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CROSS-GRAIN KNIFE PLANING IMPROVES SURFACE QUALITY AND UTILIZATION OF ASPEN

ABSTRACT. — Aspen at 6 percent moisture content was planed parallel to the grain and across the grain on a cabinet planer with a 25° rake angle, 1/16- and 1/32-inch depth of cut, and 20 knife marks per inch. Aspen was also cross-grain knife planed with a 45° rake angle, 1/32-, 1/16-, and 1/8-inch depths of cut, and 20, 10, 5, and 2.5 knife marks per inch. Cross-grain knife planing at all machine settings produced a better surface than finish knife planing parallel to the grain.

OXFORD: 823.1:832.18:176.1 *Populus* **spp. KEY WORDS: particleboard, machining.**

Approximately 60 million board feet of aspen lumber were consumed in 1965 in the United States.[1] Current trends show that aspen lumber utilization, although low compared with other hardwood species, is increasing; aspen is also a primary particleboard species.

Probably the most common wood machining process, except for sawing, is knife planing. Most lumber, unless it is used rough, is knife planed, which inherently produces machining defects and waste. A previous report[2] indicates that aspen machines easily — power consumption is low and tools dull slowly. However, the aspen fiber tends to sever less cleanly from the workpiece than many woods when machining parallel to the grain. Fuzzy grain may result. Further, aspen has a low tensile strength perpendicular to the grain, and chipped grain is easily formed when machining against the grain.

The previous study also indicated that planing aspen at 6 percent moisture content with a 30° rake angle produced the best surface, while a 25° rake angle was almost as good. Surface quality did not appear to improve as feed rate increased above approximately 20 knife marks per inch at 1/16-inch depth of cut. Also, aspen planed at 1/32 inch had better surface quality than that planed at heavier cuts. However, aspen still remains a difficult wood to plane, and technology is needed to produce a satisfactory surface.

Cross-grain knife planing has been shown to produce high-quality surfaces and flakes simultaneously on hard maple.[3] Further, slightly better surfaces and flakes were manufactured when cross-grain knife planing with a 45° rake angle.

To test the feasibility of cross-grain planing of aspen, surfaces of samples planed parallel to and across the grain were compared. Cross-grain knife planing at all machine settings produced superior surfaces.

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[1] *Gill, Thomas G., and Phelps, Robert B. Wood used in manufacturing industries, 1965. USDA Forest Serv. Statis. Bull. 440, 101 p., illus. 1969.*

[2] *Davis, Edward M. Machining and related properties of aspen. USDA Forest Serv., Lake States Forest Exp. Sta. Aspen Rep. 8, 8 p. 1947.*

[3] *Stewart, Harold A. Cross-grain knife planing hard maple produces high-quality surfaces and flakes. Forest Prod. J. 20(10): 39-42, illus. 1970.*

METHODS

Surface quality produced by the various machining situations was compared by tracing the surfaces of the panels that had the poorest quality; i.e., where chipped or torn grain extended farthest below the surface.

Cross-grain planing. — In one test aspen panels 6 by 24 inches with the cuttings aligned perpendicular to the length were conditioned to 6 percent moisture content and planed cross-grain on the top front square head of a molder with a 45° rake angle. The feed rate was increased to nominally give 20, 10, 5, and 2.5 knife marks per inch. The depths of cut tested were 1/32, 1/16, and 1/8 inch. In another test, panels were planed on a conventional cabinet planer with a 25° rake angle at commonly recommended machine settings of 1/32- and 1/16-inch depth of cut and 20 knife marks per inch. Also, a panel 18 by 24 inches was cross-grain planed with the cabinet planer at 20 knife marks per inch and 1/8-inch depth of cut.

Parallel-to-the-grain planing. — As a control, material was also planed parallel to the grain at 1/16 and 1/32 inch and 20 knife marks per inch with a cabinet planer.

RESULTS AND DISCUSSION

Results show that:

1. The maximum depth of defect was less for all planing combinations across the grain than for planing combinations parallel to the grain (figs. 1, 2, and 3).

2. The maximum depth of defect (chipped grain) was 0.067 inch when machining parallel to the grain at 1/32- and 1/16-inch depth of cut and 20 knife marks per inch on the cabinet planer with a 25° rake angle.

3. The maximum depth of defect was only 0.042 inch when cross-grain planing at 2.5 knife marks per inch and 1/8-inch depth of cut with a 45° rake angle on the molder.

4. When planing cross-grain, maximum depth of defect appears unaffected by depths of cut up to ⅛ inch at 10 or more knife marks per inch.

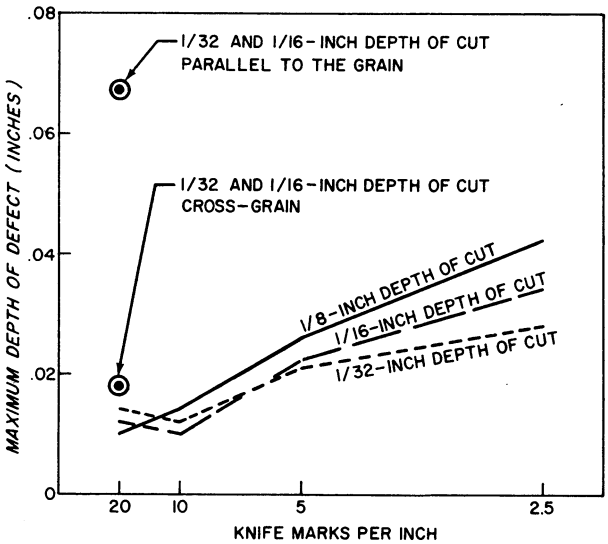

Figure 1. — *Circles depict maximum depth of defect on surfaces planed across the grain and parallel to the grain on a cabinet planer with a 25° rake angle. Lines depict maximum depth of defect on surfaces planed across the grain on a molder with a 45° rake angle.*

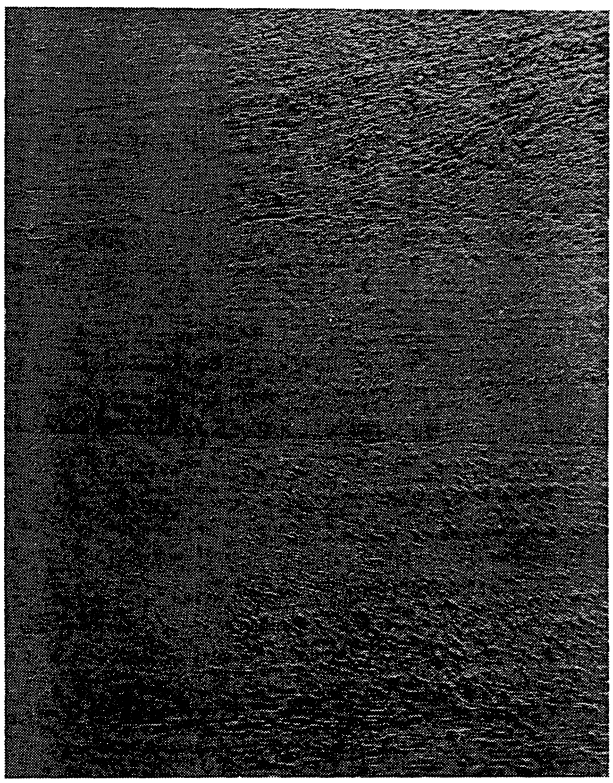

Figure 2. — *Surface manufactured by cross-grain knife planing at 10 knife marks per inch, ⅛-inch depth of cut, and 45° rake angle.*

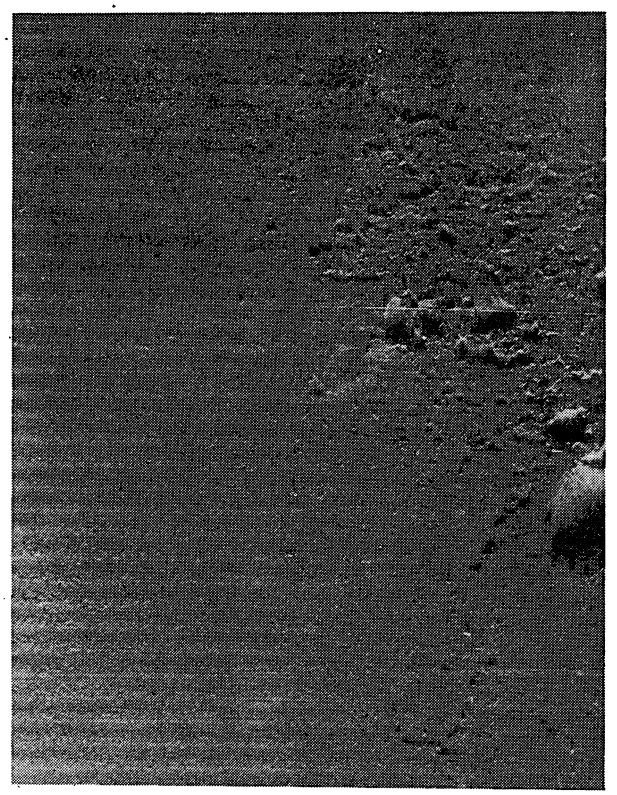

Figure 3. — *Surface manufactured by knife planing parallel to the grain with cabinet planer at 20 knife marks per inch, 1/16-inch depth of cut, and 25° rake angle.*

5. Maximum depth of defect was 0.018 inch planing cross-grain with a 25° rake angle on the cabinet planer at 20 knife marks per inch, and 0.014 inch with a 45° rake angle on the molder at depths of cut up to ⅛ inch and 10 knife marks per inch.

6. Flakes suitable for panel products were manufactured simultaneously with a finish knife-planed surface when planing cross-grain (fig. 4).

Because a surface knife planed across the grain has shallower defects than a surface planed parallel to the grain, subsequent processing and waste can be substantially reduced. More than 1/16 inch would have to be sanded away to remove the chipped grain that occurred at planing conditions commonly recommended for parallel to the grain, while approximately 1/64 inch would have to be sanded away to produce a satisfactory surface on material planed cross-grain under the same conditions but depths of cut up to ⅛ inch.

Figure 4. — *Flakes manufactured from cross-grain knife planing at 10 knife marks per inch, ⅛-inch depth of cut, and 45° rake angle.*

When cross-grain planing with a 45° rake angle, the maximum surface roughness was less than 1/64 inch in depth at 10 or more knife marks per inch for depths of cut to ⅛ inch. At 2.5 knife marks per inch and depths of cut to ⅛ inch, the maximum surface roughness was still substantially less for cross-grain planing than for planing parallel to the grain (fig. 1). Cross-grain planing with a 45° rake angle produces a slightly better surface. Consequently, production rates could be increased and sanding waste reduced. A small decrease in sanding will greatly reduce sanding dust and sandpaper consumption.

Other advantages described in the hard maple study[3] carry over to aspen. When planing parallel to the grain, the depth of the machining defects is primarily dependent on the slope of grain. The severest depth of defect occurred at approximately 10° slope of grain. The sloped grain associated with growth characteristics did not appreciably affect surface quality when planing cross-grain. When cutting cross-grain, a cleavage failure does not advance along the grain ahead of the knife. The aspen wood fibers also appear to sever more cleanly. Hence, chipped grain, tear-out, and fuzzy grain are minimal.

Flakes can be manufactured from stock kiln-dried to 6 percent moisture content; thus, the flakes require less further conditioning to be at an acceptable moisture content for particleboard.

When planing cross-grain, the glue lines of panels are parallel to the knife edge; thus, spot dulling of planer knives and downtime for resharpening can be reduced.

Knife marks from cross-grain planing are not as prominent as those from planing parallel to the grain. The less prominent knife marks may result from easier separation of the fibers and less compression by the knife edge. The lower sheen of a surface produced from cross-grain knife planing seems to substantiate this observation. Thus, less sanding may be required to remove knife marks as well as subsurface damage.

The major disadvantage of cross-grain knife planing appears to be the limited length of material that can be fed through a conventional cabinet planer. For this study an aspen panel 18 inches wide was planed cross-grain at less than 20 knife marks per inch and ⅛-inch depth of cut on a cabinet planer. Panels 24 inches wide of four other species — hickory, red oak, yellow-poplar, and basswood — have also been cross-grain knife planed at the same machine settings. In all cases, surfaces superior to those from planing parallel to the grain were manufactured.

Because particleboard consumption is increasing, the demand for particle sources will increase. Thus, the demand for flakes from a process such as cross-grain planing should also increase. Further, as the market for particleboard fluctuates, the demand for flakes should vary. Previously, part of the objective of machining processes has been to manufacture a satisfactory surface while removing a minimum of stock. However, if the demand for particleboard were to sufficiently increase the demand for particles, an optimum instead of a minimum quantity of flakes could be manufactured while knife planing. For example, core stock or solid wood furniture panels are generally manufactured from 4/4 lumber. But thickness tolerances are sometimes difficult to obtain from dry 4/4 aspen lumber that is characteristically warped or cupped. The cores or panels could be cross-grain planed from thicker stock. The excess could be sold as a coproduct instead of burned or used for stable sweepings. The net waste and waste disposal would be reduced while more fully utilizing the tree.

Cross-grain planing, of course, needs to be adapted to production and new planers may need to be developed. However, high-value flakes and higher quality finish knife-planed surfaces than are obtained by conventional parallel planing can be produced simultaneously by planing aspen cross-grain. Consequently, the utilization of aspen lumber for secondary manufactured products such as core stock and furniture parts may be increased.

HAROLD A. STEWART
Forest Products Technologist
Forestry Sciences Laboratory
Carbondale, Illinois (Laboratory maintained in cooperation with Southern Illinois University)

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