

EPOXY[®] WORKS

BUILDING, RESTORATION,
& REPAIR WITH EPOXY

ISSUE
NO. 62

SPRING
2026

EPOXYWORKS.COM



FREE



In This Issue

DELAMINATION REPAIR

The cockpit seat of this 1982 Catalina 30 was starting to feel spongy. Time to make some repairs. **P.1**

NEW WEST SYSTEM WOOD ROT REPAIR KIT

Introducing WEST SYSTEM's latest product—a penetrating epoxy system designed to reinforce rotted wood! **P.2**

HOOPY WOODEN BICYCLE

This show-stopping wooden bicycle from Woodenwidget Designs is ready to spin its wheels and turn some heads. **P.4**



GUIDE TO PREVENTING SURFACE CONTAMINATION

Terry walks us through the best practices for keeping your surface clean and ready for bonding. **P.6**

BOAT REPAIR PROJECTS WITH WOOD ROT REPAIR EPOXY

Don shows us a couple of projects where he used the new Wood Rot Repair Kit. **P.10**

INTRODUCTION TO WOOD/ EPOXY BOAT BUILDING

Jeff gives us a brief overview of the most popular boat building techniques that are featured in the *Gougeon Brothers on Boat Construction* book. **P.20**

UNDERSTANDING CARBON FIBER

Strong. Stiff. Stunning. What makes this material so difficult to use? Avery leads us on this deep dive of carbon fiber. **P.12**



DIY GARDEN SCULPTURE

Fuel your creativity with Lada, as he shows off the true versatility of WEST SYSTEM Epoxy. **P.14**

EPOXY THERMOFORMING PATTERNS

Learn about the seemingly endless possibilities that a vacuum-forming machine (and a little epoxy) can offer you. **P.16**



On the cover

Hoopy Wooden Bicycle by Benjy. **P.4**

MANAGING EDITOR Jenessa Hilger

DESIGNER Derick Barkley

CONTRIBUTORS

Mark Olgaard, Jenessa Hilger, Robin Benjamin, Terry Monville, Michael Loebig, Don Gutzmer, Avery Jorgensen, Lada Simek, Ross Pollard, Jeff Wright, and Ray McCarthy

DID YOU:

- Wrap up an interesting project?
- Discover a useful technique?
- Find a new or unusual use for epoxy?



AWESOME! WE'D LOVE TO SHARE IT WITH FELLOW EPOXY ENTHUSIASTS.

EPOXYWORKS MAGAZINE is published twice a year by Gougeon Brothers, Inc., Bay City, MI, USA. Copyright ©2025 by Gougeon Brothers, Inc. Reproduction in any form, in whole or in part, is expressly forbidden without the written consent of the publisher.

FOR CUSTOMER SERVICE AND SUBSCRIPTION QUESTIONS,

Utilize our new accounts page. You can change addresses, manage email preferences and submit questions on [Epoxyworks.com](https://www.epoxyworks.com).

Still need help? Call us at 866-937-8797, or email info@epoxyworks.com.

Epoxyworks subscriptions are FREE to US and Canadian addresses. Subscriptions do not expire. Our mailing list is strictly confidential and will not be sold.



EPOXYWORKS.COM

Delamination Repair

The cockpit seat of my 1982 Catalina 30, the *Looney Bin*, had been feeling a bit spongy. The seat was the cover for the shallow lazarette on the starboard side—the same side we board on from the dock.

I assumed the problem was a wet core, as I had repaired wet deck core on other boats in the past. Those repairs hadn't been too difficult as I could access the core from below and not have to deal with the non-skid. This repair would be easier, since I could take the cover off its hinges and work in my garage.

Back in my garage, I formulated my approach. The back of the cover had a raised section which contained core material. My first thought was to cut off the fiberglass layers with the zip saw to access the core. Thinking it through more, I decided to drill holes to see if the balsa core was actually wet to determine how extensive the repair would be.

Surprisingly, the core was dry. Drilling through the core to the top fiberglass layer, I found an air gap. It turns out the issue was delamination between the core and the top layer of fiberglass, not a wet core. The area of core delamination was approximately 1 ½' x 3' (45.72 cm x 91.44 cm) (the core was inset from the edges by 2"-3" (60.96 cm x 91.44 cm).) I ended up drilling 10 holes, ¼" (0.635 cm) in diameter, through the core to the top fiberglass layer of the cover. The gap appeared to be ⅛" (0.15875 cm) or less.

I mixed my epoxy, 105 Epoxy Resin® and 205 Fast Hardener®. I dispensed one pump at a time, as I had no idea how much it would take to fill the gap. I used a 20 cc syringe to inject the epoxy starting at one of the corner holes and progressing to adjacent holes when I saw



The lazarette was spongy. The top delaminated from the core.

them fill with epoxy. By applying repeated pressure over the area, I could help the epoxy to move around inside the gap.

After sitting for a while, the epoxy levels in the holes started dropping. It appeared the epoxy was distributing further into the gap or soaking into the core... or both. I topped the holes off, and after curing overnight, filled them again leaving a bump that could be sanded level when cured. The entire repair took about 12 pumps each of resin and hardener. I kept adding more resin and hardener to the same mixing pot and using it before it cured. This was a lot more epoxy than I originally thought I would need. I had to find old cans of resin, pouring them together to have enough.

Once the epoxy cured, the holes and entire surface were sanded. Two coats of flat white



The repair work was done from the bottom to preserve the look on the top side.

spray enamel finished the job. No more flexing. The top of the lazarette cover still matched the rest of the cockpit and the underside looked brand new.

A few lessons were learned. Drilling first rather than zipping the skin off helped me determine that the problem was delamination and not a wet core. This discovery saved a lot of time, wasted effort, and materials. The ¼" (0.635 cm) holes seemed excessive, and I could have used smaller ones, but no harm done. The amount of epoxy required to fill the space surprised me. Be prepared before you start mixing. A quart of resin, with appropriate hardener, would be enough for this job. I only used unthickened epoxy, however once I had initially filled the holes with neat epoxy, I could have topped off the holes with epoxy that was slightly thickened with 404 High-Density Filler. Filler would have minimized the amount that soaked into the core, and utilizing the 404 High-Density Filler helps minimize the potential for the epoxy to get too hot.

New WEST SYSTEM Wood Rot Repair Kit

Wood rot has a way of showing up in the worst places—a soft spot on a window sill, a spongy floor in your RV, a crumbling splash rail on your boat. Whatever the situation, the fix used to mean tearing things apart. Now there's an alternative method.

The WEST SYSTEM® Wood Rot Repair Kit is a penetrating epoxy system designed to stabilize rotted, deteriorated wood without requiring full replacement. It soaks deep into damaged wood, reinforcing it from the inside out. The flexible formulation moves naturally with the wood so it won't crack over time.

Why Wood Rot Repair Epoxy

Rotted wood loses its structural integrity because decay breaks down the wood fibers. Wood Rot Repair Epoxy has low viscosity, allowing it to flow through the wood grain and fill the voids left by deterioration, rebuilding strength where it's needed most.

The epoxy has a working time of 30–40 minutes (at 72°F/22°C), giving it plenty of time to migrate through the wood before it begins to cure. In thin films, that window is even longer, which means more penetration and better consolidation.



Penetrates deep to strengthen compromised wood.



Can be modified with WEST SYSTEM Fillers.



Rebuild decorative trim on your home.



The included mixing bottle makes application easy.

Where to Use

The Wood Rot Repair Kit can be used for many common repairs that have rotted or damaged wood, including:

Home

Door thresholds, windowsills, porch railings, any structural wood exposed to moisture

RV

Soft floors, delaminated panels, water-damaged framing in hard-to-reach areas

Boat

Splash rails, window frames, upholstery frames, planking above the waterline

General

Wood rot, stabilizing punky wood, split/cracks

If the wood is hard to reach or impossible to replace, Wood Rot Repair Epoxy is worth considering. Its penetrating formula makes it particularly effective in situations where access is limited and removal isn't practical.

Easy to Mix, Easy to Apply

Wood Rot Repair Epoxy mixes at a 2:1 ratio by volume. Each kit includes a reusable mixing bottle with pre-printed measurements. Fill to the line, mix, and you're ready to go. The bottle's nozzle is sized for injecting epoxy directly into cracks and crevices, which forces the material deeper into the wood and speeds up penetration.

The 1.5 quart and 1.5 gallon kits also include a mixing pot and stir stick for mixing larger batches. All kits come with gloves and detailed instructions.

As a general guide, 4 fl.oz. (118.3 mL) of mixed epoxy covers approximately 50 in² (320 cm²), though coverage varies based on how porous and deteriorated the wood is.

Tips Before Starting

- **Dry the wood first.** Wood Rot Repair Epoxy will cure on damp wood, but moisture limits penetration and reduces the strength of the repair. For best penetration, and to minimize potential for continued rot growth, aim for moisture content under 12%.
- **Remove loose material.** Clear away as much weakened wood as possible before applying epoxy. Excess debris can prevent the epoxy from flowing freely into uncompromised wood, which has the strongest bond.
- **Temperature matters.** The epoxy cures down to 50°F (10°C), extending your working season from early spring to late fall. For the best balance of flow and working time, 70°F (21°C) is the sweet spot. In warmer temps, the epoxy flows more easily but cures faster. In cooler temps, it thickens and slows down.
- **Work in stages.** Apply the epoxy liberally into cracks first, then coat the surrounding surface. As the wood absorbs the epoxy, reapply until the wood is fully saturated. Keep applications under ½" (1.27 cm) thick to prevent excessive exotherm.

KIT SIZES



12 OZ KIT

Small repairs, single spots



1.5 QUART KIT

Mid-size repairs, multiple areas



1.5 GALLON KIT

Large projects or repeat use

Filling Larger Voids

When rot leaves significant voids, penetrating epoxy alone may not be enough to complete the repair. WEST SYSTEM Fillers can be blended into mixed Wood Rot Repair Epoxy to create a non-sag paste for filling gaps and rebuilding shape. WEST SYSTEM 407 Low-Density Filler sands and shapes easily for a smooth finish. WEST SYSTEM 405 Filing Blend is a higher-density option with a darker wood tone that blends more naturally with surrounding material.

Finishing

Once cured, wash the surface with a Scotch-Brite™ pad and water to remove amine blush, then sand to the final shape. Wood Rot Repair Epoxy is compatible with most topcoats. Paints, varnishes, and polyurethanes all work well. A UV-stable topcoat is recommended to protect the repair long-term.

For questions about working with the epoxy, or which size kit is right for your project, contact the WEST SYSTEM Technical Staff at 866-937-8797 or visit westsystem.com.

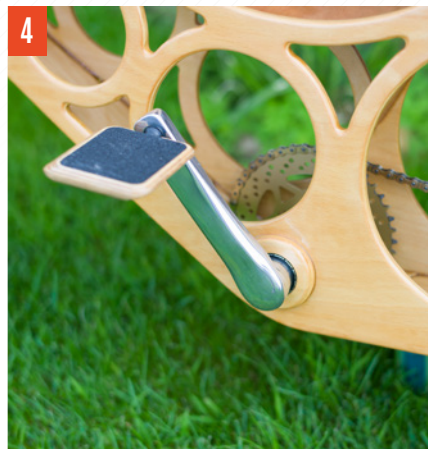
WATCH THE VIDEO



New from
WEST SYSTEM!
Wood Rot
Repair Kit



Repairing a
Rotted Wood
Spray Rail



Hoopy Wooden Bicycle

The Hoopy is a Woodenwidget design which could not exist without WEST SYSTEM® Epoxy. There is not a fastener in it. The Hoopy had been an idea of mine for a very long time. The original idea was to make the frame using hoops of steamed wood riveted together with copper boat nails. It would require great skill to build, but the end result would be spectacular. The trouble was figuring out the right proportions. I decided to simplify and test the concept before attempting it. Rather than lots of hoops, I made a simple frame from two sheets of plywood. The frame design was cut to mimic the original concept of hoops, and this is also where the name for the bike came from.

What was going to be a long winding labor of love turned into a very simple two-day affair. It didn't take long at all to make the frame. It took longer to varnish it than it did to cut it out and epoxy it together! As I wasn't sure about the geometry, I built the prototype very quickly at first just to see how sound the concept was. There's not much point making a beautiful wooden bicycle if it doesn't ride well.

I had no idea what I was doing or what made a good bike. In a way this was a blessing as I wasn't tied to any conventional wisdom. I could do whatever I wanted—just to see if it worked. The angle of the

headstock was done by eye. I came up with a simple system for ensuring the wheels would remain in line while the frame was epoxied—locking them to the workbench during assembly. It worked well.

One of the most unusual aspects of the Hoopy is the position of the front sprocket. I decided to fit it inside the frame—not outside as most bikes. I have never been one to follow the flock and didn't want to repeat what hundreds of other wooden bike makers had already done. I wanted to do something different.

Fitting the drive inside the frame proved tricky. I solved the problem using a modern structural epoxy (WEST SYSTEM) and a special clamp that gripped the bottom bracket shaft. Then I bolted the front sprocket to it. The advantage of having the drive train inside the frame is a cleaner look and no more oily or ripped trousers! Finding a strong, simple, and reliable drive solution was the hardest aspect of the entire design. By contrast, epoxying the frame together with WEST SYSTEM 105 Epoxy Resin® and 205 Fast Hardener® was a doddle!

The first prototype was rough around the edges, but despite that, it worked really well. It was comfy to ride and had good speed. You could even take your hands off the bars and the bike would track beautifully. Later on, I started to investigate and learn more about the geometry of a bicycle. I tried to understand the angles of the headstock and their effect on the way the bike rode. My prototype had a 72.5 degree head stock angle because it just looked right to me. According to the literature, this was just what you would expect a cruising bicycle to have, and I had done it by eye!

Having proved the concept of the Hoopy, I decided to make a second one with higher quality materials and taking more care in the build. In short, a posher version of the original. The frame build took just two days, but I spent 20 hours varnishing it! That was extremely difficult to do, but after eight coats, I was finally happy with the finished result.

I wanted this Hoopy to be really special, so I bought a pair of Cerchio Ghisallo wooden wheels. These are amazing albeit very expensive. They even have a carbon insert to reinforce them so the tires can be inflated to an astonishing 101 psi. (7 bar) if needed! I had them fit a Sram® two-speed automatic hub at the rear so the bike would have gears, but without the complication of cables or other ugly moving parts. It's a brilliant system. Once the speed increases to a certain amount the gear changes. As you slow down, it automatically drops into first gear again. It's a very clever, clean, and maintenance free system. It has the added bonus of a back-pedal brake, which further reduced the need for cables and leaves the design looking very clean and uncluttered.

FIG. 1
Hoopy is a plywood/epoxy bike.

FIG. 2
The details help elevate the quality of the bike, including the custom light bracket and leather clad front fork.

FIG. 3
Custom metal Woodenwidget builder's plate.

FIG. 4
Fitting the drive train inside the frame was an innovative feature.

FIG. 5
Custom tail light matching the bike's aesthetic.

Other nice touches are the wooden pedals and the hand grips that I bound in the same leather I used to make the seat. While I was at it, I covered the front forks with leather, all sewn on by hand. It took ages to do, but the end result is worth it. A friend embroidered a Woodenwidget logo (WW) on the back of the seat leather, and I made wooden lights for the front and rear. Just for fun, and to add that final bit of class, I made a polished brass builder's plate and screwed it to the head stock. (The only fasteners on the bike!)

It's been nearly ten years since I built this bike, and it is still in amazing condition. The frame is practically indestructible thanks to its epoxy construction. There is a YouTuber, called Sam Pilgrim, who somehow got hold of a Hoopy one of my customers had built. For fun, he tried his best to destroy it. He broke the wheels and many other parts, but the frame remained intact despite his best efforts. As a designer, it is very gratifying to learn that your idea is sound.

I have been using epoxy for over 30 years and love the freedom it gives me as a designer. I still dream about making a real Hoopy using many steamed wooden hoops, but I doubt it would be as stiff, strong, or as long lived as the simpler epoxied version. As they say, if it ain't broke don't fix it!

A Field Guide to Preventing Surface Contamination

Surface contamination is one of the most underestimated variables in epoxy work, and it's particularly frustrating because it's often invisible. You can look at a surface and see something that appears perfectly clean, when in reality it's carrying a thin film of oil, silicone, or solvent residue that will compromise your bond. Understanding how contamination gets onto a surface (including from your own cleaning process) is just as important as understanding how to remove it.

Clean, Dry, and Sanded

Before we dive into contamination specifics, it's important to know the fundamental principle we always come back to here at WEST SYSTEM: for good epoxy adhesion, bonding surfaces need to be clean, dry, and sanded...in that order.

Start with a visual assessment looking for visible grease, oil, or wax residue to be removed. Heavy contamination, like oil, grease, and dirt near motor mounts in an old powerboat, may require a degreaser and a scrub brush before any solvent work begins. When scrubbing a heavily soiled surface, remember to periodically clean the brush as well as the surface to minimize redistributing grime.

Acetone, lacquer thinner, and proprietary mixtures like Klean-Strip Prep-All™ are all solvents that are effective at dissolving contaminants



Sanding a fiberglass patch to prepare for bonding.

like oil, grease, wax, and mold release. Apply the solvent to a fresh paper towel and wipe the surface. Then, wipe the surface dry with a second clean, dry paper towel before the solvent evaporates. If the solvent is left on the surface to evaporate on its own, it can leave dissolved contaminants behind.

Change your paper towels frequently to prevent re-depositing removed material back onto the surface.

A surface that looks clean may still need a solvent wipe. You may never think to question a brand new showroom boat, but they can have invisible contaminants like mold-release wax from production. However, if there's genuinely no evidence of contamination, a solvent wipe is unnecessary and can introduce more risk than it eliminates. For example, an epoxy-coated part recently built in your shop, with no exposure to contaminants, would not need a solvent wipe.

Solvents Can Work Against You

The instinct to wipe a surface down with a solvent before bonding is understandable. Solvents are powerful dissolvers, but they don't

discriminate. Whatever is in or on your rag is also fair game to be attacked by the solvents. That dissolved material can be deposited back onto the surface you just cleaned. Silicone is one of the most common examples. It's a widely used mold release agent, and it also happens to be a common ingredient in laundry fabric softeners.

Synthetic fibers in rags create another problem. Many organic solvents can partially dissolve man-made fabrics like polyester and nylon. When those dissolved plastics end up on your bonding surface, they can act like a release agent.

This is why we advocate for using plain white or unbleached paper towels. Paper towels don't carry silicone, synthetic fibers, or fabric softener residue.

Hidden Contamination

One of the most important things to understand about surface contamination is that you often can't see it. Oil from your fingertips, for example, is nearly invisible to the naked eye but it can compromise the surface. Running your hand across a freshly sanded surface to check for smoothness (something almost everyone does instinctively) can leave behind a film of skin oils and salts that will prevent epoxy from bonding properly in that spot. On metal surfaces, that salt residue can accelerate corrosion beneath the coating, which creates adhesion problems over time. If you need to feel for smoothness, we recommend wearing a clean glove.

Airborne contamination is another invisible threat that often gets overlooked. If you're working in a shop with a propane torpedo heater (also called salamander heaters), that heater expels hydrocarbons and moisture into the air. Both can settle on your work surface quickly. Compressed air is another common culprit. Blowing sanding dust off a surface seems like good practice, but if your compressor has any oil or moisture in the lines, you may be spraying contamination directly onto the surface you just prepared.

Certain sandpapers introduce their own contamination risk. Some sandpapers are treated with zinc stearate which is basically a release agent that prevents the paper from clogging. Stearate is chemically similar to animal fat, and sanding with a stearate-treated paper can leave that release material in the scratches you're creating for adhesion. We recommend aluminum oxide or waterproof wet/dry sandpapers that have not been treated with stearate.

Clean First, Then Sand

When you sand a surface that has grease, wax, or oil on it, the abrasive action doesn't remove the contamination. It drives the contamination deeper into the scratches, embedding contaminants where they become nearly impossible to fully remove. Starting with a clean surface ensures that your sanding is working with you, not against you.

If you suspect contamination, clean it with the appropriate solvent and paper towels first, then sand. You will create a textured surface for the epoxy to key into that's actually clean.

Sanding Dust

There's a common misconception that sanding dust is contamination and needs to be removed entirely before applying epoxy. This creates a dilemma, because many of the methods people use to remove sanding dust (compressed air, tack rags) can introduce the very contamination they're trying to avoid.

You don't need to get every last particle of sanding dust off the surface. A freshly sanded surface, assuming you cleaned it before sanding, is about as clean as a bonding surface can be. The remaining dust essentially functions as a little filler once the epoxy is applied.

What does matter is how you remove the bulk of it. Vacuuming is excellent, provided the end of your hose is clean. Sweeping with a clean, uncontaminated bench brush works well. Rinsing with clean water is also effective, provided the surface can be fully dried afterward.

Wood Surfaces

Wood is a porous substrate, and that minimizes the risks of contamination significantly. Porous surfaces are generally more forgiving as the epoxy can penetrate into the structure and creates a deeper mechanical bond than non-porous substrates. For most wood species, no solvent wipe is needed prior to bonding. If the surface was burnished by a dull blade, sanding with 80-grit sandpaper opens the pores and is all the preparation that's required.

The exception is oily wood species, with teak being the most common example in marine applications. The natural oils that give teak its durability and its distinctive character also work against epoxy adhesion. For these species, an acetone wipe approximately 15 minutes before coating helps dissolve and lift the surface oils, giving the epoxy a better opportunity to bond with the surface. Be sure the solvent has fully evaporated before you apply epoxy.

For most other wood species, solvent wipes aren't necessary and, as we've discussed, runs the risk of introducing more adhesion issues than it removes.

Real-World Application

Though these principles are straightforward, they can be considerably more difficult in practice. The condition and geometry of the surface you're working on can add challenges, and the stakes for getting it right are higher in some locations than others.

Our video on how to replace a fiberglass stringer shows what this looks like in a heavily contaminated environment. Don tackles the bilge of a 1980 Chris Craft that had accumulated years of grease and oil near the motor. Skipping straight to grinding would have embedded contamination into the surface of the laminate, creating a less-than-ideal bond for a structural component. Instead, Don starts with a thorough

degreasing, followed by an acetone wipe-down using paper towels.

It can be difficult to get a degreaser or solvent to contact the surface uniformly and to actually remove contamination rather than just pushing it around. Due to the heavy contamination, and the course open weave of the fiberglass, it took a lot of persistence to keep cleaning until the paper towels no longer absorbed grime and contaminants. As Don notes in the video, it may seem like it's taking forever, but every additional pass is getting the surface cleaner.

When is it Actually Clean

Luckily there's a simple, reliable way to check whether a surface is truly clean before you commit to applying epoxy. It's called the water break test, and it works on most non-porous surfaces.

Wet the prepared surface with clean water and observe how the water behaves. On a clean surface, the will water sheet off evenly. On a contaminated surface, the water will channel, bead, or pull away from certain areas where contaminants are present. Those areas need more attention before you proceed.

This test works because the most common contaminants (i.e. oils, waxes, silicones, and grease) are hydrophobic. Water cannot wet out a surface covered in these materials and will pull away.

There are two important things to note when performing this test. First, the water cannot be soapy or have any additives, otherwise it will sheet off even on a contaminated surface, giving you a false result. We recommend using distilled water. Second, the water break test won't detect water-soluble contaminants like soap residues and amine blush. The good news is that, since they are water-soluble, the water from the test itself will help rinse those residues away.

The Takeaway

Surface preparation doesn't have to be complicated, but the details matter.

If there's visible contamination or suspicion of invisible contamination: Wipe with an appropriate solvent using plain white paper towels. Wipe on, wipe off while still wet. Change paper towels frequently. Keep going until the paper towels come up clean. Let the surface dry completely, then sand.

If there's no visible contamination or no suspicion of invisible contamination:

Don't introduce risk by solvent-wiping unnecessarily. Sand the surface with 80-grit aluminum oxide or waterproof wet/dry sandpaper. Remove the bulk of the dust by vacuuming or brushing. Do not use compressed air or tack rags.

For wood surfaces: Skip the solvent wipe unless the wood species is naturally oily. The porosity of the wood will help the epoxy form a good bond.

To check a cleaned surface for contamination: Do the water break test. Clean water sheeting uniformly across the surface is a sign there is no contamination. If it beads or channels, keep cleaning.

After surface preparation: Don't touch the surface with bare hands, don't blast it with compressed air, and don't work in a shop environment that has airborne hydrocarbons or compressor oil.

Most adhesion failures can be traced back to contamination which is often introduced by the cleaning process itself. The steps above won't make your work harder; they'll make it more reliable.

WATCH THE VIDEO



Rotted Stringer Replacement

Check out these cleaning principles in action during our stringer replacement.



From Broken Bird Bath to a Charming Gnome Garden



Bonding the cracked stone basin with G/flex Epoxy.



Stone bird bath getting a second life as a gnome garden.



After painting, the crack is well hidden.

When my wife Sarah and I purchased our home, the previous owners left behind a severely weathered stone bird bath. Since Sarah is getting more into creating gnome gardens, she thought it'd be a fun project to fix up the bird bath and turn it into one!

This bird bath is a two-piece design, consisting of a bowl (top half) and a standing post (bottom half). Aside from both pieces needing a fresh coat of paint, the bowl had a large crack that ran all the way from the top rim to the bottom center and went clean through on both the front and back side of the bowl. We decided to fill in the crack with WEST SYSTEM® G/flex® 655 Thickend Epoxy Adhesive because it bonds well to stone and has a 30% elongation property, allowing it to expand and contract throughout Michigan's seasonal temperature changes.

To prepare the surface, we ground a bevel along both sides of the crack (on both the inside and outside of the bowl) for a secure bond. With the surface prepared, I mixed up my G/flex Epoxy and used a disposable paint brush to apply the

epoxy into and around the crack. The bristles made it easy to coat the uneven surface and work the epoxy into the crack without too much trouble. I flipped the bowl over and repeated the process on the opposite side. Once I was happy with the amount of coverage I achieved, I let it cure in-place for 24 hours.

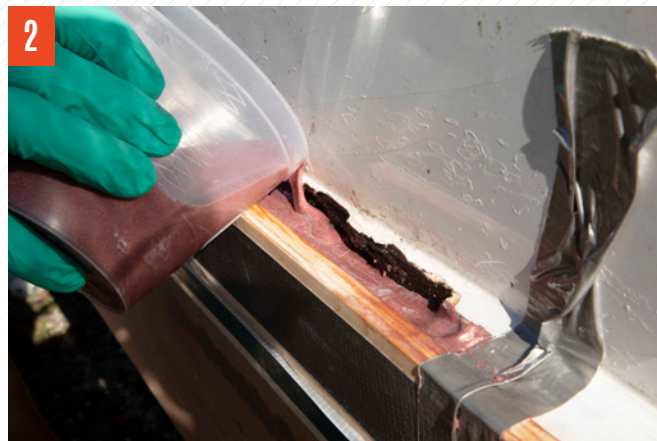
Since this bird bath is going to live outside and be filled with dirt, we didn't spend a lot of time preparing the surface before painting. I removed the amine blush with water and paper towels but didn't do any sanding before hitting it with vibrant green spray paint. We knew going into this project that we weren't going for top-of-the-line aesthetics—we just wanted to make it functional and eye-catching—so sanding and fairing the surface wasn't something we felt necessary.

Sarah did her decorating, and we're more than happy with the results! This bird bath is ready to serve as a gnome garden for decades to come.

Boat Repair Projects with Wood Rot Repair Epoxy



1 Coating rotted wood on a spray rail with Wood Rot Repair Epoxy.



2 Wood Rot Repair Epoxy thickened with 407 Low-Density Filler and poured into rotted spray rail.

Anyone who's spent time working on boats knows that wood rot is one of the most common and frustrating problems. Even quality-built wood and fiberglass boats can develop areas of weakened wood after years of weathering and repeated wet-dry cycles. Cutting out and replacing large sections of wood is a very effective method, but it can be difficult and labor-intensive.

To save time and money, I began using the WEST SYSTEM® Wood Rot Repair Kit for some of these applications. The low viscosity gives the epoxy the ability to penetrate deeply into deteriorated wood, simultaneously hardening the wood from within and sealing it against future moisture. This allows me to stabilize weakened areas without removing unnecessary material.

Recently I had a couple repairs on an older wooden boat that were ideally suited for the WEST SYSTEM Wood Rot Repair Kit. They showcase how easy it is to use for an effective repair. As with any successful repair, the first step is always investigating the extent of the damage, followed by proper surface preparation.

Spray Rail

The spray rail had a 6" long section that had mostly rotted away. I found it helpful to use a chisel and wire brush to remove the loose, deteriorated wood and expose the solid wood beneath. To dry the area completely, I used a heat gun. During this time, I kept the heat gun moving so as not to burn the wood.

To rebuild the missing section of spray rail, it would require a large volume of epoxy. The epoxy would not be able to

support itself while it cured, so I needed to make a mold roughly the shape of the spray rail. On a scrap of plywood, I applied a few strips of clear cellophane packing tape. The plywood would be stiff enough to hold the epoxy in place while the tape would act as a mold release for easy removal once cured. I attached my temporary mold to the boat with duct tape, ensuring the gap at the bottom was sealed with tape to prevent epoxy from running out.

With the area prepped, I was ready to mix epoxy. The mix ratio for the Wood Rot Repair Epoxy is two parts resin to one part hardener by volume. I used the WEST SYSTEM 806 Reusable Mixing Pots that have graduations on the side to meter the correct ratio. Using a bristle brush, I applied a generous coat of epoxy to the surface and allowed that to soak in. After about 15 minutes, I recoated to ensure the

wood was completely saturated with epoxy, and then allowed more time for that to soak in.

With the rot consolidated, it was now time to rebuild the missing section of spray rail. Mixing a new batch of Wood Rot Repair Epoxy, I added 407 Low-Density Filler to the epoxy to help increase viscosity. I thickened the epoxy enough so that it would have some body to it, while still being thin enough to flow into the contours of the damage.

To avoid the epoxy generating too much heat while curing, I poured the epoxy in two batches. The first pour was about ½" deep. I waited until the surface of the epoxy gelled to the hardness of a soft rubber, then finished filling the mold.

After curing for a full day, the temporary plywood mold could be removed. The top of the new epoxy spray rail was exposed to air during the cure process, so there was potential that amine blush formed on that exposed surface. (The epoxy against the mold surfaces was not exposed to air, which prevents amine blush from forming in those areas).

Amine blush is water-soluble, therefore it is easily removed with water and a 3M® Scotch-Brite™ General Purpose Pad 7447. I used paper towels to dry the surface, and then I sanded the repair to match the profile of the surrounding spray rail with 80-grit aluminum oxide sandpaper. Then it was ready to be painted to match the surrounding hull.

Bright Finished Around Window Frame

The cabin had been built with custom windows that had a metal frame. Years of water sitting on the lip of the frame allowed the moisture to soak into the planking end grain. The plank had begun rotting away, allowing water into the cabin. The water needed to be stopped, but replacing the rotted plank would be no easy feat. Filling the area with thickened Wood Rot Repair Epoxy was a great solution to fill the void and prevent further moisture intrusion.

A small chisel worked well to dig out decayed wood until reaching sound wood again. The heat gun was useful

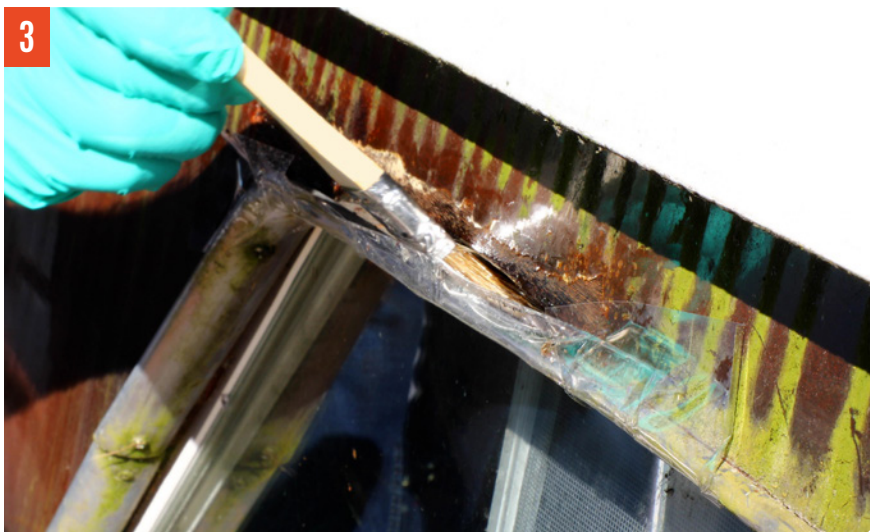
for drying the area completely. I applied clear cellophane tape to the aluminum window frame to prevent the epoxy from bonding to the metal. I mixed a batch of Wood Rot Repair Epoxy, and brushed it onto the surface, ensuring I coated all the exposed wood. After 30 minutes, I applied another coat of epoxy allowing the epoxy to penetrate as much as possible for the best adhesion.

Then it was time to fill the void. The area around the repair was clear-finished mahogany, so I decided to thicken my epoxy mixture using the 405 Filing Blend Filler. This filler was specifically formulated to be wood-toned for creating fillets on clear finished boats. I added enough filler to make it non-sag and then loaded it into a WEST SYSTEM 807 Syringe. The syringe allowed me to inject it into the tight, hard-to-reach areas to prevent trapping large pockets of air. For the finishing touch, I used our 804 Reusable Mixing Stick to smooth the surface, leaving it slightly proud.

From here, I took the same steps as with my previous repair. I started by removing the amine blush with water and a Scotch-Brite pad, dried with paper towel, then sanded the surface fair with the surrounding area. All that was left was to apply a UV-stable top coat.

The Results

Both the spray rail and the window resulted in a solid repair that blended in nicely with the surrounding wood. This saved hours, maybe even days, of time compared to cutting everything out and starting over. Once the final UV-stable top coats are applied, the repairs are complete. Overall, WEST SYSTEM Wood Rot Repair Kit made it easy to rebuild the damaged wood, and protect the areas from further water damage.



Coating the wood above the window to consolidate the deteriorated wood.

Understanding Carbon Fiber

What Makes It Great (and What Makes It Fail)

Carbon fiber is strong, light weight, and looks stunning, but why is it used? Do I even need it? Why does it seemingly attract loads and crack before anything else? To understand these questions and learn how to use it properly in your repairs, we need to understand what carbon fiber is and why it is so awesome!

What is Carbon Fiber?

Carbon fiber is made of long chains of carbon atoms that have a tight crystalline arrangement. The manufacturing process typically begins with materials such as polyacrylonitrile (PAN), pitch, or rayon. These materials are spun into long strands, then heated to extremely high temperatures, between roughly 1,800°F and 5,400°F (1,000°C and 3,000°C). The heating chamber is generally filled with inert gas such as nitrogen to prevent combustion or deformation. Heating to these temperatures removes nearly all non-carbon components, resulting in fibers composed primarily of crystalline carbon. The resulting atomic structure gives carbon fiber those insane properties it is known for.

Carbon fiber is five times stiffer than fiberglass (E-glass) and is less dense.

| | Carbon Fiber | Fiberglass (E-glass) |
|-----------------|----------------------|------------------------|
| Tensile Modulus | 390 GPa | 72 GPa |
| Density | 1.9g/cm ³ | 2.54 g/cm ³ |

This is why it is commonly found in high-end speed boats, high-speed cars, sporting goods, and aerospace applications where strength and weight are limiting factors. When these carefully engineered structures need repairs, those need to be done with carbon fiber as well to preserve the stiffness and strength of the original design. Fortunately, WEST SYSTEM® works exceptionally well with carbon fiber, so there is no need to shop around.

Why Can't I use it to Repair Everything?

Everything that makes carbon fiber so awesome also makes it ill-advised as a universal repair material. When an item is engineered, the material's performance properties are considered when determining the laminate thickness and the placement of reinforcements.

Think of stringers on a boat. The stringers are engineered to carry the loads from the hull, and the entire structure works as an integrated system. When you add reinforcement to a single stringer, it can create hard spots or stress concentrations which increase the likelihood of repeated damage to the area.

This stiffness mismatch is key to why carbon fiber often cracks before the surrounding fiberglass. When force is applied, the carbon fiber repair and the fiberglass laminate both deflect the same amount. However, the carbon fiber has a tensile modulus, or stiffness, five times more than fiberglass. This means carbon fiber requires five times the force to move the same distance as the fiberglass. Unfortunately, the carbon fiber is not five times stronger than fiberglass, so under the same deformation, the carbon fiber experiences five times more force and reaches its failure point first resulting in cracks.

Picture two springs—one stiff and one flexible—hanging with the same weight attached. The stiff spring stretches far less, resisting deformation. Imagining our stiffer spring is like our carbon fiber, it would require five times the amount of weight to stretch the same distance as the flexible spring representing the fiberglass. The carbon fiber may be much stronger than the fiberglass, but again, it is not five times stronger, which is why it is often the first to fail.

Matching the same thickness and materials as the original laminate is often the best way to prevent cracking.



Example of carbon fiber skinning previously featured in Epoxyworks.

How do I Repair Carbon Fiber?

There are two main types of carbon fiber repairs: structural and cosmetic. For structural repairs, aligning the new fibers with the original fiber direction is more important than with fiberglass. Most of the carbon fiber's strength runs along the fibers, so changing fiber directions can impact the strength of the laminate. As you grind the repair area and create your scarf angle, the fiber orientation becomes visible.

For best results on structural carbon fiber repairs, we recommend using a 20:1 scarf ratio. This is larger than the typical 12:1 ratio used for fiberglass. While this may seem daunting, carbon fiber laminates are often thinner than their fiberglass counterparts, resulting in a similarly sized scarfed area. The longer scarf angle helps the forces transfer more gradually between the repair and the undamaged laminate. Structural carbon fiber can be successfully repaired with WEST SYSTEM 105 Epoxy Resin® and any of the 200 series hardeners.

Cosmetic carbon fiber (or carbon fiber skinning) is typically a thin layer on the outside of non-structural components that gives the illusion of the part being built of carbon fiber. This is generally done because carbon fiber looks cool, especially with certain fabric weaves. When repairing cosmetic carbon fiber, we recommend using WEST SYSTEM 105 Epoxy Resin with 207 Special Clear Hardener® for a clear finish to keep the carbon looking sharp.

Since the carbon fiber is cosmetic, it is not structural and does not need to be scarfed into the surrounding area. You can simply cut away the damaged carbon fiber and replace it with a new piece. Try to line up the weave direction of the new piece and existing carbon to minimize the appearance of the repair. Generally, the repair is still visible using this technique. For a seamless repair, it may be easier to remove the entire outer layer of carbon and replace it with a new one. If this isn't practical, a new layer of carbon can be adhered to the top.

Carbon fiber can also be difficult to wet out because it often has a very tight weave, and the black color makes it hard to see which areas have been saturated. Because of this, we recommend wetting the surface with epoxy, then placing the dry fabric into it. It is much easier to pull the epoxy up through the tight weave than force it down through. It may also be helpful to add some bright lights to see slight differences in color.

What Does This All Mean?

Carbon fiber is an incredible material. It's strong, lightweight, and sleek, but like all high-performance materials, it demands respect. Its stiffness and low weight make it unbeatable when properly designed into a structure, yet those qualities can cause problems when used carelessly in repairs. Understanding how carbon fiber behaves can make the difference between a lasting repair and a repeat failure. Using WEST SYSTEM 105 Epoxy Resin and 200 series hardeners can keep parts strong for any structural needs, but when paired with 207 Special Clear Hardener, it is easy to make it look good, too.

Whether restoring a part or touching up a cosmetic weave, the goal is to work with the material, not against it. Remember, the next time you reach for that roll of carbon fiber, it is not just about making something look cool, you have to understand why it's strong and how to keep it that way.

Hooke's Law

$$\sigma = E \epsilon$$

Hooke's law is the formula that is used to calculate the variables of stress (σ), strain (ϵ), and tensile modulus (E). It states that stress (force per unit area) is proportional to strain (deformation per unit length), and that relationship is governed by a material's tensile modulus (stiffness). A carbon fiber repair and the surrounding fiberglass laminate are going to experience the same strain, however, because the tensile modulus is five times higher for carbon, the stress is also five times higher.

DO-IT-YOURSELF GARDEN SCULPTURE

Much has been presented in Epoxyworks on boat repairs using WEST SYSTEM® Epoxy, however there is another application where WEST SYSTEM excels—the field of art. Over the years I've learned how to build sculptures out of steel, Styrofoam, fiberglass, and epoxy... and had a lot of fun doing it. It's caused me to end up with an eighteen-foot-wide pterodactyl hanging above my driveway, a six-foot tall Bugs Bunny, an Easter Island head, and a coyote chasing the road runner.

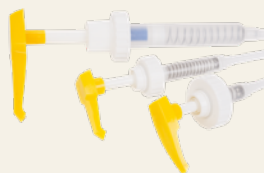
Building Basics

To build large sculptures like these, you start with a basic frame which you then cover with a wire mesh. Chicken wire works well and is cheap. If the sculpture will be indoors, wrap the wire with pieces of burlap, soaked in a loose mixture of water and plaster. For sculptures that will reside outside, cover the wire with fiberglass cloth that has been saturated with WEST SYSTEM Epoxy. Alternatively, the base could be carved from Styrofoam. When the Styrofoam is covered with two layers of fiberglass and two coats of epoxy, it becomes like a rock.

When fiberglassing over chicken wire, I recommend two layers of fiberglass bonded with three coats of epoxy to get a good degree of stiffness. You will undoubtedly have unevenness, bumps



105 EPOXY RESIN & HARDENERS



300 MINI PUMPS

or hollows. These bumps are ground off and the hollows can be filled with a little epoxy mixed with filler, or Bondo®. Bondo is available in just about every hardware store as auto body filler.

WEST SYSTEM Epoxy

For my sculpture work, I choose to work with WEST SYSTEM Epoxy. Though it may be a little more expensive than a polyester resin, WEST SYSTEM Epoxy has many properties that benefit the sculpting process. It's low odor allowing work to be done inside, it can be used over Styrofoam, and there are a variety of hardeners to choose from for the cure speed that works best for your process. I use the 105 Epoxy Resin® with the 205 Fast Hardener® because, at 72°F (22°C), I have about an hour of working time in a thin film and it will take about six hours to cure.

Curing time depends on air temperature, and the 205 Fast Hardener can cure down to 40°F (4°C). With epoxy, it's important to mix the resin and hardener on ratio. WEST SYSTEM resins and hardeners are sold in different size cans to reflect the difference in volumes due to mix ratio. The cans can be fitted with the 300 Mini Pumps for easy dispensing. One pump on each can delivers the exact ratio of resin to hardener. It is a wonderful system! The convenience and accuracy of utilizing the Mini Pumps is unbeatable. West Marine sells both the epoxy and the fiberglass cloth plus they are willing to give advice. The resins and hardeners are sold in three sizes, so you can get the most appropriate size kit for your project.

Pants Planter

I made a pants planter from a sacrificial pair of old jeans. I went to Goodwill and bought a pair for ten dollars. Note: men's size 40 jeans fit a five-gallon plastic bucket. If you do this project, you will need some kind of a container inside the waist of the pants to get them to keep the shape. Next, I needed to make artificial legs. Using 1" x 2" lumber, I measured from my waist to the floor. Then, I cut it in half and connected the two pieces with a nail. The joint had to be somewhat loose to make a movable knee. The thigh and calf were stuffed with crumpled newspapers, insulation, rags and whatever I could find. Using string, I wrapped the leg to give it the natural shape. Then I put the legs inside the jeans so that they protruded out of the bottom.

To complete the look, my pants needed boots. I placed the leg apparatus into the boots, stuffing rags and paper in the boots, so the wood leg frames fit snugly. I made sure the fabric overlapped the top of the boots. I mixed some epoxy and poured it inside the boots. A few hours later the boots were attached.

With everything arranged in a natural sitting position, it was time for the bucket. I covered the five-gallon bucket in wax paper to prevent the epoxy from sticking, then inserted it into the waist to hold the jeans open. Once satisfied with the final positioning, it was time to solidify everything with epoxy.

I brushed on two coats of mixed epoxy over the jeans and the boots and allowed it to cure. With the sculpture stabilized, I could remove the bucket and cover the leg holes inside with fabric. Mixing another batch of epoxy, I applied two coats to the inside of the jeans. I had to be sure to seal everything well, so rainwater wasn't running into the legs or boots.

When everything cured, I drilled several holes in the seat of the pants so that any rainwater, or overwatering of the planter, would have a way to drain out. The epoxy turns the pants a very dark color. If you were recreating this project and wanted to paint them, wash the surface with water, and paint with Rustoleum® Clean Metal Primer and the color of your choice.

The planter was ready for a bucket of flowers. Since real flowers need watering, which can be troublesome, I found a better solution. I put in a block of Styrofoam with artificial flowers in the planter instead. No more problems.

Good luck with your creations.

FIG. 1 Sacrificing a pair of old jeans evolved into a custom, humorous garden planter. A project that anyone could tackle.



FIG. 2-4 Lada has built many outdoorsculptures out of steel, Styrofoam, fiberglass, and epoxy. His creations include a six-foot tall Bugs Bunny, an Easter Island head, the Pink Panther, an eighteen-foot-wide pterodactyl, and Wile E. Coyote chasing the Road Runner.



Get Creative!

You can have a lot of fun with the epoxy and a little creativity. I got a hold of a friend's underwear, laid it out on wax paper and painted it with mixed epoxy. When it got hard like a piece of plywood, I had his wife put it in his drawer as a joke. A little too much starch!

Epoxy Thermofforming Patterns

A benchtop vacuum-forming machine can be used in conjunction with homemade epoxy patterns to make a wide variety of thermoformed plastic parts and pieces. I use WEST SYSTEM® products to craft an aluminum filled epoxy pattern with improved heat transfer for making clear PETG chocolate molds. The process is very approachable, and something you may be able to utilize too.

Tools & Materials

For this process, you will need the following supplies from WEST SYSTEM: 105 Epoxy Resin®, 206 Slow Hardener®, 420 Aluminum Powder, reusable mixing sticks, and a reusable mixing pot. You will also need two-part silicone mold rubber, sewing pins, mold release spray, sheets of thermoforming plastic, and a benchtop vacuum-forming machine.

Instructions

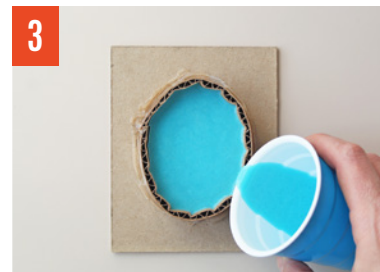
To get started, create an original model. For this demonstration, I sculpted a bas-relief ear of corn out of modeling putty **FIG 1**. If sculpting is not your forte, feel free to use a 3-D printer instead. For best results, the model should have a relatively thin cross-section and no undercuts.



1 *Sculpt a three-dimensional model.*



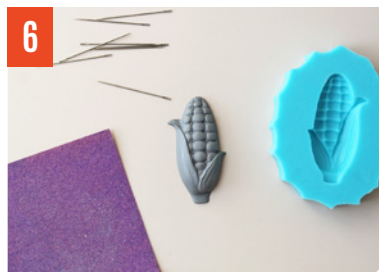
2 *Hot glue a strip of cardboard around the model.*



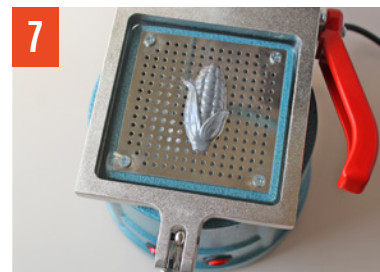
3 *Pour a silicone rubber mold.*



5 *Let the epoxy cure overnight and then remove the pins.*



6 *Smooth the back of the pattern with sandpaper.*



7 *Form PETG plastic over the epoxy pattern with a benchtop vacuum-forming machine.*

Next, use a hot glue gun to attach a strip of cardboard around the model **FIG 2**. Mix a batch of two-part silicone mold rubber and pour it over the relief **FIG 3**. After the rubber cures, insert sewing pins into the mold as shown **FIG 4**. The pins will be extracted later on to create air vents in the aluminum-filled epoxy.

To mix the epoxy, you will need five parts WEST SYSTEM 105 Epoxy Resin, one part 206 Slow Hardener, and three parts 420 Aluminum Powder, by volume. Combine the 105 Epoxy Resin and 206 Slow Hardener in a reusable mixing pot. Next, add the 420 Aluminum Powder and stir with a reusable mixing stick for two minutes. Coat the mold with release spray and pour in the aluminum-filled epoxy.

Let the epoxy cure overnight and then pull out the pins with a pair of pliers **FIG 5**. If the bottom of the epoxy pattern is uneven, flatten it with sandpaper **FIG 6**. When you are finished sanding, clear the dust from each vent hole with one of the sewing pins or a can of compressed air.

To vacuum-form the finished product, center the pattern on your machine's molding table, insert a sheet of PETG plastic in the clamp frame, and switch on the heating element. As it heats up, the plastic will rise slightly and then slump back down. When it does so, switch on the vacuum and quickly lower the frame over the pattern **FIG 7**. After a few seconds, turn off the machine and remove the molded sheet of plastic **FIG 8**. Let the pattern cool down before repeating the cycle.

For this demonstration, I used .02" food-grade PETG plastic to make chocolate molds to share with friends and family **FIG 9**. Other items that can be made with a benchtop vacuum-forming machine include model airplane parts, slot car bodies, and custom packaging.

SUPPLIES:



WEST SYSTEM 105 Epoxy Resin,
206 Slow Hardener, and
420 Aluminum Powder



4
Insert sewing needles for air vents, then pour the aluminum-filled epoxy.



8
Remove the molded plastic. Let the pattern cool down before repeating the cycle.



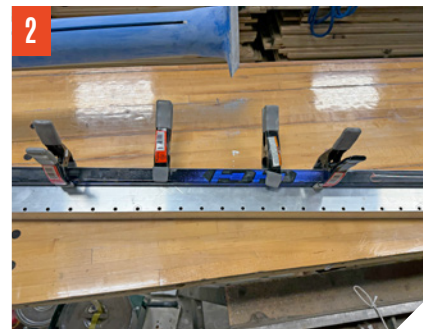
9
Use food-grade PETG molds to cast chocolate candies and other treats.

SPORTS EQUIPMENT REPAIR

HOCKEY STICK REPAIR BY GRANT HILGER

Grant bought a \$400 hockey stick for \$25. The only problem was the shaft was broken. His plan had been to cut the stick down to make a mini stick, but once he got it home, he thought “You know what, I can repair this!”

He cut the damage away, mirroring the cut on both pieces **FIG 1**. To align and support the joint, he fitted a foam plug inside the shaft, epoxying it in place with G/flex® 655 Thickened Epoxy Adhesive **FIG 2**. Once cured, he beveled the joint. Then he filled the bevel with carbon fiber tape wet out with 105 Epoxy Resin® and 206 Slow Hardener®. He wrapped heat shrink tape around the wet epoxy, shrinking it down to clamp the joint while the epoxy cured. Once cured, the tape could be removed and the stick was ready to hit the ice again **FIG 3**.



WOODEN BOAT BUILD

PRAM BUILD BY JIM COOPER

Jim built this 8' pram for the boat's namesake, his granddaughter Amelia. The lines were taken from an older pram. This labor of love is ready to carry Amelia wherever the wind takes her.



RUDDER REPAIR BY AMY LAHR

Amy bought her first large boat in the fall of 2021. It was a 1993 Tartan 31 Piper that Amy named *Unplugged*.

Her previous owner stored her indoors in the winter, so 2022 was her first winter outdoors in the Minnesota snow. *Unplugged* showed her disapproval by splitting her rudder. Amy discovered it a couple days before she was supposed to splash.

Not having any previous experience, Amy followed the WEST SYSTEM® manuals and rebuilt the rudder in a month. She used 105/205, 105/206, 406 Colloidal Silica Filler to put the skin back on, 407 Low-Density Filler for fairing, G-flex® around the shaft, plus syringes, etc. Amy states, "I went from zero to our club's epoxy expert."

FIG. 1 Outer skin removed, exposing the saturated core. **FIG. 2** Old foam removed and replaced with new two part foam. **FIG. 3** Outer skin rebonded with release fabric over top. **FIG. 4** Final fairing **FIG. 5** Repaired rudder reinstalled



An Introduction to Wood/Epoxy Boat Building Techniques

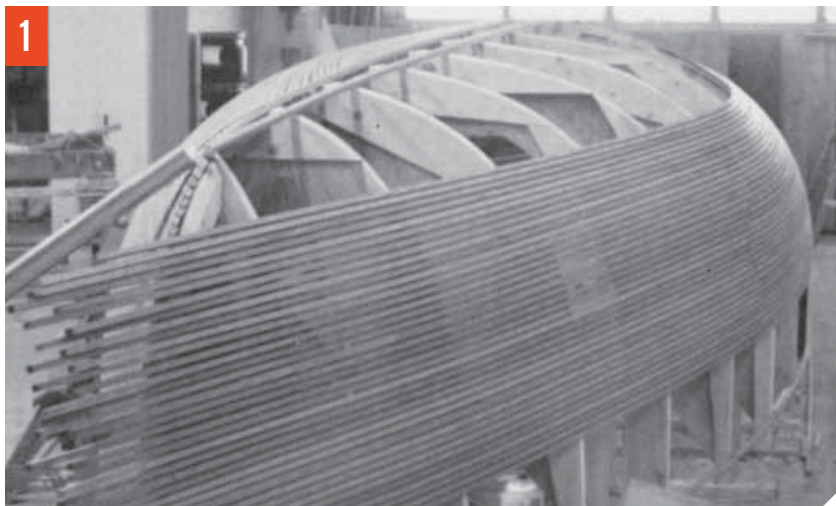
Contemporary wood/epoxy construction offers versatile approaches to building custom, one-off boats that combine traditional craftsmanship with modern materials. The *Gougeon Brothers on Boat Construction* book explains techniques for creating strong, lightweight, and durable boats ranging from small dinghies to large sailing yachts. These same techniques can also be used to build smaller custom parts such as hardtops, furniture, and center consoles.

Importance of Design and Engineering

Every successful boat-building project begins with proper planning. Designs must provide accurate dimensions to build a fair hull or part. A fair surface is one with smooth, flowing lines free of bumps or irregularities. Structural details are also critical to ensure the vessel achieves the required strength and stiffness. Engineering calculations determine appropriate material thicknesses, reinforcement schedules, and construction methods to build a safe boat that will perform as intended.

Controlling Moisture

One of the most significant advantages of contemporary wood and epoxy construction is the ability to control the moisture content of the wood. Maintaining constant moisture content reduces the chance of rot and improves dimensional stability. This allows stiff reinforcing fabrics, such as fiberglass and carbon fiber, to be bonded directly to the wood without the movement that would otherwise cause them to crack or delaminate. All seams can be epoxied rather than



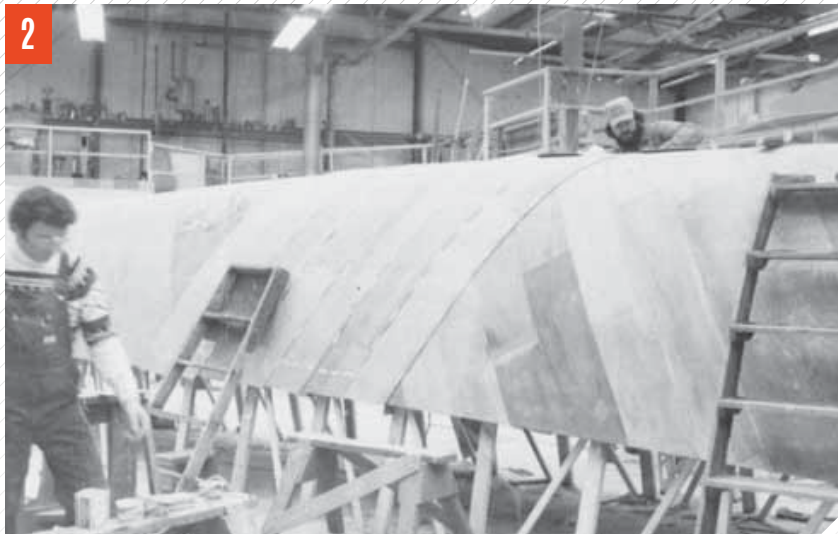
LAMINATING VENEER OR PLYWOOD Ribband mold framework around which the veneers are bent for lamination. The ribbands for this 26' (7.9 m) mold were run parallel to the sheer and butted along the centerline of the keel.

caulked, which means drier bilges and a more structurally unified hull.

Achieving this stability requires complete encapsulation. All wood components must be thoroughly sealed before assembly. Every surface, every edge, and every hole drilled for screws or hull fittings

must be sealed with epoxy to create a complete moisture barrier. This protects the wood and creates a stable, dry structure.

It's worth noting that restoring traditionally built boats with WEST SYSTEM® Epoxy uses a different approach. Instead of encapsulating,



STRIP/VENEER COLD MOLDING Cold molding implies that the adhesive does not require heat to cure. Here they are applying a second layer of veneer, which typically runs in the alternating direction.

traditional built boat planks should be epoxied together and coated on the outside only. The interior remains uncoated to allow the wood to breathe. This method is appropriate for boats built with traditional techniques but does not provide the complete moisture protection of full epoxy encapsulation.

Wood Selection

Not all wood species perform the same. Wood selection depends on balancing the tradeoffs across several characteristics including weight, rot resistance, dimensional stability, aesthetics, and cost. Regardless of the species selected, all wood should have a moisture content between 8% and 12% for dimensional stability during and after construction.

- **Cedar:** Cedar offers lightweight properties combined with natural rot resistance at a reasonable cost, making it a popular choice for many builders.
- **Okoume and Mahogany:** These tropical woods cost more but

provide excellent rot resistance and attractive appearance. Okoume is particularly favored for marine plywood.

- **Oak:** While oak provides exceptional strength, it presents challenges due to its dimensional instability. It tends to change shape significantly with moisture variations. Oak requires special attention when gluing and should be used selectively.
- **Spruce:** Spruce is very light weight with good strength properties and moderate rot resistance, making it suitable for structural members where weight is a priority.
- **Ash:** Ash also offers low weight and good strength but lacks natural rot resistance, so it must be thoroughly sealed with epoxy.
- **Marine-Grade Plywood:** When using plywood, marine grade is essential. Marine plywood features waterproof glue, no internal voids, more plies for

strength, and is typically made from okoume. All holes drilled in plywood must be sealed with epoxy to prevent moisture intrusion into the edge grain and core plies.

Construction Methods

One of the strengths of wood and epoxy construction is the range of building techniques available. Whether the project is a small kayak or a large sailing yacht, there is an approach suited to the hull type, the available materials, and the builder's experience level.

1. Laminating Veneer or Plywood

This method uses a ribband mold (which is a framework of temporary forms over which thin wood veneers or plywood strips are bent and laminated.) Staples or small nails hold the wood in position until the epoxy cures, creating a strong monocoque shell. The ribband approach provides ample area for fastening the veneers, ensuring good contact between layers and the ability to pull them into the desired shape.

2. Strip/Veneer Cold Molding

The term cold molding implies using an adhesive that does not need heat to cure. This technique is often used to build larger hulls. These typically have multiple layers of veneer applied at various angles over a mold. This cross-grain lamination provides exceptional strength and stiffness. Fitting pieces requires careful trimming to maintain fair curves without gaps (spiling).

3. Stringer/Frame Construction

The string/frame construction technique is similar to veneer molding, except it incorporates internal stringers and frames. This method works well for boats of

any size. The additional structure allows for thinner planking, reducing weight and material costs while maintaining strength.

4. Strip Planking

This is a very popular method for building canoes and kayaks. In strip planking, builders create frames or station molds, then apply narrow planks edge-to-edge over these forms. The planks are temporarily fastened with staples, screws, or clamps while being edge-glued with epoxy. This technique allows builders to create complex compound curves from simple lumber. The temporary fasteners can be removed after cure, or in some cases, the entire hull is built over permanent bulkheads that become part of the structure.

5. Hard Chine Plywood/Stitch and Glue

Stitch and glue is a popular method for hulls of many sizes and is especially accessible for first-time builders. The plywood panels are “stitched” together with temporary wire or cable ties before being permanently joined with epoxy fillets and fiberglass tape. This method requires minimal frames or molds, and the plywood reduces cost and the number of pieces needed. The trade-off is that plywood limits hull shapes to those with distinct chines rather than smoothly rounded sections.

The fillet radius at joints is critical to strength. Therefore, fillets need to be properly shaped with an adequate radius to distribute loads effectively. Builders often use simple tools, like plastic discs, to create consistent fillet shapes.

6. Scarfing: Joining Wood Lengthwise

Any of these methods may require joining boards or plywood sheets end-to-end when standard lengths aren’t long enough. A scarf is a beveled edge on two joining ends of boards—often created with power

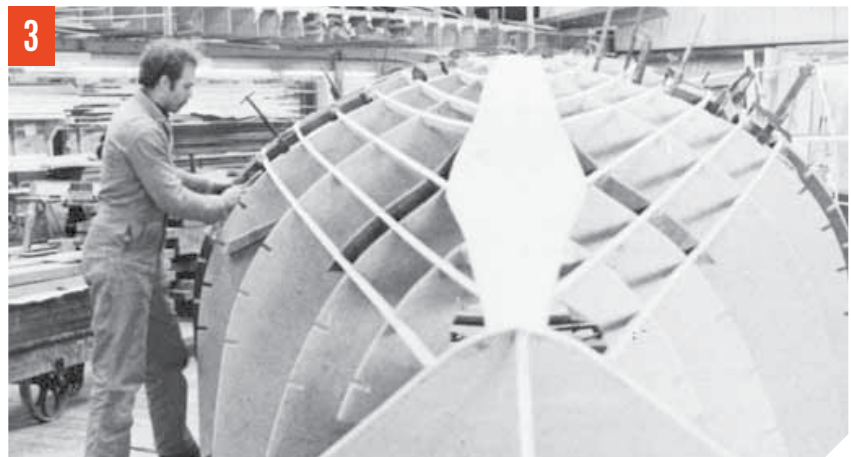
planers or saws—to achieve smooth, matching bevels. Specialized scarfing jigs mounted on benches help create accurate, repeatable joints. When done properly, the overlap creates a nearly invisible joint. We recommend an 8:1 bevel for enough bonding surface to create a strong bond, while not creating a hard spot at the joint. For ½” thick material, an 8:1 bevel would produce a 4” long joint.

Two-step bonding is essential for scarf joints because the end grain absorbs more epoxy than surface

grain. Moderate clamping pressure is all that is needed to hold the joint while it cures. For plywood, the glue lines should run parallel to maintain strength.

Composite Construction

Similar construction methods can be applied when building with composite materials rather than wood. Foam strips or thermoformed foam sheets can be used to form a core over a mold. Then fiberglass or carbon fiber skins are applied to



STRINGER/FRAME CONSTRUCTION Stringers form the mold shape as the hull is built and support the planking when finished.



HARD CHINE PLYWOOD/STITCH AND GLUE Popular for first time builds for the ease of construction. Panels are stitched together over top of a frame to hold shape until joints are reinforced. Showing construction of a pram.

the outside. Once cured, the hull is removed from the mold or frames and the interior is laminated with a fiberglass or carbon fiber skin. This creates a sandwich structure with exceptional stiffness-to-weight ratio.

Engineering Considerations

Whether building with wood or composites, building a safe boat requires engineering analysis. These calculations determine the appropriate laminate schedule for the inner and outer skins, core thickness,

and reinforcement placement. This is all done to ensure the hull achieves the required strength and stiffness while minimizing weight. Building a safe boat requires balancing these factors with proper construction techniques and quality materials.

Finishing

After construction, proper surface preparation is essential before applying varnish or paint. Any amine blush must be washed away and surfaces sanded smooth before

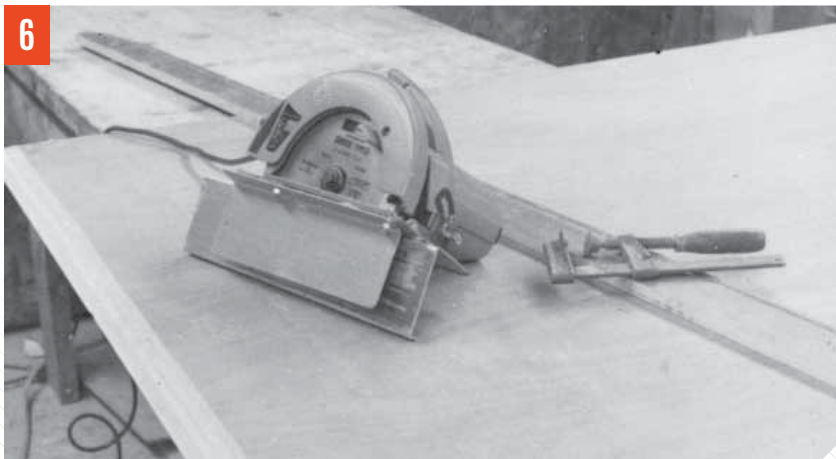
painting. For clear finishes over wood, using 105 Epoxy Resin® with 207 Special Clear Hardener® provides optimal clarity and UV resistance. A high-quality marine varnish or urethane coating will provide the needed UV protection for durable, long-term bright finish.

Boat Building with WEST SYSTEM

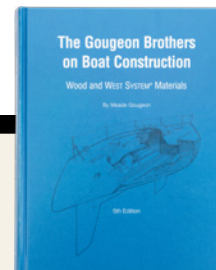
Boat building with WEST SYSTEM Epoxy offers tremendous flexibility in construction methods, materials, and vessel types. Whether working with traditional woods like cedar and oak, modern marine plywood, or advanced composites with foam cores, the fundamental principles remain consistent: careful planning, proper moisture sealing, appropriate material selection, and sound construction techniques all contribute to creating attractive, durable boats that provide years of reliable service on the water.



STRIP PLANKING *Narrow strips are edge glued over a frame. Though popular on canoes and kayaks, this strip planking is on a 42' (12.8 m) hull.*



SCARFING *A great technique for extending the length of boards. For boat construction we recommend an 8:1 bevel. The WEST SYSTEM 875 Scarffer helps improve the speed and accuracy of cuts.*



Did you know

The Gougeon Brothers on Boat Construction is available as a free download on westsystem.com?

Learn more about all these construction techniques.



MUD GUPPY GUNNEL REPAIR

When Ray bought this 2000 Sturdee Amesbury skiff, it had a trashed starboard front gunnel. He used a saber saw to cut out the damage on the gunnel. The removed section was fitted with a new oak strip, and he used thickened WEST SYSTEM® Epoxy to bond in the replacement strip. After the epoxy cured, he planed the scarfed oak strip, beveled the edges, redrilled

screw holes, inserted stainless steel screws, and then applied wood putty.

The bow piece was also damaged, so while he was repairing the gunnel section, he also removed the bow piece. The section was replaced with a new piece of mahogany, it was bedded in 105 Epoxy Resin® and 205 Fast Hardener®

thickened with adhesive filler, and then the cleat was reinstalled.

To finish the wood for the sun and the sea, he sanded the oak gunnels and sealed them with 105 Epoxy Resin and 207 Special Clear Hardener®. This was followed by five coats of Minwax® Indoor/Outdoor Helmsman® Spar Urethane. Now the boat is ready to head off to the marsh!



Fully restored bow section.



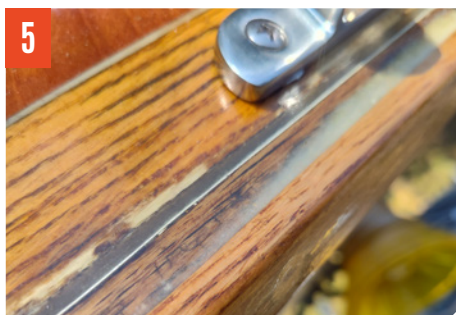
Fitting the replacement bow piece.



Bow piece installed. The damaged gunnel needs to be replaced.



Looking down the length of the replaced gunnel section.



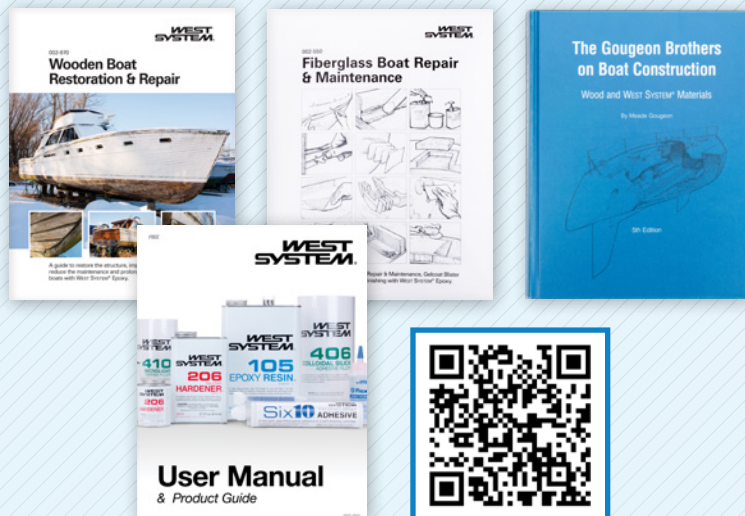
The new section was scarfed onto the old section with 105/205.



Completed repair ready to hit the marsh.

WEST SYSTEM®

Publications



WEST SYSTEM® offers a range of detailed publications that can help you get started on your building or repair projects. These publications are available at your local WEST SYSTEM dealer or as free [downloadable PDFs at westsystem.com](https://westsystem.com).

Contacts by Region

North and South America,
China, Japan and Korea

WEST SYSTEM

P.O. Box 665
Bay City, MI 48707
westsystem.com
P: 866-937-8797

Australia and
Southeast Asia

Atl Composites Pty. Ltd.

atlcomposites.com

Europe, Africa, the
Middle East and India

Wessex Resins & Adhesives Ltd.

eu.westsystem.com

New Zealand and
Southeast Asia

Adhesive Technologies Ltd.

adhesivetechnologies.co.nz

Readers' Projects



CREATIVE REPLACEMENT

GOBLETS BY DAVID BLACK



David Black shared some of his latest toasting goblet designs. David's goblets first made an appearance in *Epoxyworks* back in 2015. He has continued refining and developing his styles over the years having "pushed this set of goblets farther than ever before, thanks to my faith in G/Flex®. On every project that I have used this adhesive for, it has never let me down....even in my yacht building." As a long-time WEST SYSTEM® user, and 3rd Generation Master Shipwright, that's high praise indeed!

VINTAGE RESTORATION

GUITAR REPAIR BY FRANCOIS DE FAYMOREAU



Francois de Faymoreau bought this guitar at a flea market for \$5. The head was broken clean off at the nut. Using six layers of 1/8" Honduran mahogany, he bent them to follow the transition from the neck to the head of the guitar. He cleaned up the break by cutting a 5.67:1 ratio scarf joint to meet the new mahogany head and epoxied it together. It has been doing wonderfully for over five years.

HOUSEHOLD REPAIR

PICKUP TOPPER BY MIKE JARVIS



Father and son partnered together to build this custom camper shell. Tired of a low pickup bed topper, Mike and his son Joe salvaged this topper to use as the base for their custom creation.

The design they developed increased the height while factoring in aerodynamics for a more efficient profile. Using a mix of different WEST SYSTEM® Epoxy products, they were able to transform their design concept into reality.

WOODEN BOAT BUILD

LAKE BOAT BY STEPHEN KNOWLTON



This is a modified Rangeley lake boat built from western red cedar and ash framing. The 1/8" strips were sheathed with fiberglass and WEST

SYSTEM® Epoxy. This photo is from a three-month tour of Great Slave Lake.