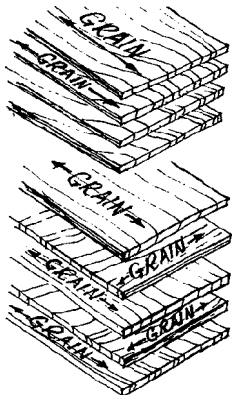
Bent Laminations

Slice and glue the wood to make it curve

by Jere Qsgood

Samples of laminated wood have been found dating from the 15th century B.C. Lamination means a layering process. All the layers are aligned with the grain going in the same direction, and are held fast by a glue. Thin slices of wood can be laminated flat or to a curved form.

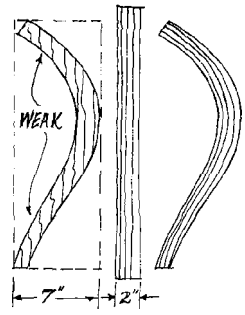
It is important to distinguish lamination from veneering. The grain of the laminate layers is always oriented in the same direction. In contrast, in veneering or plywood the grain directions alternate and an odd number of layers must be used. In lamination the layers, when glued together, will act like solid wood, expanding and contracting across the long grain. In veneering, grain alteration stabilizes the unit and there is no movement across or with the grain. Another form of lamination, stacking, is really a separate subject. (See "Stacking," *Fine Woodworking,* Winter '76.)



Furniture-related examples of lamination are flat or curved cabinet panels, tabletops, and curved leg blanks. The simplest lamination is the use of a fine figured wood as an outer layer on a tabletop or cabinet panel.

In many cases I find laminations more acceptable than solid construction. For example, one plank of an unusual figured wood could be resawn into many layers. These could perhaps cover all the sides of a cabinet, if backed up by layers of wood of lesser quality or rarity. If used at full thickness, many planks of this unusual wood would be needed to achieve the same effect.

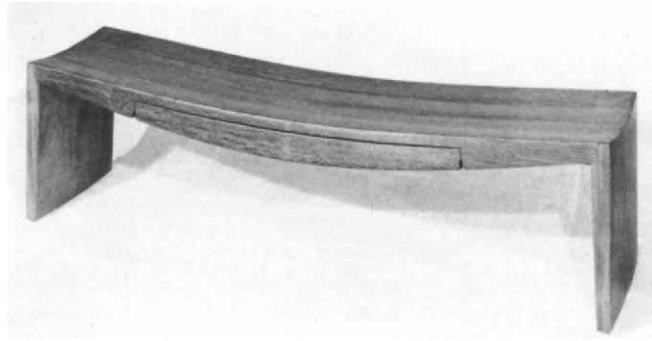
Lamination is an economical way of obtaining curved forms. Members can be thinner when laminated as opposed to sawn because of the inherent strength of parallel grain direction. Steam bending is of course an alternative for curves and is an important process. However, lamination offers the advantage in many cases of more accurate reproduction of the desired curve. Modern glues have eliminated the bugaboo of delamination—the glue lines are as strong as the wood itself. An excellent use of laminated wood is in chair or table legs where short-grain weakness might inhibit design. It is important in some cases to make the layer stock thick enough so that any shaping or taper can be done in the outer two layers because going through the glue lines might be unsightly. In addition to counteracting short-grain weakness, laminating a curved leg also saves scarce wood, because a laminated leg can be cut from a much narrower plank than would be required for sawing the curved shape out of solid stock.



For flat panels such as a tabletop or a cabinet panel, a core of some stable wood (poplar or mahogany) is used. A face wood, which can be veneer or resawn stock, is glued on both sides with the grain directions the same. It is important to cover both sides to forestall warp and to use the same species

Jere Osgood teaches woodworking at Boston University. He lives in New Milford, Conn.

Dining table by James Schriber: Top is simple laminate faced with tamo veneer; apron and legs are laminated ash. Bench by Osgood: Curved ends, top and front are all bent laminates.



Chest of chair, laminated curly maple, by Jere Osgood.

on both sides. However, if the densities are kept the same, substitutions can be made. Typical veneer thicknesses are 1/30 in., 1/28 in., 1/16 in. and 1/8 in. Resawn stock is thicker—perhaps 1/8 in., 3/16 in., 1/4 in. or 3/8 in. The core thickness in a cabinet panel might be 1/2 in. and in a tabletop, 13/16 in. The core requirements disappear when laminating something like a drawer front, which might typically be two layers of 3/8-in, material or three layers of 1/4-in, stock.

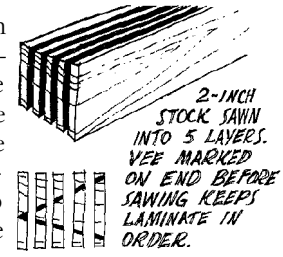
When panels are curved the thickness of the layers is important. A thick core might not be possible. Whatever size layers are used, they must each be able to take the desired curve. For example, 1/16-in. layers might be needed to bend a 3-in, radius, but for a lesser bend of, say 1-in, deflection over a 36-in. drawer front, 1/4 in. or 3/8 in. might be thin enough. The appearance of the visible edge of something like a drawer front is also a design factor to consider.

A general rule is to keep layers of the maximum thickness that will take the desked bend. This not only saves time and money (each time a lamination is cut, a slice the thickness of the saw blade turns into dust) but also aids in gluing evenly. A multitude of thin layers of, say, 1/28-in. veneers risks a surface unevenness from disparate clamp pressure marks resulting from a poorly bandsawn form or from unevenly spread glue. But you don't have any choice if you have 2000 square feet of very thin veneer that will fulfill the stock requirement for a specific piece of furniture.

First, determine the thickness needed by testing the bend with a sample. Narrow or simple cuts, say for chair legs, are usually possible with a single pass on a table saw, the limitation being the diameter of the saw blade. In many cases a carbide rip blade will give a good cut for gluing that will not need to be run through a thicknesser. Stock cut with a normal rip blade will need to be thickness-planed.

Wide laminations that can't be cut in one pass on the table saw can be cut on a band saw using a resaw jig. Another tablesaw method involves dressing stock normally, cutting from opposite sides of the board with the blade height set to cut halfway, and thicknessing the cut-away pieces. Because there is one smooth face they can be surfaced as is, ignoring warp if they are thin. The center portion of the board is left rough and should be resurfaced before repeating the operation.

Resawn stock may warp or cup. If this is not desirable the stock must be left thick enough to plane warp out. There is a tendency to overestimate the number of resawn layers available from a board. Therefore take careful account of kerf loss and warp. Be sure to laminate resawn stock in the same order it was cut. A vee marked on the ends of the laminate boards makes it easy to keep them in this order when they are glued to the curve. For wide laminations, the resawn pieces can be folded apart, or bookmatched, to keep the grain in a pattern.



Almost any glue works for flat laminations where the only stress is the seasonal movement of the wood. However, I prefer a slow-setting glue for a lot of layers or a large surface area. I do not recommend white glue for fine furniture because of the variation in quality from one brand to another. A yellow glue such as Franklin Titebond (an aliphatic naphtha-based glue) is good for shallow bends or curves without a lot of stress. Cold creep (slippage after drying) occurs to a lesser extent with yellow glue than with white glue. A chair leg laminated with yellow glue will slip minutely and show the layers after about nine months. The layers are trying to become straight again—you can see and feel the unevenness.

If a lamination is sharply bent and under stress, a urea formaldehyde glue such as Weldwood or Cascamite is called for. I have had good results with Urac 185, made by American Cyanamid Co., Industrial Chemicals and Plastics Division, Wayne, N.J. 07470. Unfortunately, it is available only in 55-gallon drums. I recommend a two-part resorcinol formaldehyde where wetness is a problem, but the dark glue line may be objectionable. These glues don't suffer cold creep.

Springback is normal as the layers try to straighten out against the formed curve. It is slightly greater with yellow glue than with urea glue. But the amount of springback is usually small and can be estimated with practice. In many cabinet or chair parts it can be ignored. Joint angles should be checked after laminated parts are made. Where a precise curve is needed one could use thinner (and therefore more) layers, which will tend to reduce or eliminate springback, or test-glue the part and adjust the form before laminating the actual piece.

In lamination, as in all gluing, there are four potential trouble areas: moisture content of the wood, temperature, oily woods, and dull thickness-planer blades. Opinions may

vary, but below 6% moisture content is risky.

Temperature is another important factor. While yellow glue can set at a lower temperature, 70° F is about the lowest for the urea type, and at that temperature about 12 hours of clamping time are required. For urea-resin glue a temperature of 90° F reduces the pressure period to about five hours. One easy way to increase temperature in a workshop is to throw a drop cloth over the clamped work and put a 150-watt bulb underneath. Be careful, because most glues don't reach maximum strength for 48 hours.

Oily woods such as teak or rosewood can be laminated in several ways. Titebond is more likely to succeed than a urea glue. Another way to achieve a bond is to roughen the glue surfaces with a toothing plane or 40-grit garnet paper. Narrow pieces cut with a carbide table-saw blade which are not cleaned up or jointed may glue better. Another method is to clean the surface with lacquer thinner or carbon tetrachloride before gluing. Oily stock should be tested first, before committing an expensive lot of wood.

Another area of potential trouble that is often overlooked is a dull thickness-planer blade. Dull knives beat and mash down the wood fibers; sharp knives slice them off cleanly. Microscropic differences in the surface greatly affect gluing.

A simple flat lamination can be done with two cover boards and a few quick-action clamps. An alternative to this is a veneer press. In addition to flat pressing, the veneer press can be used for curved parts with a two-part form.

For simple parts a one-piece form can be used. The layers are held in place under pressure with quick-action clamps.

Free clamping without a heavy back-up form can be done for parts requiring a spiral or otherwise impossible compound curve. A lamination of several layers can be held in place with 1/4-in. Masonite strips as cover pieces on either side of the layers of wood. Masonite of this thickness twists easily.

On a wide piece, a good rule is to begin clamping from the center out to the sides or from one side to another so that air or glue pockets aren't trapped between the layers.

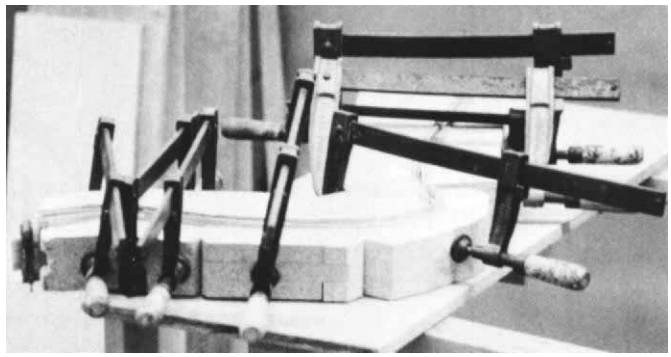
The cheapest material for making forms is particle board, chipboard or floor underlayment, all basically the same material. Fir plywood is the next most economical choice and should be used where strength is required. Particle board has an advantage over fir plywood in that the band saw won't track off the pencil line into some strong grain configuration.

I usually face my press or forms with Masonite to help obtain even gluing pressure and to compensate for slight irregularities in bandsawing. I use 1/8-in. or 1/4-in., depending on the severity of the curve. Masonite is cheap and its surface resists glue.

In determining the curve to be drawn on the form, the actual piece plus the thickness of the facing must be considered.

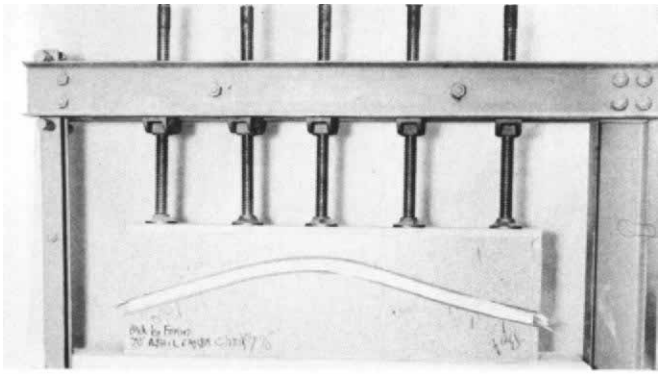
Forms five or six inches thick could be made.from solid, but it is often more economical to make the form as a series of ribs with spacers in between each rib. The form can be made as a one-part, open-face jig or constructed as a two-part form. Usually the decision depends on the gluing process. Clamping pressure must be maintained approximately perpendicular to the work. While I prefer a two-part form that fits in a press for most work, there are many cases where the curve is too great or the piece is too large. For example, the semicircular apron for a round dining table can be made most easily with a one-piece form.

A two-part form with a shallow curve, such as for a drawer



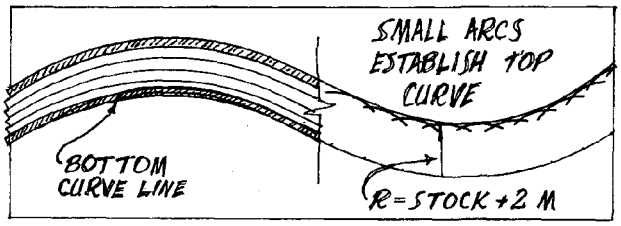
Chair by Tom Hucker: Quick-action clamps hold thin layers of maple in two-part chipboard form, above. Outer part of form is segmented for easier assembly. Then eight identical staves are joined and shaped to make seat of chair. Legs are also laminated.

Hardwood board under screws of veneer press distributes pressure and keeps form from crumbling at center.



front with a one-inch deflection over a three-foot distance, requires bandsawing only along a single pencil line. The form will flex enough over that length to give even clamping pressure. For a drawer front of the same length but with a two-inch deflection, it would probably be necessary to calculate the various radii by the method described below.

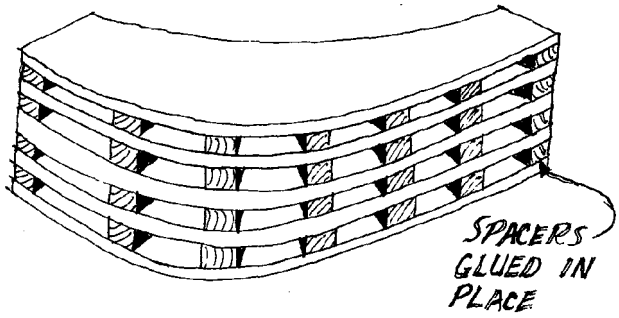
The first step is to thickness-plane the laminates to the desired thickness and check the true combined thickness with calipers. For example, four 1/4-in. layers might actually measure 1-1/16 in. together, and a one-inch form would be off. The form needs to be that precise. The two band-saw lines are established by taking the curves of each side of the desired piece, adding the facing thickness to each side and transferring the total dimensioned curve to the form. For a compound shape, the bottom curve line is taken from a full-size shop drawing. Then a compass is set to the total laminate thickness plus the two layers of Masonite. The compass is lined up with the bottom line and small arcs are swung at the

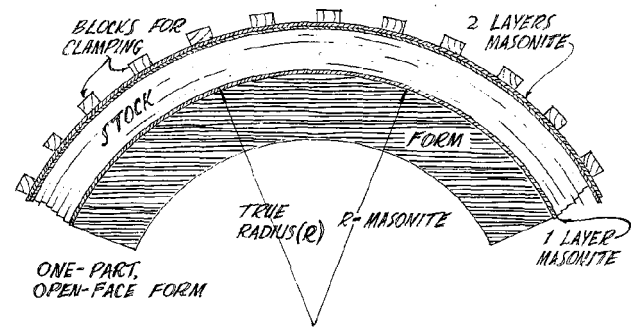


correct distance from points all along the bottom line. The crests of these small arcs are connected using a flexible curve, to establish the correct top line.

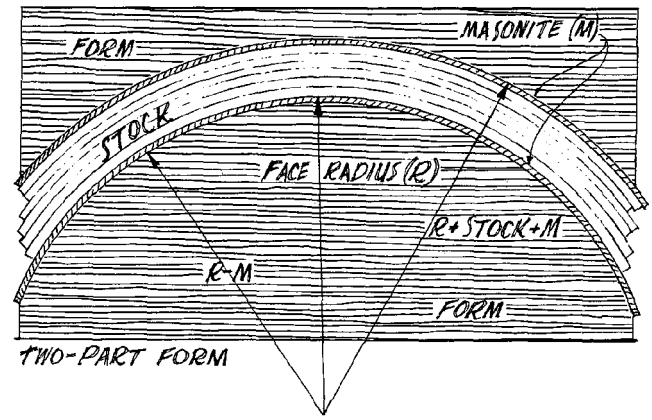
When laying out the curve onto the form, the normal inclination is to work from a vertical or horizontal reference on the drawing. This does not necessarily ensure perpendicular gluing pressure. Often the curve layout on the form must be tilted to center the curve.

Most of the directions so far have been for narrow furniture parts of up to five inches. Another method is suited to larger pieces such as door panels, cabinet ends and bench seats. The same method would be used to veneer the panels. After establishing the curve on the form, band-saw lines are drawn onto the end piece of a stack of ribs that have been carefully cut to the exact length and width and then dadoed. These ribs are not glued together, but held by four spacer strips press-fitted into the dadoes. The idea is to make a short, easy package to bandsaw. For example, a 20-in. form can be made of eleven 3/4-in. ribs which would make a stack 8-1/4 in. high to bandsaw. The stack can be kept uniform by inserting short, temporary spacer strips into the dadoes. After bandsawing, the short strips are replaced by strips of the total length. Masonite sheets are then used to line the form, and finally two sheets of particle board or plywood are cut for top and bottom plates.

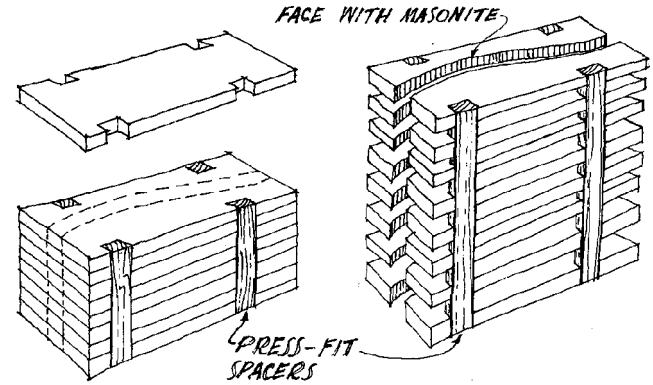




One-part, open-face form is used with quick-action clamps for parts that are too large for veneer press, Masonite regulates pressure, but must be accounted for in layout.



Two-part forms provide most even squeeze with either clamps or veneer press. Again, accurate layout is essential.



Rib-and-spacer forms bandsawn from a stack of boards are best for wide, curved panels. At left, an open-face ribbed form is made from chipboard with pine spacers.