An Examination Of Knife Pitch Settings For Rotary Peeling

Three knife pitch configurations are examined and compared to a reference pitchrail that was empirically found to yield good results. Of the three, the one based on constant length of rub matches the reference curve the best.

By Henry Spelter

A previous report (May, *Panel World,* page 54) examined peeling variables in general that influence veneer quality and described developments in technology to improve control over those variables. This article focuses on the specifics of individual lathe settings, starting with the angle between the knife and the block, or pitch angle.

Forces bearing on a fixed knife during a peel change because of the changing curvature of the block. If the pitch angle is too high (too much lead) the knife is pulled into the block until sufficient tension builds up to cause it to spring back, tearing some wood. The resulting roughness and corrugation seriously detracts from veneer quality. If the pitch angle is too low (too much heel) the knife is pushed away from the block. It oscillates back and forth resulting in thick and thin veneer. The main effects of pitch angle then are on veneer thickness variation and surface roughness, although additional effects on lathe check depth have also been identified (1 ,2). The purpose of changing the angle of the pitch during the peel is to find a compromise between these extremes so that the knife tip is relatively stable.

Contact between the knife face and block is governed by the feed and by the block radius. The knife advance per revolution is a constant determined by the veneer thickness. But the newly cut block surface below the knife tip does not move directly away from the knife; its velocity is initially mainly downward. This leads to contact or rubbing with the knife which is steadily advancing into the block. At some angle of rotation the horizontal component of the block's motion begins to exceed that of the knife's and the intensity of contact diminishes until contact ceases.

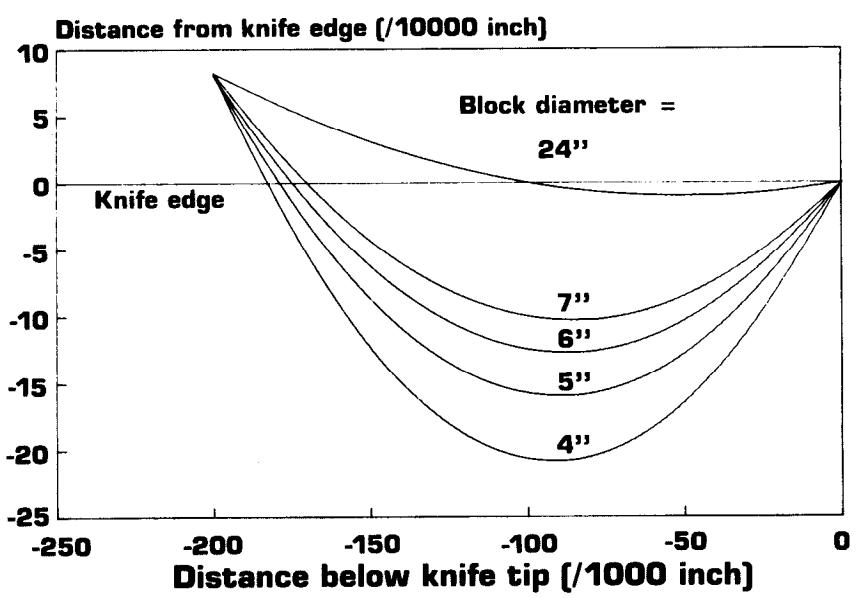
Table 1–Lathe specifications.

	in	mm
Roller bar diameter	0.625	15.9
Horizontal gap	0.115	2.9
Vertical gap	0.088	2.2
Exit gap	0.115	2.9
Veneer thickness	0.135	3.4
Main knife bevel [deg]	23	

This can be visualized as an overlapping of the knife face by the block surface with the length of the overlap equal to the "rub" and the depth equal to the amount and intensity of pressure that is actually compressing the wood cells. As block radius decreases, both the length and depth of the overlap lessen, increasing the net force pushing the knife into the block. The knife has to be gradually inclined toward the block, therefore, to provide a countervailing force. We examine three strategies for altering the pitch angle based on maintaining (1) a constant distance between the knife and block at a given point below the knife tip, (2) a constant contact length or rub, a common industry benchmark, and (3) a constant volume of wood under pressure.

Table I summarizes typical lathe parameters on which the pitch angle calculations were based. Settings of small diameter nosebars generally cause the veneer to be squeezed as it exits behind the knife. For these particular settings, the exit gap is .115 in. (2.9 mm) compared to veneer thickness of .135 in. (3.4 mm), which means that pressure is transmitted

Figure 1–Theoretical overlapping of knife edge by blocks of various sizes for a specified constant gap. 1 in. = 25.4mm.



through the veneer by the roller bar. Amount of such force varies with different exit gap/veneer thickness ratios and influences the appropriate pitch angle.

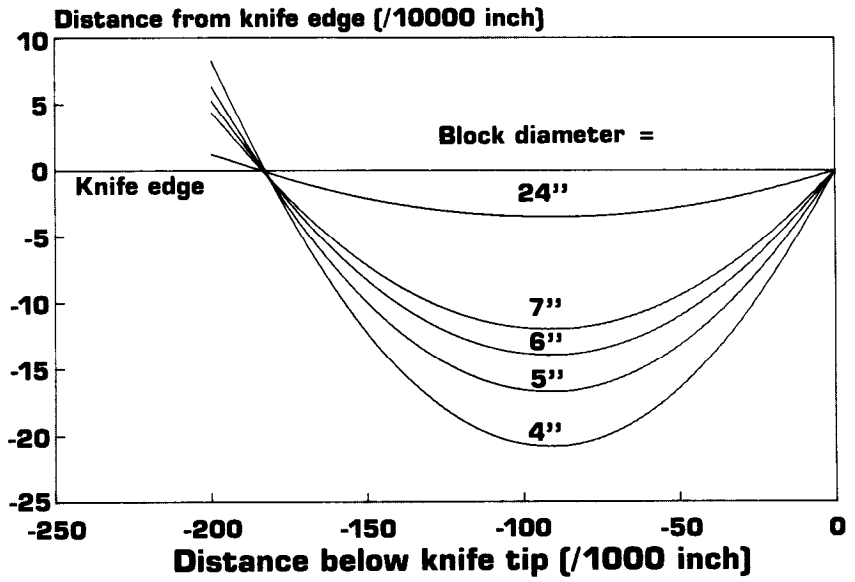
Figures 1-3 illustrate the knife/block interaction in terms of the hypothetical overlap between the two discussed above. In all cases the scale is magnified for clarity. The figures present sideviews of the block/knife interface with the block center located toward the top and the knife body toward the bottom of the charts. The vertical axis represents the horizontal distances from the knife edge, negative readings being into the knife body.

Figure 1 illustrates the hypothetical knife/block overlap when angles are selected such that the gap between the knife and block stays at a constant .0084 in. (.21 mm) at a point .2 in. (5.1 mm) below the knife tip. In contrast to a fixed pitch, where pressure decreases with block diameter, pressure increases as block diameter declines with these settings.

Figure 2 shows what happens when angles are selected so that a constant rub length of 0.18 in. (4.6 mm) is maintained. While the length of overlap is now constant, the overlap still deepens with declining block diameters, increasing the amount of pressure during the peel.

To obtain uniform pressure on the knife face throughout the peel, a third strategy could be to maintain the volume of wood under pressure constant. Figure 3 shows the resulting knife/block overlaps. The lengths of rub and the depths of overlap are both variable in such a way so as to maintain equal volumes of wood under pressure.

Figure 2–Theoretical overlapping of knife edge by blocks of various sizes for a specified constant rub. 1 in. = 25.4mm.



To evaluate the effect of these pitch angle profiles on veneer quality we use results developed at the Canadian Forest Products Laboratory (1) for the lathe settings in Table I. For this study, blocks of various sizes were peeled at six pitch angles between +1 and -2 degrees in half degree increments. Veneers peeled from blocks between 6 and 26 in. (15 and 66 cm) in diameter at 4 in. (10 cm) increments were collected and evaluated according to (1) thickness variability, (2) roughness and (3) lathe checks.

In the quality rating scheme, veneer that varied by more than 0.008 in. (.2 mm) in thickness from the intended cut, or that had surface roughness greater than 0.02 in. (5 mm) in depth was considered unsuitable. The combined percentage of veneer outside of tolerance for these two measures represented the main criterion for acceptability. Results were grouped into three categories: less than 5% out of bounds (good), 5-15% (marginal), and more than 15% (reject). An additional criterion, however, was that depth of lathe checks be at least 40% of the thickness. Rationale for this was to assure a minimum flexibility in the veneer so that the automatic stackers would handle them effectively.

Figure 4 shows results of these tests. A pitchrail configuration that best matched the good and marginal data points while avoiding the rejects was empirically derived by the researchers. It's represented by the thick solid line. Placed alongside for comparison are the three angle sets developed by the geometric criteria described above.

All three curves fit the empirical curve reasonably well. None stray into reject territory. The best match to the empirical curve is the one based on constant length of rub. The curve based on constant distance between the knife and the block comes closest to a reject point, but the particular reject occurred not because the veneer had excessive thickness variation or surface roughness, but rather because the 38% lathe check depth failed

Figure 3–Theoretical overlapping of knife edge by locks of various sizes for a specified constant pressure. 1 in. = 25.4mm.

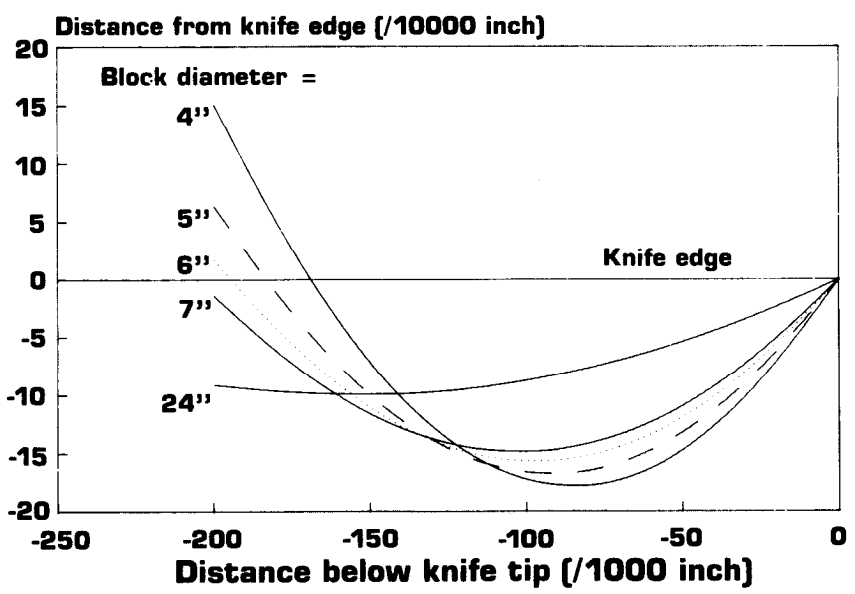
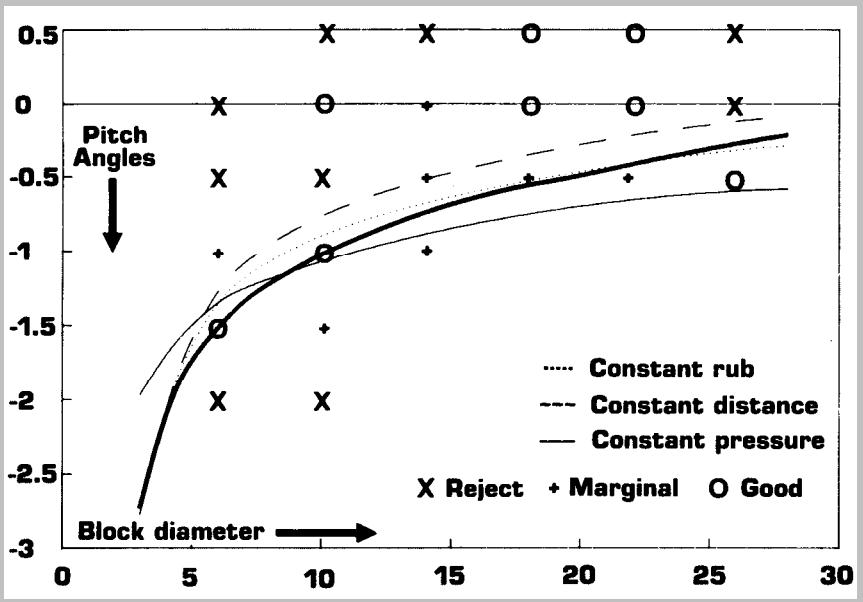


Figure 4–Results of empirical investigations of veneer quality for different pitch angle and block diameter combinations compared to various pitch angle profiles. 1 in. = 25.4mm.



40% criterion. The greatest discrepancy occurs between the constant pressure curve and the others at small block diameters, but because there was no veneer tested in that range, the discrepancy cannot be evaluated on the basis of the study.

As noted above, the angles mathematically derived for a given criterion will vary depending on lathe feed. Thinner peels require more negative angles (Figure 5). However, the veneer itself contributes to the force pushing the knife into the block. Contact between veneer sheet and knife back is partly a function of veneer thickness and the thinner the veneer, the smaller the pressure. This lowers the requirement for knife/wood contact and means higher angles. These two tendencies tend to cancel each other out.

In the Canadian study (1), the derived pitchrail was also tested on 0.1 in. (2.5 mm) veneer and quality loss was minimal. Thus performance loss should be negligible when veneer in the normal range of thicknesses (0.1-0.22 in., 2.5-5.5 mm) is peeled, although for very thin peels, higher angles would be required (2).

Figure 6 compares the constant length of rub pitch angles derived here for .625 in. (1.6 cm) diameter roller bars with a pitchrail configuration for a 3.75 in. (9.5 cm) bar. Angles for the large diameter bar are higher than for the small bar. The curve also breaks sharply at a diameter of 6 in. (7.6 cm), something that is generally not desirable because of the rapid changes that that can cause in the balance about the knife. However, it should be remembered that the exit gap between the knife and a small diameter roller bar is constant during the peel, whereas the settings in a large diameter setup change as block diameter declines.

Depending on what vertical gap is chosen, the narrowest point between bar and knife back (exit gap) may exceed veneer thickness throughout the peel or begin to compress the veneer only near the end. In the latter case the balance of forces would change rapidly at the moment the roller bar begins to press on the exiting veneer and a radical change in knife pitch may be warranted. Since the position of the nosebar affects what happens at the knife tip, appropriate pitch angles for large diameter nosebars cannot be determined without consideration of what is happening to the nosebar. This will be examined in a later article.

Summary

Three knife pitch configurations were examined and compared to a reference pitchrail that was empirically found to yield good results. Of the three, the one based on constant length of rub matched the reference curve the best. Both the reference curve and the two that best matched it involve increased pressure on the knife from the block as diameter decreases.

The geometric criteria examined are influenced by the amount of pressure exerted by the nosebar on the veneer. A narrow exit gap exerts greater force on the knife requiring, for example, a longer rub length or larger volume under pressure to compensate. This is accomplished by lower pitch angles.

To implement these results on a lathe with fixed pitchrails, a new set of rails would have to be machined and installed. The angles for any of the criteria de-

Figure 5–Effect of veneer thickness on pitch angles, given the same amount of rub. 1 in. = 25.4mm.

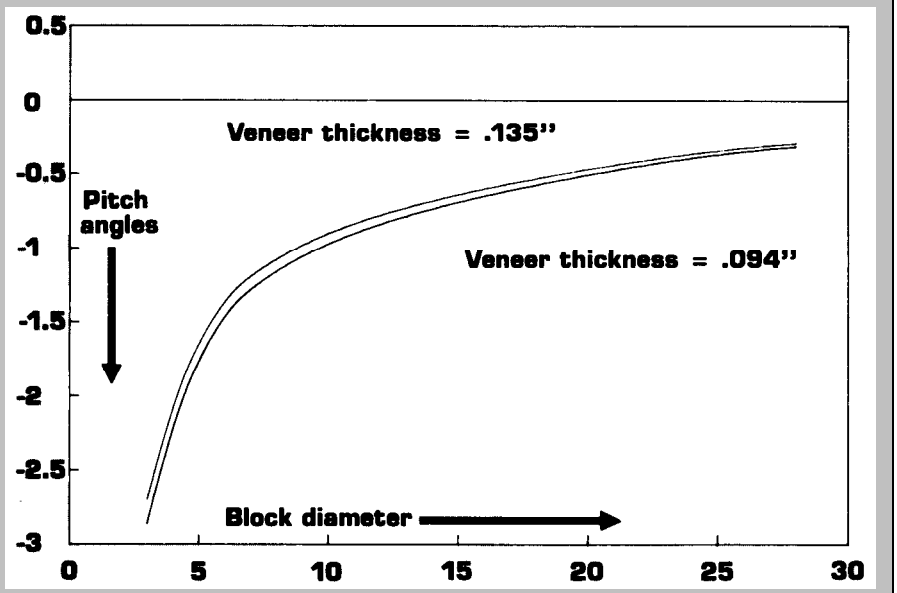
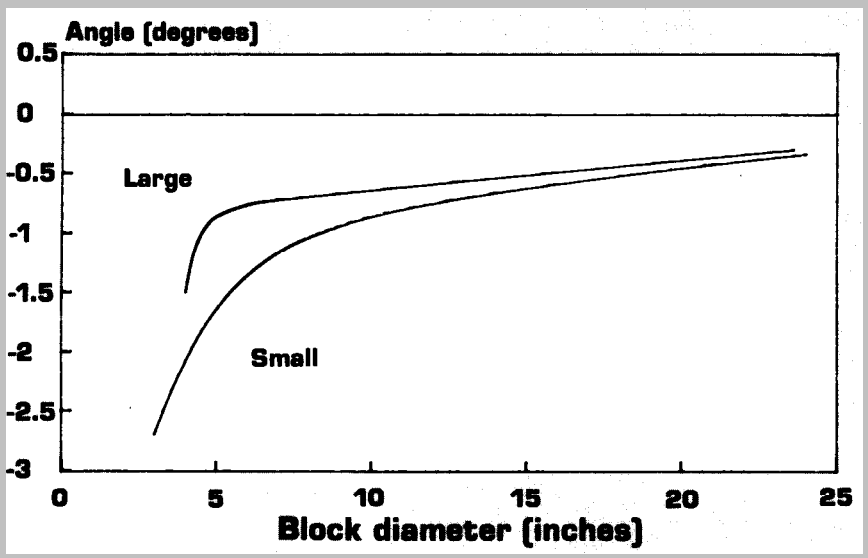


Figure 6–Pitch angle profiles for large and small diameter nosebars. 1 in. = 25.4 mm.



scribed here can be obtained from the U.S. Forest Products Laboratory at the address given at the end of this article. They are applicable to lathes with small diameter roller nosebars. Further improvement in pitchrail designs may be possible if the requirement for certain amounts of lathe checking can be relaxed. It seems odd to target a given level of veneer damage. If the sole necessity for this is to accommodate automatic stackers, then an opportunity exists for improved stacker designs that are capable of handling tight veneer at the speeds required in today's mills. Replication of the Canadian pitch angle studies with a lathe modified with a large diameter roller bar would also appear to be needed. ●

Literature cited:

1. Hancock, W. V. and J. R. T. Hailey. 1979. Improved pitchrails for peeling Douglas-fir and White Spruce. Forest Prod. J. 29(2):30-34.

2. Palka, L. C. and B. Holmes. 1973. Effect of log diameter and clearance angle on the peel quality of 0.125-inch-thick Douglas-fir veneer. Forest Prod. J. 23(7):33-41.

3. Spelter, Henry. 1991. Recent developments in veneer peeling confront quality variables. Panel World, May 1991, pgs. 54-65

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