

**The ideal:**

Put a piece of wood on the lathe, turn it in one go, apply the finish on the lathe and then remove a piece we are proud of. Unfortunately (or maybe interestingly) there are innumerable ways that nature, material problems, tool limits, complex designs and sometimes our skill, require that we must assemble or repair two or more pieces before we finish a turning. And – in many cases, we need some 'glue' to accomplish this.

**General information about adhesives****DEFINITIONS:**

- An adhesive is a compound that adheres or bonds two items together. If you wish to delve deeply into the theory of adhesion and bonding, take out a copy of the following from your local reference library: Adhesive Bonding : Science, Technology and Applications, Edited by R D Adams, University of Bristol, UK. ISBN: 1855737418 (1-85573-741-8)
- 'Adhesive failure' is the failure of the adhesive to stick or bond with the material to be adhered. e.g. in separating an Oreo cookie; both halves remain intact, but the entire filling (adhesive) is on one side.
- 'Cohesive failure' is structural failure of the adhesive. e.g. In separating an Oreo cookie, both halves remain intact with filling (adhesive) remaining on each.

**ADHESIVE CATEGORIES****Aliphatic Glues:**

Includes most of the modern, single component woodworking glues such as PVA (Polyvinyl acetate) glues ('white' and 'yellow' glue), Aliphatic resin glues (Titebond, Weldbond, Probond etc) and water based contact cements.

Most of these adhesives are not fully waterproof. Other common problems include poor gap filling capabilities, glue line visibility, glue line protrusions over time and poor sanding characteristics.

If water based glues are used over a large and thin wood surface area, water may be absorbed unevenly by the wood and distortion could occur.

Aliphatic glues are inexpensive, spills clean up with water and most types have a very short "tack time".

Woodturning uses: gluing pieces together for segmented

turning, crack and void filling (if 'filled' with at least 50% sawdust), bonding waste blocks, temporary joints for pieces turned together, then separated.

**Solvent Glues:**

Group includes aerosol adhesives and contact cements. Woodturning uses: temporary bonding of light weight workpieces and adhering paper templates.

**Thermal Curing Glues:**

This type are 'liquid' when heated and solid at room temperature. Hide glue, the oldest continuously used woodworking adhesive, and the various forms of "Hot Melt" glue.

Titebond Liquid Hide Glue is the first hide glue to be offered in a liquid, ready-to-use form. It requires no mixing, heating or stirring. Long assembly time, strength, superior creep-resistance and excellent sandability makes it a good choice for any dry application. Note that is sensitive to moisture which allows for easy disassembly of parts, a critical benefit in antique restoration or the repair of musical instruments but can be a disadvantage in some woodturning applications.

Some modern hot melt glue types can be a good substitute in hide glue applications. These glues are heated to a liquid and applied to one (sometimes both) surfaces. The glue bonds immediately then hardens as it cools to room temperature. The primary use for hide glue is for furniture joints where the glue joint is hidden (mortise and tenon, etc).

Woodturning uses: 'hot melt' glues primarily to bond waste blocks to workpieces and to stabilize pieces with extensive voids.

**Reactive Adhesives:**

Adhesives cured by a chemical reaction when two components are mixed together. Epoxy resins and Polyurethane glue are the most common types.

Epoxy glues are supplied as 'monomer' or 'resin' and 'hardener' or 'catalyst' or a premixed formulation.

Polyurethane glues are mostly supplied as single component glues whose curing depends on reaction with trace moisture from the pieces being glued. This is a disadvantage as any moisture entering the glue container will reduce shelf life considerably.

Epoxy is an excellent crack filler as it does not lose its strength when filling a wide area. Slow setting epoxy can also be mixed with almost any solid material for filling cracks and voids.

Note that fast curing epoxies, setting in less than 20 minutes at room temperature are subject to cohesive failure as they are generally fairly 'soft' when cured. They should not be used for joints that will be subjected to severe mechanical stress. Also note that all epoxy compounds, even '5 minute' epoxy, take 5 to 7 days to fully cure at room temperature. Cure time for any epoxy compound can be shortened by heating. Some epoxies can be heated up to 90°C to shorten the seven day cure time to as low as an hour or two.

Woodturning uses: Epoxy – can be used for any woodturning glue application – except gluing cracks that are tight together and cannot be separated to apply adhesive. Polyurethane glues – primarily used for gluing pen brass tubes and segmented turning.

**Recommended Epoxy Glues:**

For the ultimate solution:

West System, using their 105 resin and any of the following hardeners:

205 Fast Hardener; 9-12 min 100gm pot life, 60-70 min working time and 6-8 hours cure to solid time.

206 Slow Hardener; 20-25 min 100gm pot life, 90-110 min working time and 10-15 hours cure to solid time.

209 Extra Slow Hardener; 40-50 min 100gm pot life, 3-4hrs working time and 20-24 hours cure to solid time.

207 Special Clear Hardener: 20-26 min 100gm pot life, 100-120 min working time and 10-15hrs cure to solid time.

West System guarantees that with storage at room temperature, resin and hardeners should remain usable for many years. Over time, 105 Resin will thicken slightly and will therefore require extra care when mixing. Repeated freeze/thaw cycles during storage may cause crystallization of 105 Resin. Warm resin to

125°F and stir to dissolve crystals.

There are many epoxy compound manufacturers, most that they make are quite suitable for woodturning applications. To be safe, purchase the smallest container and give it a test in your application.

“5 minute” epoxy compounds are generally available from many sources. These are only suitable for low stress adhesive applications e.g. pens. Do not use for segmented turning, or any application which has a small width glue joint as these compounds are fairly 'soft' and subject to cohesive failure.

**Cyanoacrylate (CA) Glue:**

This is a 'reactive adhesive', normally using trace moisture as a catalyst. Slow curing CA glues can be hardened quickly by using a catalyst, usually applied in aerosol form. CA adhesives are available in various viscosities, from water like to spreadable paste.

Woodturning uses: Thin viscosity types are used to stabilize cracks, torn end grain and hardening soft spots as it easily creeps fairly deep into tight spaces or open pores. Medium viscosity types are used for temporary bonding, gluing brass pen tubes and as a wood finish. Thick viscosity types are mostly used for finishing on open grain wood species.

**Non Curing Adhesives:**

These include most pressure sensitive adhesives, “rubber cement”, aerosol adhesives and 'double-sided' tape.

Woodturning uses: To temporarily bond light workpieces to faceplates, holding segmented rings to a faceplate, etc.

**TEMPORARY ADHESIVES FOR WOODTURNING**

A temporary adhesive makes a bond between two or more pieces of wood which can be taken apart without a great deal of effort.

The purpose of the temporary glue joint is to hold a workpiece to a waste block or to join two or more pieces which must be turned together, then separated. The bonding method must have sufficient strength to survive the turning process, yet be easily separated.

A "TEMPORARY" GLUE JOINT IS NOT AS RESILIENT OR STRONG AS A 'PERMANENT' GLUE JOINT. EXERCISE CAUTION; USE THE TAILSTOCK FOR ADDITIONAL SUPPORT AND TAKE LIGHT CUTS.

A temporary glue joint should not be more than twice its diameter away from the drive centre or chuck and the workpiece should not extend more than the same amount beyond the temporary glue joint without solid tailstock support.

DO NOT attempt deep hollowing using temporary glue joints.

Before using any of the methods described in this article, make a few trials. It may take some experimentation to find a procedure that will work in your application and with the wood you choose.

**Method 1: PVA (white) glue / Kraft paper**

This glue joint is made of Kraft paper sandwiched between two pieces of wood coated with PVA glue. Use Kraft paper that is 4 mil (0.004" / 0.1 mm) thick (standard Kraft paper envelope thickness). Thicker Kraft paper will make a weaker joint. Thinner paper (e.g. newspaper or copy paper) can be used, but separating the joint may be very difficult if too much glue is used. Also, today's newspapers use a vegetable based ink, which PVA glues will dissolve and the ink will soak into and discolour any end grain.

To make the joint, place a minimal amount of glue, spread evenly, on each piece of wood to be joined. Place the Kraft paper on one piece and put the next piece (with glue applied) against the Kraft paper. VERY LIGHTLY clamp the pieces together for about 45 minutes, then allow the glue to cure an additional 8 hours before turning. After the joint is separated, some paper and glue will remain on the workpiece and will need to be removed. This can be done by turning or by sanding of the lathe.

**Method 2: Double-Backed Tape**

Double-backed tape is the easiest choice. It's

inexpensive, quick to apply, requires no special equipment and the pieces can be separated easily (usually) with a thin knife or by twisting the pieces to break the bond. After the joint is separated, and the tape removed, there is usually some glue residue remaining, a plastic pencil eraser makes short work of removing them.

Breaking a joint made with foam or rubber cored double backed tape is easily done with a thin knife, but cleaning up the joint can be a chore. Since a foam or rubber tape joint is somewhat flexible, your workpiece may wobble while spinning. Using the tailstock for support can minimize this problem.

Rubber or thin foam tapes (less than 1mm (1/32") thick) are adaptable for turnings that have mating surfaces with minor mismatches.

Do not use thin plastic film tape. Even with nearly perfect, flat, matching surfaces, plastic film tapes are too thin to make good contact with both sides.

The adhesive on all double backed tape creeps, use a tailstock while turning and leave the tailstock in place if the work stays on the lathe for long periods.

A small joint can creep while you turn – use a mechanical 'key' or clamp to stabilize such joints.

Fabric carpet tapes and thin core foam tape perform very well. Here are a few suggestions:

1" & 2" (25 & 50mm) cotton fabric 'turners' tape are available from Lee Valley Tools [www.leevalley.com](http://www.leevalley.com)  
3M (Scotch) Outdoor Carpet Tape 38Mm X 12.5M  
Model: CT3010 | Home Depot SKU: 1000125276.

Tape used for attaching automotive trim: 3M Pressure Sensitive Acrylic Foam Tape 4257, Gray, 15 mil 5314, Gray, 30 mil and 4229P, Dark Gray, Red Printed Liner, 30 mil. These may be difficult to source.

Scotch Exterior Mounting Tape, Model: 4011, Home Depot SKU: 1000100622. Scotch 110 Long Mounting Tape Model: 110L, Home Depot SKU: 1000407415

Fabric and thin foam core tapes hold well as long as both wood surfaces are clean, dry and matching. Cover the entire contact area with tape, leaving small gaps (if using more than one piece of tape) to prevent any lumps developing. Hold the joint together with firm pressure applied by the tailstock for 15 – 30 seconds, this will force the adhesive to 'creep' into position and make the joint more secure.

Just remember that tape is not a suitable solution for heavy or tall items!~

**Method 3: Hot Melt Glue**

Before attempting any hot melt glue joint, make some trial joints first! There are many different kinds of hot melt glue with varying characteristics. Ethylene vinyl acetate (EVA) based hot melt glues intended for craft purposes are still quite soft at room temperature and may shear when turning. Hot melt glue is NOT suitable for wet or green wood.

The latest type of hot melt available is a polyurethane reactive (PUR) adhesive. This type of hot melt glue will make a permanent bond after reacting with trace amounts of water so would not be suitable for a temporary joint in wood.

Do not use hot melt glue containing fillers or fibers, the joint made is not as resilient and can crack when subjected to the shock and vibration of turning.

For a light strength temporary joint, dots of hot melt glue placed on the outside edge of the waste block surface, followed by quickly placing the workpiece against it can hold a small turning, or slightly larger turnings if the tailstock is used. Twist off the workpiece to separate the glue joint. Use a thin knife to partially cut through the outside edges of the dots if the joint does not separate easily.

To make a stronger joint, lay a continuous bead of hot melt glue (slowly so that it heats both pieces) in the corner of the 'shoulder' made by the different diameters of the mated pieces. Wait for the glue to cool thoroughly before turning.

Turn away the hot melt glue bead when turning is completed. Make very light cuts and use the tailstock to hold the workpiece when turning away the glue!!

A sharp knife or chisel and sandpaper will usually remove residual glue.

Product sources: just about everywhere a selection of hot melt glues are sold. You don't want to use the sticks included with an inexpensive glue gun purchase or the glue sticks normally sold at craft stores.

Use glues rated for higher temperatures or strong adhesion.

Joints made with hot melt glue covering the entire surface of the joint are strong and not easily separated. The only way to successfully make this type of joint is to use a pot (electric frying pan is best) in which the glue sticks are melted. Dip the smaller of the pieces to be glued in the pan, hold for a few seconds to heat the wood, then immediately fit against the mating surface. This can be difficult to line up accurately, and will make a 'permanent' joint that must be turned away.

**As noted at the beginning, before using any of the methods described, experiment to see what will work in your application. In all cases, work safely – always use your tailstock for that extra support.**

## ADHESIVES FOR CRACKS AND VOIDS

There is a lot of information available on an enormous number of web sites regarding this subject. To check out what others do for cracks and voids, I opened more than one hundred web sites containing relevant information before deciding not to spend any more time looking. Many of the methods used for filling cracks and voids in general woodworking do not take into account the specific requirements of woodturners. Some of the information on woodturning web sites describe methods and processes that are for very specific situations and possibly not for general use. Working with wood that contains cracks and/or voids can be a dangerous undertaking. A good repair can turn into flying pieces when critical portions are turned away. The risk can be extreme if an unsuitable method of repair is employed.

Make a very critical evaluation of every crack/void before proceeding. A good piece of wood with a large crack may better be used by dividing it into smaller pieces, each of which do not contain cracks.

**Always wear protective gear, especially a face shield whenever turning. This is very important when turning a repaired piece of wood.**

Before committing yourself to any new process, give it a thorough test first. This includes any of the methods described in this article.

In woodturning there are just too many variables; wood species, condition, water or oil content, differences in manufacturers' adhesives, shop conditions, etc.

My personal belief is not to use any piece of wood that contains cracks and/or voids for any product intended for direct contact with food that will be washed often.

**There is no such thing as glue with the same physical characteristics as the wood it is bonding to. Any glue joint made in pieces that are used for food will be soaked with food, washed, shocked and otherwise roughly treated. Any joint made in these pieces will eventually fail to some degree. Yes, those gorgeous segmented cutting boards will eventually fail to some degree.** Our Sugar Maple segmented board developed cracks at the glue joints after about 18 years of use. Was it worth making it? YES, after many years of service, it helped keep us warm during a winter power failure :).

## THE "NO ADHESIVE" REPAIR

Leave the crack in the piece as a feature. To prevent a crack from spreading further, provide some relief by making a rounded 'hole' where the crack begins (see fig. 1.). This will allow the crack to open further with time, without propagating any further. I suggest that this relief 'hole' be made before final turning.

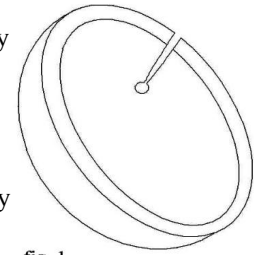


fig. 1

NOTE: Exercise extreme caution when turning such a piece. Employ some method of holding the work piece together e.g. fibre reinforced packing tape.

## FILLING CRACKS

If the crack is 'tight', with no perceptible gap, most turners (including me) simply get out the 'thin' viscosity CA glue bottle (Cyanoacrylate glue), soak in a few drops, wait at least one minute (if wood contains some moisture – longer if wood is very dry) before continuing to turn. If you intend to turn the entire crack away, this is a good method to keep the crack from growing while you turn.

Low viscosity CA glues will soak quickly into any porous material. An open crack (or very small void) can first be filled with fine sawdust, metal filings (brass works well) or stone dust. CA glues bond well to wet wood, but note that if the wood is wet and the crack is deep, the bond may not be suitable as the CA glue can solidify before penetrating, leaving a weak repair.

CA glue on it's own will not fill even small gaps! To repair a crack with a small gap, I suggest using a suitable epoxy compound, with or without filling.

If a repaired crack is to remain in the finished piece, a few points must be considered:

- Any repaired crack is weaker than a whole workpiece. A crack beginning at the outside diameter, extending further than about 20 percent of the diameter has weakened the piece considerably and probably should be cut into smaller pieces or put into the burn bin.
- Any dirt, bark inclusions or pitch pockets in the crack will dramatically weaken the glued joint. If the joint cannot be cleaned out or turned away, discard at least that portion of the wood.
- If the crack is older than a month or two (especially if the crack developed when the wood was green), the surfaces will have changed and glue will not adhere nearly as well as a freshly machined/sanded surface.

If the surfaces cannot be 'roughed up', turn away that portion of the workpiece.

- If the crack has a gap, use an adhesive that is capable of filling the gap.
- If the repaired crack is to provide structural support, use an adhesive that is capable of this function. Note: CA glue is very brittle so it is unsuitable for structural support.
- CA glues are good for hardening soft, spalted or grain tear out areas.

### CA (Cyanoacrylate) glue cautions:

- If there is ANY uncured CA glue in the workpiece, it WILL fly off the piece as soon as the lathe is spinning. Of course, any such flying glue drops will follow the law of selective gravity and attach and immediately cure, to the place where they will do the most damage. e.g. your face shield, glasses, caliper slides etc.
- All brands of CA glue soaked deep into a tight crack can take up to 5 minutes to cure solid, up to 2 hours to cure to full strength.
- Even 'gap filling' types, do NOT suitably fill any gaps. Surfaces to be glued must be touching each other or filled with fine particles of another material.
- Do not use in cold temperatures, most CA glues will not cure properly at temperatures below 12C (54F).
- CA glues do not bond well with oily woods, even using acetone to 'clean' oily wood surfaces first does not always work satisfactorily.
- CA glues lose adhesion (after curing) in the presence of excess moisture. **DO NOT USE ON CUTTING BOARDS!**
- CA glue shrinks as it ages and some brands eventually turn an ugly orange colour.
- If accelerator is used, remember that you have only quickly cured the glue near the surface where the accelerator was applied. Inside the crack, the CA glue may still be liquid. Accelerator may also turn the CA glue surface 'frosty' if too much is used.
- CA glues will stain the wood around the joint. If possible, put some sealer or finish in the area around the crack. This can be turned or sanded away after the glue has cured.

Polyurethane glues are a good choice if:

- The crack can be opened to apply some moisture to the wood to help the glue cure and adhere better.
- The crack has a small gap. Polyurethane glues can fill small gaps. Pen barrels fit in here.
- If the wood is oily, do wipe the surfaces 2 – 4 times with acetone first.

Polyurethane glue cautions:

- Short shelf life.
- Difficulties with clean up.
- High coefficient of expansion with temperature and humidity change.
- Incompatible with water borne finishes.
- Moisture must be added to dry wood before applying the glue, follow manufacturers recommendations carefully.

Epoxy glues are a good choice if:

- The crack can be opened to apply the compound. Even very low viscosity epoxies will not soak into a tight crack under normal workshop conditions.
- The crack is open. Both sides of the crack can be taped and the epoxy poured in – or one side taped, thicker epoxy put

inside and then the other side taped to contain the adhesive. Small voids in the repair can be filled after the initial application of epoxy has cured. Epoxy does not loose strength, even if filling a wide and open crack or void.

- The crack is open but cannot be taped to contain the adhesive. Mix dry, clean filler into the epoxy to make a paste, then 'trowel' the paste into the crack. Adding filler (up to half by volume) will not seriously affect the properties of most epoxies. Sawdust, metal filings, stone dust and some dye powders can be used.

- If colour is desired for an open crack or void; West System sells a powder colouring system that works very well. You just need Black, Red, Blue, Green and Yellow – combinations of which can be mixed to make any colour. Good quality artist oil paints are suitable for colouring most epoxy compounds. Check first with a small sample of your epoxy to confirm suitability of filler desired.

Epoxies can be heated, this will lower viscosity and help release entrapped air bubbles.

**DO NOT USE A MICROWAVE OVEN!** The Epoxy can easily catch fire. Use a hair dryer to warm the individual component containers just prior to mixing. Caution, this will reduce working time. If heated to a high temperature, working time may be very short.

### Epoxy glue cautions:

- Don't use very short cure time epoxies (less than 20 minutes) for any 'permanent' joint. All brands that I have ever tried are quite soft when cured so not of much use.

- Epoxy is UV sensitive and requires either a filler or a UV block coating to prevent the cured adhesive from yellowing, crazing (a network of fine hairline cracks) or becoming brittle with exposure to sunlight or fluorescent lighting.

-Epoxies take 7 days to reach full cure strength (this includes all types, including short time cure types).

**-Do not mix epoxy in large volumes!** Epoxies generate heat while curing, large quantities can generate enough heat to catch fire. Note that there are some formulations which can be mixed in quantities up to 5 litres or more, but these only cure at temperatures above 60°C (140°F)

Spread mixed epoxy out thin to extend open time. Adding filler will also reduce the heating effect.

-Epoxies all have a problem with an oily film forming on the surface. If used for food items, cleaning the surface with alcohol or acetone several times is the only way to stop this.

-Aliphatic Resin glues such as Titebond, Weldbond, Elmers, Franklins etc are not as useful for cracks as CA, Epoxy or polyurethane glues. They are however used extensively for segmented turning.

**VOIDS****THE “MINIMUM WORK” REPAIR**

Clean the edges of the void and apply finish, what could be easier. This is the best way to deal with a void – as long as the hole is smaller than what will be put in or on the finished piece.

**FILLING VOIDS WITH PLUGS**

This is (in my opinion) the best way to fill a void. Either carve a plug to fit the void or shape the void to match a plug. Glue the plug in place using Aliphatic or Epoxy glue. A simple solution? Almost. The plug should be made of wood from the same species, using a piece from the workpiece is better. The grain orientation should match where it is being placed. This will ensure the longest stress free life for both the plug and the glue joint. If a contrasting coloured wood is desired, select a species with the same characteristics as the workpiece.

**FILLING VOIDS WITH PASTE**

Regardless of what product is used to fill a void, there is the problem of how to hold it in place while it cures. One easy way is to fill epoxy with sawdust from the workpiece until it forms a thick paste. There is not much concern about glue strength, as this is a void – not a crack, so exceeding the 50% fill rule is acceptable.

**Procedure:**

Place thick, strong and slightly pliable tape on the void's smaller side, totally covering the hole and some space around it – no wrinkles!

Fill the void with the glue/filler paste until filled. Ensure that the paste is tightly formed against the walls of the void. Smooth the surface to conform to the shape of the workpiece, and ensure that the tape side has bulged slightly to follow any curve. Allow the ‘plug’ to cure.

When cured, the tape can be removed and the workpiece turned to smooth the filled void to conform to the workpiece shape.

Bring for Demo

- **RP: Weldbond, Titebond glues, sawdust**

Demo: filling with sawdust

Demo: waste block

Demo: two piece turning

- **RP: Aerosol glue, 2 pcs wood, template**

Demo: gluing wood, adding template

- **Hot Melt glue, Hide glue, workpiece/waste block**

Demo waste block attachment (various ways)

- **RP: Epoxy (fast / slow set), filling material**

Demo: filling epoxy (fill A, then mix with B)

- **RP: CA glue (thin / med) wood with crack, end grain, punky spot(s)**

Demo: filling cracks, end grain, punky spots.

- **RP: Double-sided tape, small waste block / 2 pc turning**

Demo for waste block / two piece small turnings

- **RP: Set up for kraft paper temporary joints with PVA**

Demo; how to make these joints

- **Hot melt glue gun + setup for waste block joint**

Demo; how to make these joints safely

- **RP: Glue / wood for minor / major crack filling**

Demo; how to fill small cracks, big cracks

- **RP: Glue / wood / tape for void filling**

Demo; how to fill a void

- **Material and glue to demo segmented gluing**

Demo; how to glue segments together