PANEL LAYUP OPERATIONS

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Most wide furniture parts, such as table tops and bed or chest panels, utilize edge glued panels in their product. These panels can be constructed either of fixed width or random width components, although use of the latter is more common. The panel layup operation as a function of the rough mill consists of manufacturing a gluable edge, color matching, grain matching, and panel sizing.

Making a Gluable Edge

Producing a smooth edge that will successfully perform in a glue line is the first and most important step in panel layup. Poor machining or poor moisture control can lead to a surface that will cause glue bond failure. It is common practice that the edge to be glued is produced either with a straight line rip saw or with a gang saw. Regardless of which saw type is used, edges must be:

- surfaced smoothly and straight from end to end;
- square with the part face and back;
- parallel with the opposite edge;
- free of loose fibers;
- not burnished by sawing.

Having a well maintained rip or gang saw is crucial to forming a surface suitable for a glue joint. Improper saw lead can result in a rough surface characterized by deep arcs left by the saw blade. Ideally, the edge to be glued should be straight from end to end so adjacent strips touch completely along their length. An opening along the glue joint may indicate a problem with the feed chain tracking. Open glue joints or gaps at the ends are unacceptable. A gap that occurs at mid-length between two adjacent strips is a "hollow joint" which may be acceptable if slight and it can be forced closed by the subsequent gluing process. Forcing the hollow joint closed will build stresses into the glue line proportional to the amount of force used, and thus the width of the gap allowed should be limited. The rule of thumb for the allowable hollow joint gap at mid-length of two freshly sawn forty-inch long pieces is 0.005 inches. Although wider gaps can be forced together with sufficient pressure, the resulting glue joint may experience early failure. Joint preparation is most critical with continuous flow glue machines because accumulated errors in width will be too large for this process to close. The same degree of error is better tolerated with the more forgiving clamp carrier.

The saw alignment must be perpendicular to the saw bed (anvil) so the part edges are square with the face and back. Out of square edges will cause gaps between parts when they are assembled for gluing. These gaps are often forced closed by the use of excessive pressure in the press, which can crush the wood cells and squeeze too much glue out of the "high spot". At the same time, an inadequate amount of pressure is applied to the "low spot", resulting in too large of a gap for the formation of a high strength bond.

Planed lumber works best to provide stability as the part travels through the rip saw. Rough, unplaned lumber may rock and roll in the ripsaw, resulting in an uneven edge and possibly kicking back either the part or the ripped edging strip.

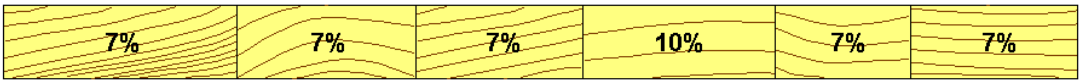
Opposite edges of the part that are to be glued should be parallel. Occasionally an operation will try to improve yield by sawing without the fence, producing an edge that is at an angle to the opposite edge. The resulting wedge shaped parts may not be stable in clamps, and it is difficult to apply uniform pressure across the glue joint.

Sharp saw blades should be maintained at the ripsaw. A dull saw will generate excessive heat that may visibly burn or scorch the wood. A less obvious problem is the dull saw may burnish or polish the wood. The sawn surface may have a lustrous sheen but does not appear burned. However, glue cannot wet and penetrate this inactivated surface and as a result, a poor glue joint will form.

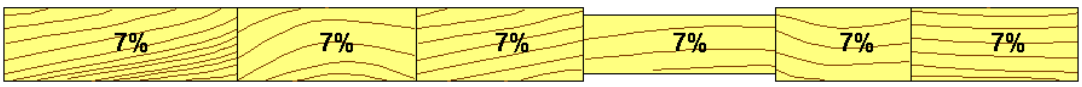
A dull saw can also accentuate inherent wood problems such as tension wood, an abnormal growth response in leaning hardwoods. Cutting tension wood with a dull saw will often result in fuzzy grain, wood fibers that are not completely severed during the cutting process. These partially attached fibers can interfere with panel assembly resulting in a poor adhesive bond. Problems related to fuzzy grain are greater if the wood has a high moisture content.

Machining may initially produce a gluable edge, but moisture content changes before or after the wood is glued may result in an unacceptable glue line or glued product. Many if not most of the problems with edge glued panels originate with changes in moisture content. Consider the description and cure for several of the more common gluing problems.

- *Sunken or raised board*. This occurs when boards of various moisture contents are glued into panels and then surfaced flat. A high moisture content board will eventually lose moisture and shrink to a smaller thickness than adjacent boards that were at a lower moisture content initially (see Figure 1). Cure: boards should be at the same moisture content when glued (within a 2% moisture content range).



Panel and moisture content of components as glued, pressed, and surfaced.



Panel after high moisture content part has reached equilibrium, resulting in shrinkage of that part (exaggerated shrinkage shown here).

Figure 1. Development of sunken board in a panel containing one board of high moisture content.

- *Sunken joints.* Water from the glue swells the wood adjacent to the glue line. Planing the panel before the moisture has had time to distribute throughout the panel will remove more wood near the glue line than further away. Although the surface appears smooth immediately after planing, future movement of moisture away from the glue line to a uniform distribution will cause wood shrinkage near the glue line, leaving a shallow channel or sunken joint (see Figure 2). Cure: panels should have a conditioning period before being surfaced, the length of which depends on thickness, temperature, and the end product.

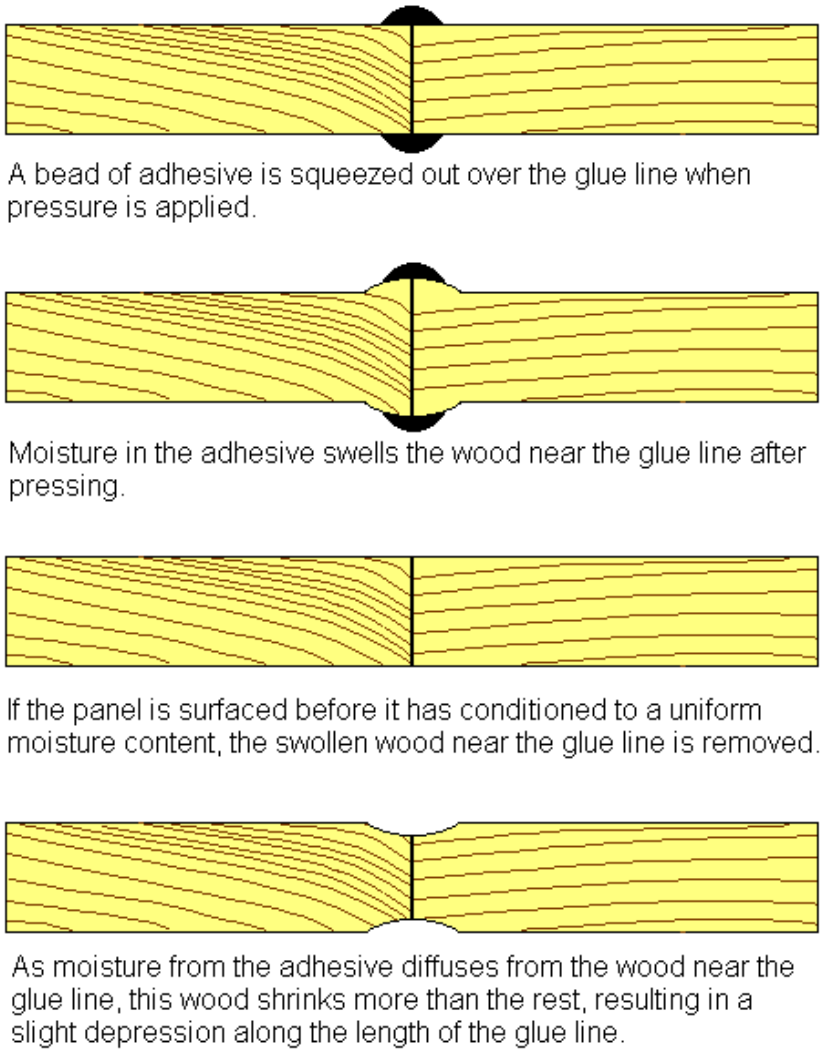


Figure 2. A plausible cause of the development of sunken joints in panels

- *Open joints.* Assuming that the wood is at the correct moisture content initially, open joints are often caused by moisture content changes that occur in the machined wood part during delays between machining and gluing. Parts to be glued are typically dead piled, leaving the end grain exposed. Changes in moisture content and dimension occur more rapidly (about 5 to 10 times faster) on end grain surfaces than other surfaces. An

overnight delay between machining and gluing can result in moisture pickup (or loss) within parts. This problem occurs more frequently in winter when the relative humidity in the rough mill is lower, resulting in greater dimensional changes in the ends of the cut parts. Extra pressure at the gluing operation may be required to close the visible gaps that result. Although the gap is temporarily closed, it is likely to open with future moisture changes. Cure: Adopt the rule of thumb that what is sawn today should be glued today. Such practice will also minimize contamination by wood dust, dirt, or oil. In addition, yield losses from moisture problems can be lessened if the equilibrium moisture content in the part storage room is carefully controlled.

- *Cupped panels.* One of the causes of cupped panels arises from the differences in tangential and radial shrinkage. Boards that are not perfectly flatsawn or quartersawn will not maintain perpendicular edges with changes in moisture content. Although this may be very slight in each board, gluing several similar boards together can result in a warped panel. Cure: The direction of annual rings in adjacent boards should be alternated to maintain panel stability.

Grain Matching

Concerns about panel warping often bring limits to the maximum part width allowed in the panel. Many operations limit the width of the individual component to 3- or 4-inches to minimize the individual strip's ability to cup the panel. Unfortunately, there is often no effort to alternate the annual rings (as described above). The net result is that wide boards are ripped and then simply glued back into their original orientation with no increase in dimensional stability, but with a lot of added costs. Anecdotal evidence from some operations suggests that for some species and products, the width of strip that can be safely incorporated into a panel can be increased if the initial moisture content matches the end-use moisture content.

Color Matching

A panel constructed of components of similar color is generally more attractive and has a higher value than a panel constructed of randomly placed parts. For some operations, the appearance requirement of the end product necessitates the color matching of component panel parts. Color matching may be as simple as separating heartwood from sapwood, or it may involve the careful matching of various shades of color and grain appearance. Human operators are capable of manually sorting parts into as many as four color groups. Possible limitations include: 1) differences in color perception ability between operators, and 2) reduced accuracy caused by operator fatigue as the day wears on. Recently, equipment has been developed to automate the color sorting process and alleviate the shortcomings of manual color sorting. With automated color sorting, the challenge is to insure that even the "off" color components are placed in a marketable panel product.

Panel Sizing

Panel sizing is an area that is often overlooked or done poorly. Too often panels are built ½ to ¾ inches wider than required. It is important to remember that ½ inch of waste in a

25-inch wide panel represents 2 percent of the panel yield. Assembled panels should be within ± 1/8- inch of the rough panel dimension. There are at least four techniques that can be used to minimize waste generated during panel layup:

1. Optimize your panel layup with automation. Available technology will measure the widths of several boards and automatically select the best combination of those available to lay up a panel of desired width. Although it has the ability to build a panel to within 1/8-inch of the target panel width, some operations find that they need to increase the tolerance if they only produce a limited number of fixed width parts (perhaps with a fixed width gang rip saw). Also note that to obtain color matched panels when using an automated panel layup machine color presorting must be performed and thus a more complex parts inventory system will be required.
2. A template fixture might be used to limit the size of the panel during lay up. A wide variety of templates may be devised. A marking system can be used by the ripsaw tail person that uses a template and a magic marker or paint striper to indicate on the board where it should be cut (see Figure 3). The board is then passed to the ripsaw operator for cutting. Alternatively, some operations utilize a two-sided partition that boxes the panels as they are placed on the cart or pallet. One side of the partition is marked to indicate the target panel width. The tail person and the ripsaw operator communicate by hand signals to indicate how much width is needed to finish out a panel.

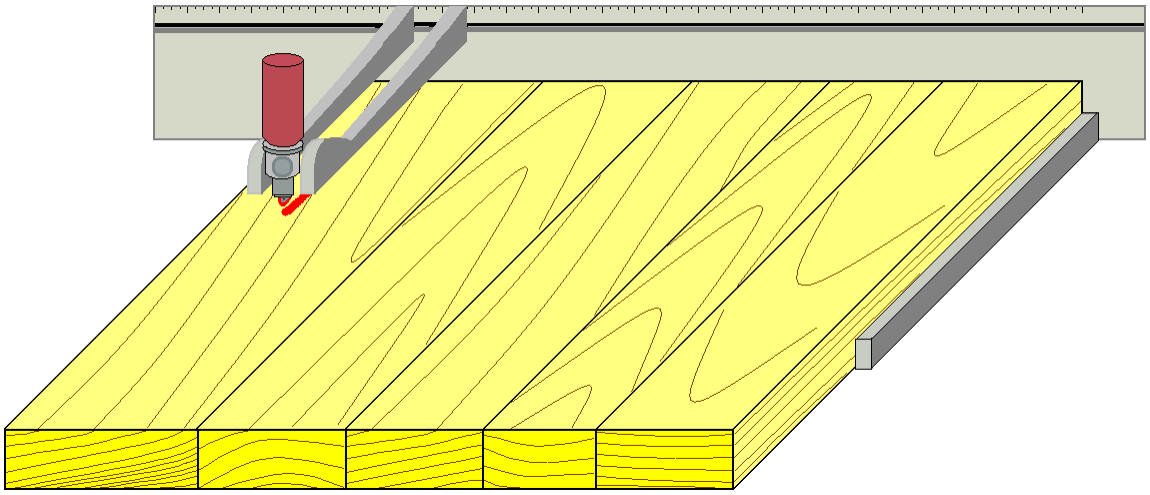


Figure 3. Using a paint striper to mark the desired panel width.

3. Use a wide part as the final edge when laying up the panel, and then size the assembled (but not glued) panel using either a matching saw or a straight-line, chain fed rip saw equipped with a panel gauge. The trimmed overage can then be used as the first piece of the next panel (see Figure 4).
4. Rerip the glued panels and save the trimmed strips for later use. The cautionary note is that strips must actually be saved and reused to accrue a yield benefit. In addition, the increased costs associated with inventory tracking and material handling must be less than the yield benefit realized.

With sawmills improving their board thickness tolerances, rough mills now have thinner stock to use for panel layup. As a result, manufactured panels may be too thin, resulting in losses at the finish planer. Additional care in panel layup and lumber manufacture will be required to prevent these panel losses.

Having the ability to manufacture random width parts for use in glued panels can increase rough mill yield generally by about 5% compared to fixed width only part production. Many factors such as lumber and part grade, fixed part size, and panel specifications, to name a few, can dramatically influence the actual yield increase each plant may attribute to using random width parts in panels. Higher yield gains are accrued when the moisture content of the lumber and parts is carefully controlled. It is important to keep in mind that one wet piece of lumber can affect multiple panels. Moisture related problems are the biggest cause of diminished yields in panel operations.

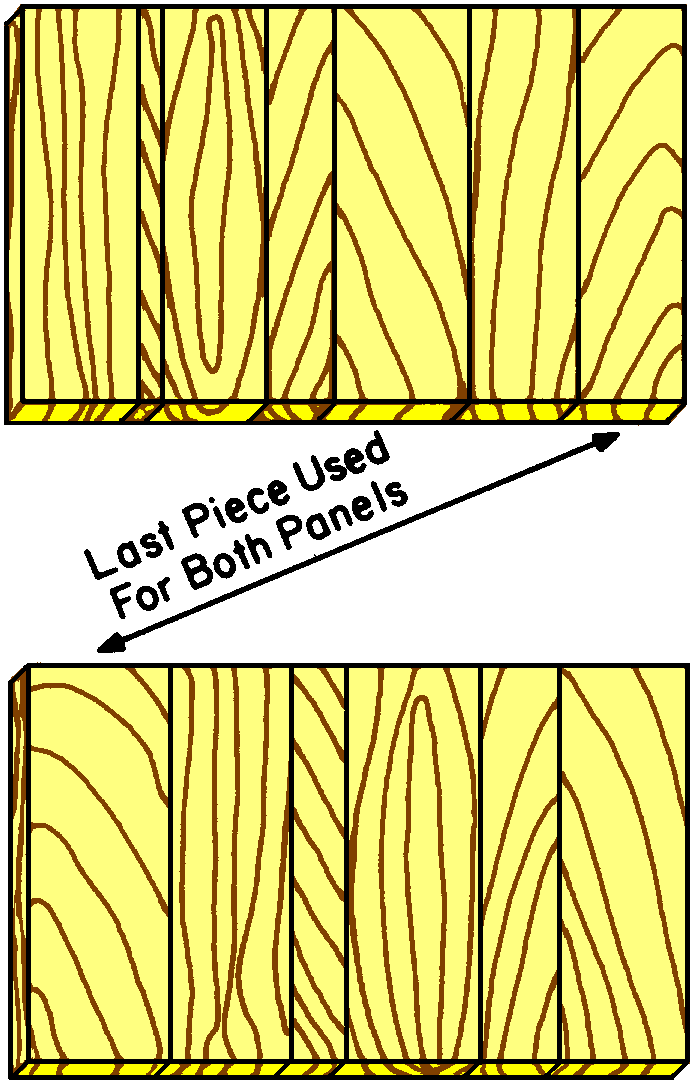


Figure 4. Using overage from preceding panel for first piece in next panel.

[1] Phil Mitchell is an Associate Professor and Wood Products Extension Specialist in the Department of Wood and Paper Science at NC State University, Raleigh, NC. This article is an excerpt from a series of articles that will be published by the Forest Service as the new rough mill operators guide. The full text of the articles will be available on North Carolina State University's web site at: www.ces.ncsu.edu/nreos/wood