



WOOD GLUING



Wood

The Original Composite

- Comes in a variety of sizes
- Light and Strong
- Easily Worked
- Hard and Elastic
- Permanence of Shape
- Retains stiffness until burned through
- Beauty
- Low Cost
- Sustainable
- **EASILY JOINED TOGETHER**



Hickory will stand more pull than a wrought iron bar of equal length and weight.

For applications where an article must withstand constant blows, no substitute has been found for hickory wood



[Go to: Wood University](#)

The objective of the bonding process is to develop a glued joint as strong as the wood itself



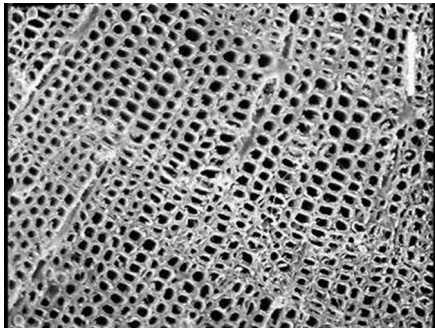
Various properties of wood affect its gluing characteristics

1. Wood density
2. Moisture content
3. Dimensional changes associated with changes in moisture content
4. Pitch content
5. Oiliness
6. Surface contaminants
7. Presence of extractives



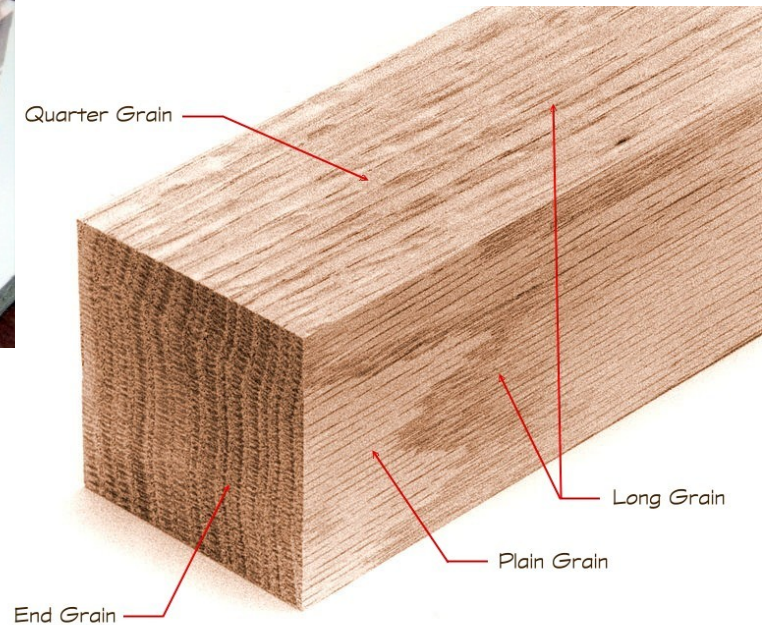
Wood Density

- Woods with lower [density](#), [hardness](#) and strength tend to be easier to glue
- Developing bond strength equal to the strength of wood is easier to achieve with weaker woods



The cellular structure of red oak is so open that you can blow smoke through it from end-grain to end-grain (flat sawn).

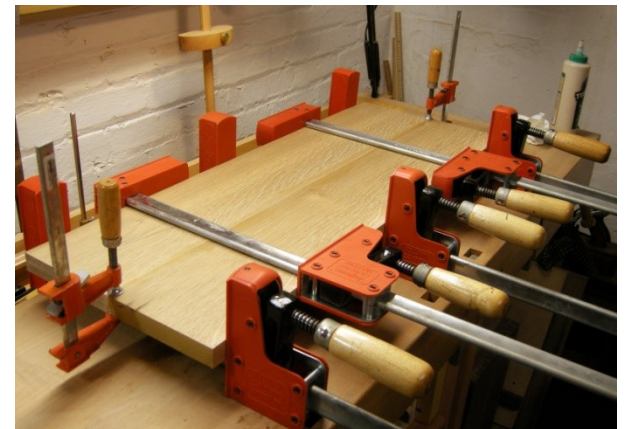
White oak, on the other hand, has such a tight cell structure that water can't pass. That's why white oak works so well for whiskey barrels and outdoor furniture.



[Go to: Wood University](#)

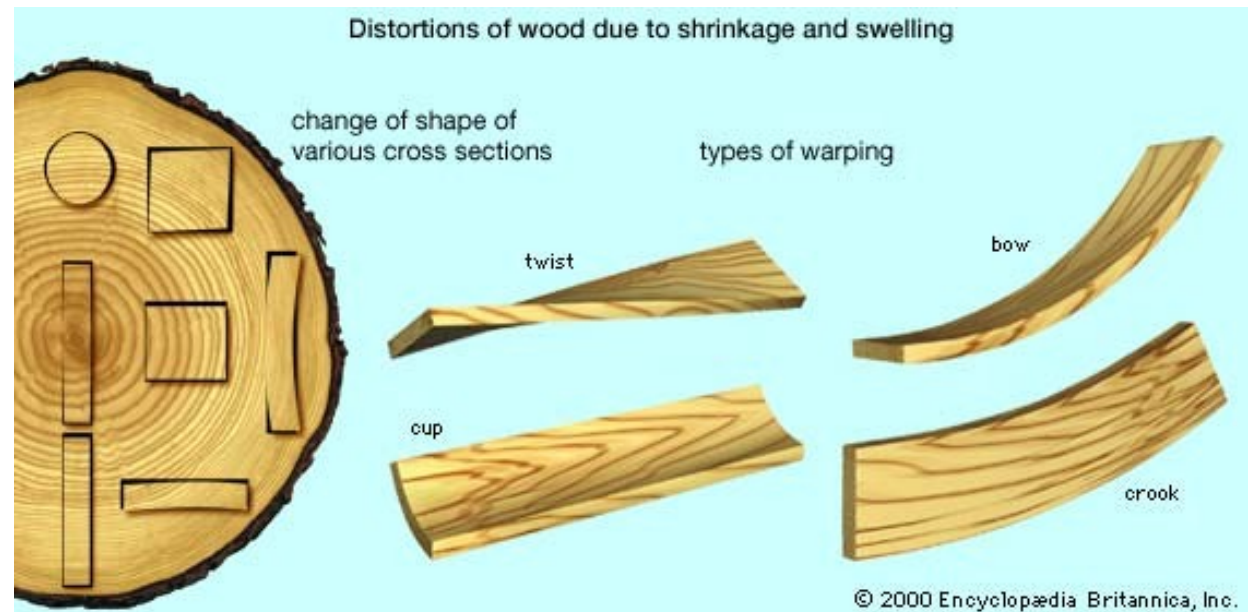
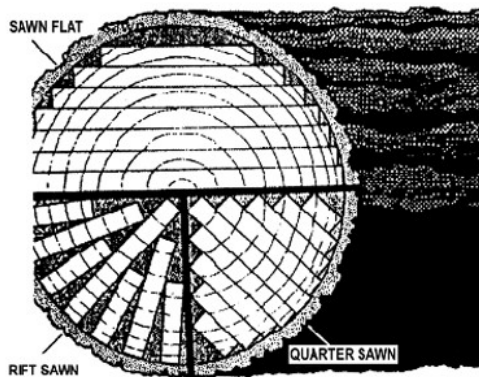
Moisture Content

- Wood may be glued with moisture content ranging from 6 to 17 percent
- Proper moisture content depends upon where the wood is to be used
 - In heated and air conditioned buildings
 - 7-8 percent
 - For exposure to the outdoors
 - 12-15 percent
- Glued joints will perform best when %moisture equals the average moisture content the product will attain in service
- Longer clamp time needed for higher moisture content



Dimensional changes associated with changes in moisture content

- Wood must be at similar moisture content to avoid [stepped joints](#)
- Wood grain direction can add to or minimize assembly movement
- Allow time for moisture to equilibrate before machining to avoid [sunken glue joints](#)
- Allow wood to attain use moisture content before machining wood
- Dissimilar woods will have [different moisture dimensional changes](#)
- Quarter/rift sawn wood is most stable



Pitch content, Oiliness, Surface Contaminants, Presence of Extractives

- Contaminants must be removed from gluing surfaces to allow tight fit
- Wipe joints with acetone on a white rag until the rag comes back clean
- Oily wood will keep water based adhesives from penetrating and wetting out the surface of the wood.
- Wood Glues bond to cellulose and anything that masks the cellulose will decrease potential bond strength
- Metal salt extractives in some woods can turn glue lines different colors
- Chain of adhesion states that the weakest link will dictate bond strength



[Will Titebond Wood Glues bond to dry wood glue](#)



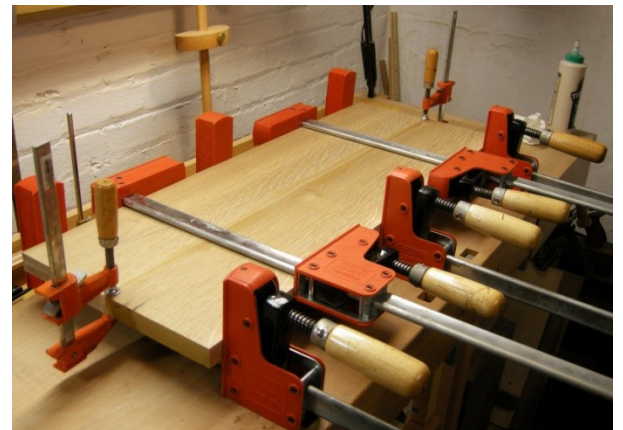
[Will Titebond Wood Glues bond to finished wood](#)





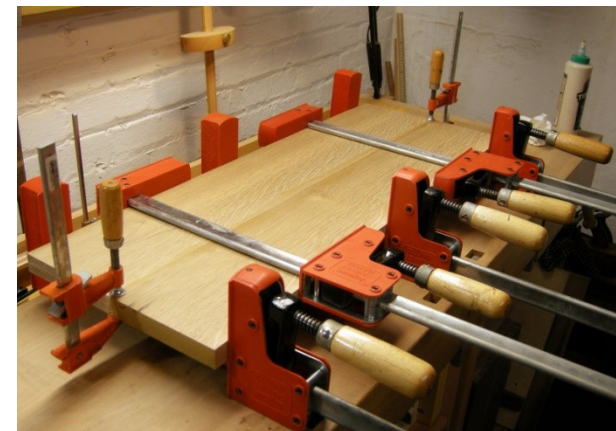
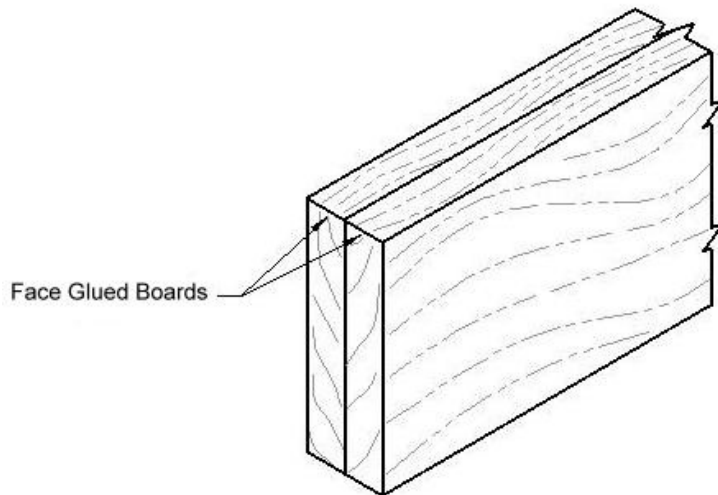
Wood Glue Applications

- Edge and Face Gluing
- Assembly Gluing
- Cold Press Laminating
- Hot Press Gluing



Edge and Face Gluing

- Edge gluing used to create large panels
- Face gluing used to create thicker stock
- Usually only glue, no other fasteners are used
- Joints need to fit tightly
 - Square
 - Free of defects like saw marks, knife marks, glazing or burnishing
- Clamping required to hold stock together during drying of adhesive
- Grain patterns should be assembled to minimize warping and cupping
 - glued up panels should be quarter sawn if possible
 - place the cups in the boards opposite to each other

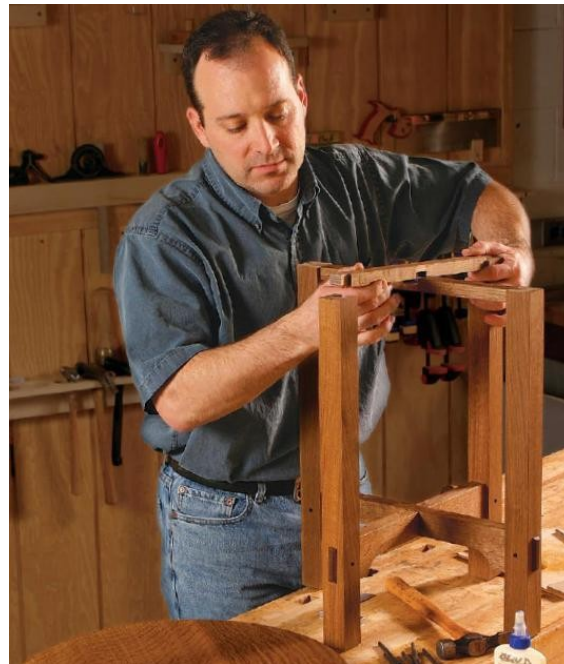


Assembly Gluing

- Joint Gluing

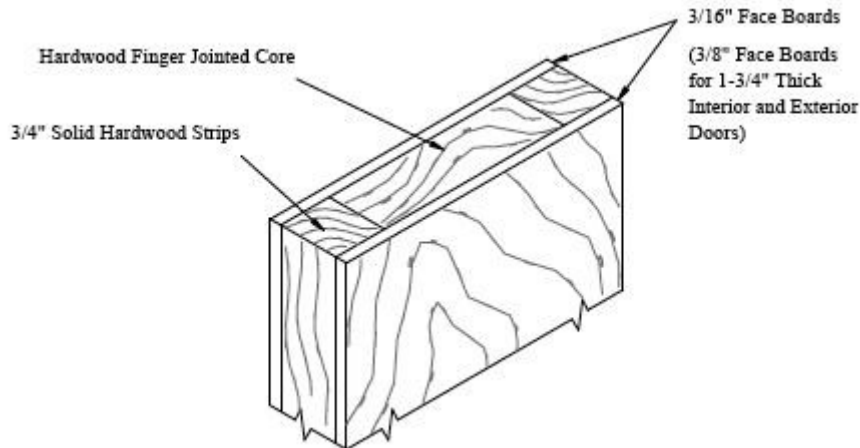
- Mortise and Tenon
- Dovetail
- Tongue and Groove
- Corner Blocks
- Dowels
- Biscuits
- Miters

- Side to side grain gluing
- Side to End grain gluing
- Tight fitting

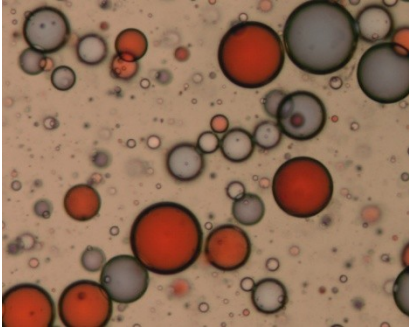


Cold and Hot Press Laminating

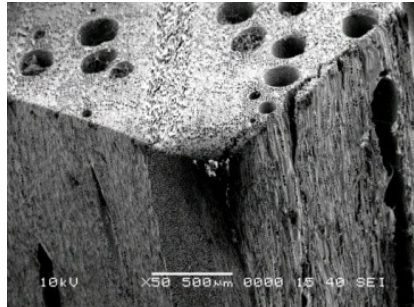
- Usually used for large number of like sized materials
- High Pressure laminates and [veneers](#) to plywood, particle board, MDF
- Environmental alternative to solvent based contact cements
- Need close tolerances for bond lines
- Use proper adhesive to minimize bleed through on veneers
- [Uniform pressure critical](#)
- Variable Press time
 - ambient conditions (temperature and humidity)
 - Glue spread
 - Core materials
 - Type of equipment with heat capabilities



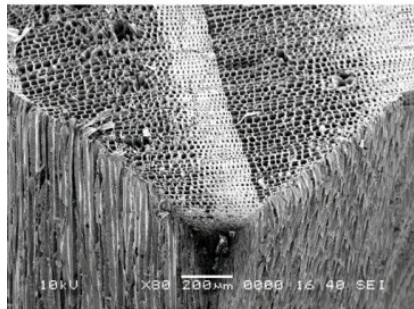
A Word on End Grain Gluing



Synthetic wood glues are based on an emulsion polymer composed of polyvinyl acetate (PVA) stabilized with polyvinyl alcohol (PVOH). In general these water based wood glues are just, microscopic balls of plastic suspended in water. Each company adds chemicals or reduces the amount of water, to add water resistance, fast grab, color, thickness (viscosity), and ability to stick to plastic substrates such as melamine counter tops. To the left is a microscopic picture of a water based emulsion (this picture was taken from the internet):



What allows these polymers to stick to wood so well is that the PVOH has an affinity for cellulose. This attraction coupled with the strength of the PVA polymer makes for a strong bond. To the left are microscopic pictures of wood (taken from the internet), the top picture shows a large pore structure and the bottom a finer pore structure. In edge and face grain gluing, there is a large surface area of cellulose that is available for bonding, therefore the bonding per square inch is maximized and the cellulose is held together strongly to the point where the adhesive forms a bond stronger than the inherent weakness in the wood structure itself. This weakness is observed as wood failure during stress testing.



End grain gluing, as can be seen from the picture at left, has much less cellulose available for bonding. Most of the structure is air, similar to gluing the ends of a drinking straw together versus the sides of a straw. This is why end grain gluing is so weak. The cellulose bonding per square inch is much reduced, to the point where the force to break the bond is much less than the strength of the wood and no wood failure is observed. Therefore joints using end grain gluing must be designed to limit stresses versus stresses placed on side or face glued wood and therefore should not be used where high stress joinery is required. In all cases, these bonds should perform as designed for the duration of the wood structure itself.

There are other issues with end grain gluing that causes weak bonds also. In some cases, the viscosity and particle size of the polymer is so low that most of the adhesive is transported, through capillary action, through the ends of the pores, causing a starved wood glue joint. In other cases, water is “sucked” from the adhesive so quickly that the glue dries too fast before the parts can be assembled.

[End grain test report](#)

A Word on End Grain Gluing cont.

Because of the reduced amount of cellulose, water based wood **glued end grain joints will always be weaker than face or side grain gluing.** To **maximize the bond, high viscosity glue** should be used to keep adhesive from disappearing down the end grain. Franklin makes a product specifically for end grain and mitered joints. **Titebond No Run, No Drip is 36,000 cps versus 4,000 cps** for most wood glues and sets with minimal clamping. Otherwise, lower viscosity wood glues can be used by first priming the end grain with a 50/50 mixture of glue and water and allowing it to dry. This will plug the pores of the wood without covering up the cellulose for subsequent gluing. The end grain can then be glued normally without issues of premature drying or starved glue joints.

It is important to understand that the bond is dependent on the availability of cellulose. In using some species of tropical hardwoods or fragrant soft woods, oil from the wood can contaminate the cellulose and must be removed to create a strong bond. Side and face grain gluing can be accomplished by wiping the wood with acetone until a white rag returns clean. Immediate gluing after cleaning will result in acceptable bond strength. **With end grain gluing however, ability to remove oils from the ends of the “straws” can be difficult and bond strength should be tested before including this type of joint in your design.**

Additionally, wood glues need to dry to build strength. If using a dense, tropical hardwood with high oil content, water will have a difficult time finding a path out of the glue line, therefore more time should be given to clamping/drying. In some cases, a full week should be given for full strength build.

Wood with high moisture content can also inhibit drying of the adhesive. Normal dry times given in company literature are based on wood that has a moisture content of 6-8%. Moisture content above this value will increase the need for clamping/drying time. Moisture content above 15 to 17% may not allow the wood glue to dry at all. Lower moisture content can cause the glue to dry quickly and reduce the amount of time to assemble a project, so it is important to have a good handle on what moisture content your wood has during assembly.

Titebond II and Titebond III are designed to be used for wood working projects that need water resistance. Titebond III has the additional capability to withstand boiling water so is a good choice for cutting boards that may see a dishwasher cycle.



Gluing Application Guidelines for Titebond Wood Glues

- Temperature
 - Keep from [freezing](#)
 - Most freeze thaw stable
 - Designed for 5-10 freeze thaw cycles
 - Thaw and mix before using
 - Eventual irreversible thickening
 - Assembly time
 - Cold moist conditions will extend set and final strength attainment time
 - Hot dry conditions will greatly shorten open time
 - [Chalk Temperature](#)
- Humidity and Moisture Content
 - High humidity will extend set, clamp and final strength attainment time
 - Excess or uneven moisture can cause distortion, warpage, delamination
 - Moisture in glue line can cause [sunken wood joints](#)
 - Best moisture content is between 6-8%
 - Allow assemblies to equalize moisture content before final machining
- Clamp Time
 - Vary with species of wood
 - Vary with temperature, and moisture content
 - Stable woods such as maple require short clamp times
 - Ring porous woods such as oak and walnut require slightly longer clamp times
 - Composites such as MDF and particle board tend to require even longer clamp times



Gluing Application Guidelines for Titebond Wood Glues (cont.)

- Clamp Pressure

- 30-80 psi for High Pressure Laminates and veneers
- 100-15 psi for soft woods
- 125-175 psi for medium density woods
- 175-250 psi for hardwoods
- Avoid excessively bowed or distorted wood
- Use uniform clamping pressure

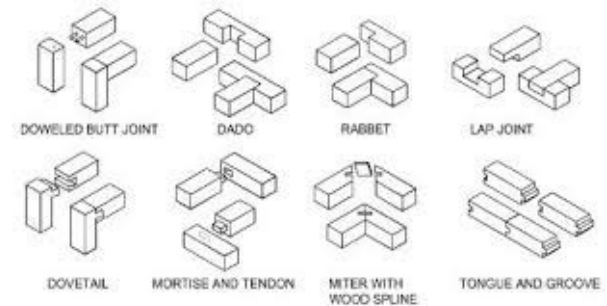


- Joint Preparation

- Surfaces must be free of saw marks, knife marks, glazing, burnishing
- Clean off any foreign materials that seals wood pores
- Be sure joints are tight fitting a square
- Joint that are too tight can scrape glue off of surfaces during assembly

- Joint Design

- Design joints to handle usage stress
- Minimize amount of end grain to end grain gluing
- Maximize amount of edge to edge gluing
- Minimize gaps between joints

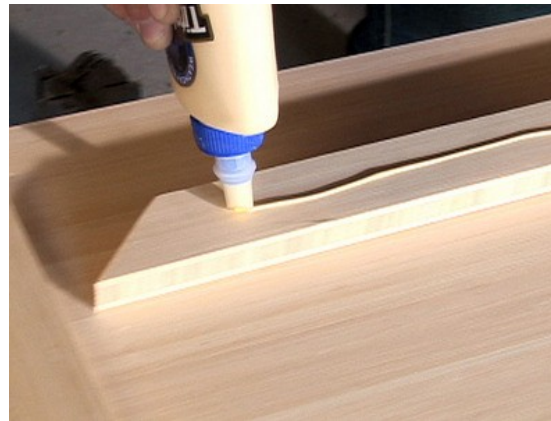


- Clean-Up

- Allow glue to reach partial dry state before removing
- Minimize amount of rubbing of wet glue onto wood surfaces
- A straw cut on an angle can help remove wet glue squeeze out in corners
- Scrape off excess dry glue with a sharp chisel
- Sand remaining glue to get a clean surface
- Keep clothing contaminated with glue wet as dry films are very difficult to remove.

5 Steps for Successful Gluing

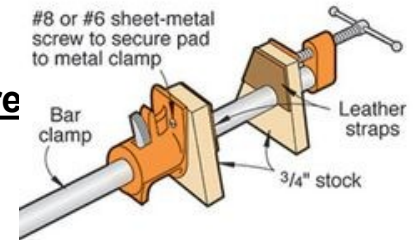
- Do a Dry Fit
- Prepare the Glue and Accessories
- Prepare Clean Up Items
- Glue up
- Allow to Dry/Cure



5 Steps for Successful Gluing

Do a Dry Fit

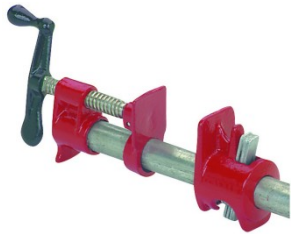
- Clamp pieces without glue to make sure the **joints come together tightly**
- Mark pieces for **proper alignment** (and to keep them from being glued in backwards)
- Test for **choice of clamps and blocks**
- Make blocks, strips or pads to **protect the wood from clamping pressure**
- Use double sided tape to **keep blocks, strips and pads in place**
- **Fix joints** which are too tight or too loose
- Water based wood glues don't fill gaps so **loose joints may require an epoxy adhesive**
- For easy clean up, put **masking tape on all joints** then cut apart to disassemble
- Bridge edge to edge joints with a clamp to **keep seams from creeping**
- Check moisture content of all wood to be sure **all parts are within 1% moisture content**
- **Clean** away any residual saw dust or contamination that may keep joints from fitting tightly



5 Steps for Successful Gluing

Prepare the Glue and Accessories

- Determine the correct glue for the project requirements
- Be sure glue is in good condition by mixing with a small stick
- If glue has settled stir in settled material before proceeding
- If unsure of glue, test on scrap piece of wood, clamp 24 hours then break with hammer
- Clean glue bottle applicator tip
- Clean glue brushes and remove any loose bristles
- Coat or mask any iron pipes to avoid black stains
- Arrange and orient clamps from the dry fit for easy access



5 Steps for Successful Gluing

Prepare clean up items

- For water-based wood glues have a bucket of water handy for spills
- For other types of adhesives, use acetone or mineral spirits for cleanup
- Spread plastic sheeting over work surface to protect against drips



5 Steps for Successful Gluing

Glue up

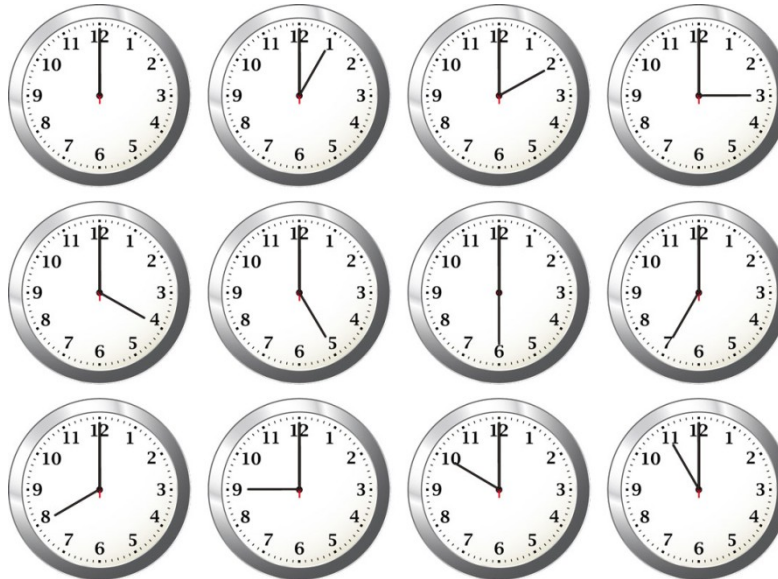
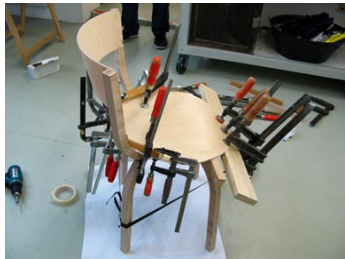
- Be sure the **shop and substrate temperatures are above the chalk point** of the adhesive
- **Consider gluing in stages** to reduce open and total assembly time
- A threaded rod or hand trowel (1/16" x 1/32" x 5/64" U-notch) works well as a **tool to spread the correct amount of glue**
- **Wipe joints with acetone** before gluing especially for oily tropical woods
- Apply approximately 6 mil wet film or **250 ft² per gallon**
- Peel off any masking tape **when glue is slightly rubbery**
- Use wax paper under clamps if in contact with any glue squeeze out
- Allow squeeze out to dry for 10-20 minutes then remove with a putty knife
- After gluing **remove cap from bottle and clean out glue**, replace with clean cap



5 Steps for Successful Gluing

Drying

- Allow joints to dry for at least 2-3 hours before unclamping, **best to leave for 24 hours**
- Allow edge to edge joints to **dry for several days** before sanding or planing smooth to reduce the chances of sunken glue joints



Questions?