, and others with an intimate knowledge of hardwoods and furniture manufacture.

Part I

We first wanted to test the gross perception of Sem joints. Could participants identify the curved end joints if they were unaware of Serpentine end

Figure 1.—Close-up of Serpentine end joint in cherry panel.



matching? We used a "triangular" test in which observers examined displays of oak and cherry panels. Each display consisted of two, four-piece panels and one "odd" three-piece panel. All panels were the same size. Each four-piece panel contained a Sem joint; the single three-piece panel did not. Forty-seven participants were asked to select the odd non-Sem panel in each display.

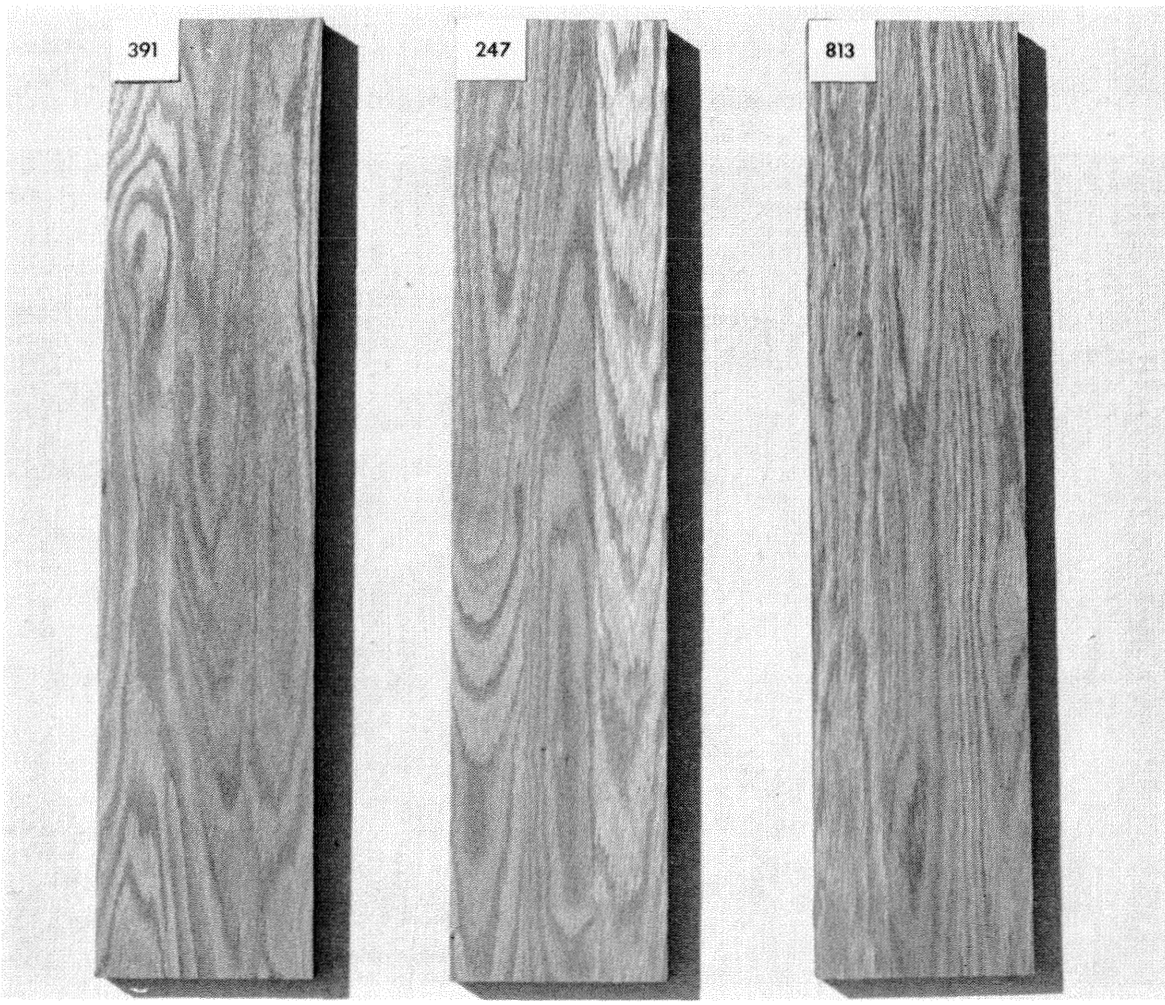
The observers were told:

> "Each display contains 3 panels. Two of the panels are made up of 4 pieces of wood. The other is made up of just 3 pieces. All pieces are the same width. You are to pick the 'odd' panel; that is, the one made up of just 3 pieces."

As can be noted from the instructions, focusing attention on the wood pieces caused observers to look for an end joint of some kind in two of the three panels.

The participants viewed each display from a distance of 5 feet. All were required to select one of the three panels in each display as the non-Sem panel—even if they were unable to perceive the difference between the odd and Sem panels. If none of the observers could detect this difference (identify the Sem joints), each panel would have an equal chance of being chosen. Thus, for each display, participants would have perceived the difference between non-Sem and Sem panels only if the odd panel were selected significantly more often than would be expected by chance alone (Fig. 2).

Figure 2.—The three-panel oak display. Can you identify the odd non-Sem panel?



Part II

In the second part of the test, we measured the sensitivity of perceptions of Sem joints. Could the degree of matching of grain and color around the joint alter perceptibility? We displayed two 39 x 10-inch panels (one oak and one cherry). We made a detailed presentation of what a Sem joint looked like, and gave each observer a sample piece with a Sem joint. Thirty-four of the 47 participants of Part I volunteered to take the second part of the test. We do not know why the others did not wish to continue, but it is possible that they became frustrated in failing to perceive the Sem joints.

To speed processing, the second group of observers was divided in half. One half was asked to locate the Sem joints in the oak panel; the other half was asked to locate the Sem joints in the cherry panel. Neither group was told that there were five joints in each panel, or that two joints were purposely made to be easily seen, two were made to be difficult to spot, and one was made so that the degree of visibility fell between these extremes.

Panel construction

In developing the test panels for Parts I and II, we chose close-grained (black cherry) and open-grained (northern red oak) pieces of No. 2 Common lumber, and we used clear finishes. All joints were the same size and shape. Factors considered were the Sem pattern, grain pattern, and finish.

Sem pattern. The end joint pattern was a sine wave with a 2½-inch amplitude (height) and a 5-inch period (width). With the precision machining possible with a numerically controlled router, glue lines .001 inch or less in thickness can be produced easily. From a distance of 4 to 5 feet, the actual glue line is not readily visible. What is observed are differences in the joined pieces.

Grain pattern. Hiding the Sem joint in edge-grained pieces is easily done. The use of Serpentine end matching to remove knots from edge-grained strips often results in a match of straight-grain patterns from the same strip. Our studies suggest that edge-grained joints are more easily detected when pieces with widely different growth patterns are joined.

Flat-grained material can be more difficult to match because the grain pattern appears to change continually along the length of the strip. Also, series of annual rings often "point" in opposite directions. For best grain matching, annual rings of the same size and shape should be joined. Because flat-grained pieces offer the widest range of differences in grain patterns and, therefore, in the degree of visibility of Sem joints, we used only flat-grained strips to strengthen the objectivity of the tests.

Finish. Finishing can be used to hide or obscure differences in joined pieces of wood panels. Multi-step finishing—the use of combinations of bleach, dark stain, filler, sealer, and topcoat—minimize these differences. It is also possible to tone, highlight, or distress panels to draw attention from joined areas. However, we avoided such techniques in this study. We finished all panels by spraying them with a penetrating oil, a sealer, and a clear topcoat. These materials heightened the contrast between the earlywood and latewood in the annual rings, and made differences between pieces more obvious.

RESULTS

Part I

The results indicated that participants generally failed to detect the Sem joints in either display (Table 1). Chi-square tests revealed no significant differences between the number of times the non-Sem panels were selected and the number of these selections that could be attributed to chance. But in the oak display, one Sem panel (No. 247 in Fig. 2) was chosen significantly more often than the other panels. However, closer examination re-

Table 1.—The number of times each panel in the oak and cherry displays was selected as the non-Sem panel

Panel code and type	Number of times selected	Percent
OAK		
No. 813 Sem (4-piece)	11	23
No. 247 Sem (4-piece)	24*	51
No. 391 non-Sem (3-piece)	12	26
CHERRY		
No. 980 Sem (4-piece)	16	34
No. 154 Sem (4-piece)	18	38
No. 638 non-Sem (3-piece)	13	28

*Significant at 5 percent level.

vealed that the grain pattern in Panel 247 blended less well than that in the other panels.

Did this difference in panels bias our test for the oak group? We do not believe so, because it was not great enough to preclude other choices. In fact, we had not been aware of this rather subtle difference before examining the test results. Although a substantial number of participants used this difference as the basis for selecting the odd panel, they nevertheless failed to detect the Sem joint in Panel 247. Also, there was little difference in the number of correct choices in the oak and cherry displays. Yet all panels in the cherry display were chosen according to what was expected. So, in one sense, the similar number of correct choices in each display tends to support earlier indications that the Sem joints had not been detected.

Part II

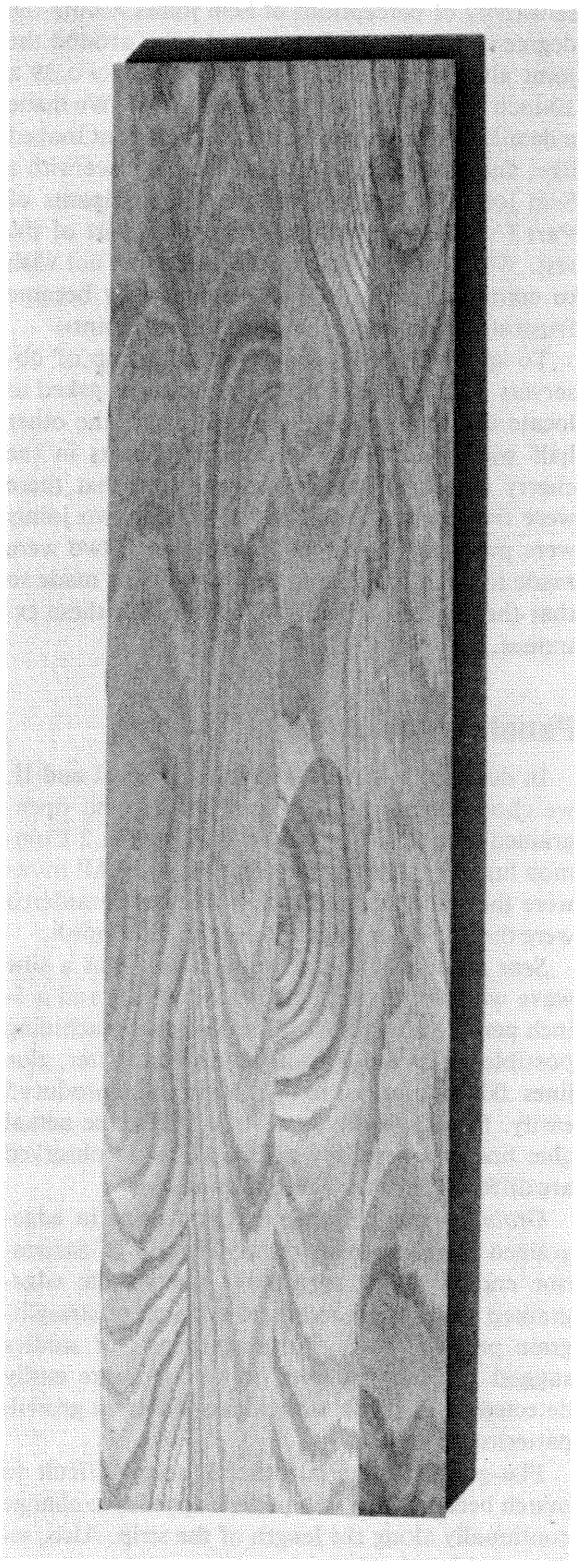
The results conformed to what was expected. The most conspicuous joints in both the oak and cherry panels were identified most often, and the least conspicuous joints were identified least often (Table 2). Though the 17 people in each test group knew exactly what they were looking for, it was apparent that joint perception was difficult in many instances. For example, only one joint—a highly contrasting light-dark match in the oak panel—was found 100 percent of the time (Fig. 3). By contrast, three of the four inconspicuous joints went undetected about 66 percent of the time.

While the pattern of joint selection was similar for both the oak and cherry panels, the difference

Table 2.—The number of times each Sem joint in the oak and cherry panels was identified

Joint no.	Degree of visibility	Number of times identified	Percent
		OAK	
1	Inconspicuous	5	29
2	Inconspicuous	8	47
3	In between	9	53
4	Conspicuous	16	94
5	Conspicuous	17	100
		CHERRY	
1	Inconspicuous	6	35
2	Inconspicuous	6	35
3	In between	10	59
4	Conspicuous	12	71
5	Conspicuous	12	71

Figure 3.—The nine-piece oak panel with five Sem joints. Can you locate all five joints? Two should be obvious.



between selections of the conspicuous and inconspicuous joints was greater for the oak than for the cherry panel. This was a result of the greater variation in grain and color in the oak lumber.

Only two participants in the cherry group correctly identified all five joints in the cherry panel; only one observer identified the five joints in the oak panel. The latter observer also identified two joints that did not exist, but this situation was not unusual; five observers in each group were deceived by characteristics of the wood itself.

CONCLUSION

We believe that we developed a strong test of Serpentine end matching. Except for preselecting the pieces to be joined, we did nothing to hide the joints, either by drawing attention from jointed areas or by altering the normal variation in grain and color around the joints. In fact, the finish of penetrating oil, sealer, and clear topcoat tended to accent the differences in grain and color. Also, all joints were the same size and shape. Thus, once one joint was detected, subsequent identifications were made easier.

The observers were knowledgeable in the properties of hardwood and furniture manufacture. Yet they generally failed to perceive the Sem joints in the test of gross perception. In each display, the non-Sem panel was chosen less often than could be attributed to chance. And while the test of sensitivity of perception suggests that oak may require greater attention than cherry when panel materials are matched, the less conspicuous joints were difficult to detect, even when observers were well-informed about Serpentine end matching.

We believe that joint perceptibility need not be of undue concern to the hardwood furniture industry in adopting Serpentine end matching. Given proper selection of pieces for matching and moderate finishing, the industry can produce joints that are as good as or better than the most inconspicuous joints in the test panels.

Additional information about Serpentine end matching can be obtained from the USDA Forest Service, Forestry Sciences Laboratory, Princeton, West Virginia 24740.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1978—703-112:23

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