

FREE



# EPOXYWORKS®



BUILDING, RESTORATION & REPAIR with EPOXY  
Number 45 ■ Fall 2017

# In This Issue

## Bronze, Glass, and Epoxy Sunflowers

George loved seeing the sunflowers in his back yard until they became deer food. He decided to create a more permanent display that was just as bright but more deer resistant.

## Clamping Basics

Find out the best techniques for clamping to ensure you get a strong, even bond every time.

## Building the Modern Vardo

After Greg and his friend Jill studied RV's, train cars and tiny homes, they came up with the perfect design for a modern vardo.

## Faster, Neater Fillets

A modified 810 Fillable Caulking Tube and Jack's fast filleting tool will help you finish large filleting projects in no time.

## Obsessing about *Obsession*

After more than ten years of navigating raging rivers, it was time for *Obsession* to get a full-service makeover.

## Penetrating epoxy— legend or myth?

Over the years we've hear a lot of incorrect information about penetrating epoxy. Bruce does some testing to disprove some of the myths surrounding it.

## Epoxyed Porch Columns and Railings

After 15 years of use, Tom's epoxyed porch columns and railings only needed a fresh coat of paint to look brand new.

## Bubble-Free Casting in Knotholes and Cracks

Don shares the techniques he used for filling large voids to create the top for a beautiful end table.

## Large Wooden Vessel Repair

We didn't just write the go-to book on boat construction; we wrote the guide the Coast Guard uses for inspecting wooden boat repairs too.

## Hot Canary Becomes *Vivacious*

The Gougeon built i550 *Hot Canary* returns home to Michigan to get refit and a couple fresh coats of paint.

## Michael A. Barnard

It is with heavy hearts we say goodbye to our irreplaceable friend and coworker Mike Barnard.

2

5

6

6

8

11

14

16

19

22

26

**Editor/Designer** Jenessa Hilger

**Managing Editor/Copy Editor** Grace Ombry

**Contact/Subscriptions** Mari Verhalen

**Contributors** Alex Boelkins, Bruce Niederer, Don Gutzmer, George Gish, Greg Hatten, Greg Ryan, Jeff Wright and Tom Pawlak

*Epoxyworks* is published twice a year by Gougeon Brothers, Inc., Bay City, MI, USA.

Product Number 000-605

© 2017 by Gougeon Brothers, Inc. Reproduction in any form, in whole or in part, is expressly forbidden without the written consent of the publisher.

*Epoxyworks* is a registered trademark of Gougeon Brothers, Inc. WEST SYSTEM, 105 Epoxy Resin, 205 Fast Hardener, 206 Slow Hardener, 410 Microlight, G/5, G/flex and Six10 are registered trademarks of Gougeon Brothers, Inc. 207 Special Clear Hardener, 209 Extra Slow Hardener, 422 Barrier Coat Additive, Episize and Scarffer are trademarks of Gougeon Brothers, Inc.

## Subscriptions, US and Canada

*Epoxyworks* subscriptions are FREE to US and Canadian addresses. Subscriptions do not expire. To start or stop a subscription, change address or subscribe for a friend, complete and return the tear-out mailer or call 866-937-8797 toll free. You may also subscribe via e-mail to epoxyworks@gougeon.com (be sure to include your mailing address) or by filling out the subscription form at epoxyworks.com. Our mailing list is strictly confidential and will not be sold or used for any other purpose.

## Contribute to *Epoxyworks*

If you have completed an interesting project, or developed a useful technique or a practical or unusual use for epoxy, tell us and your fellow epoxy users about it. Send a photograph or two, or e-mail digital photos (about 300 dpi). Include a note describing the project and how we may contact you. By sending photographs you are granting permission to publish your photos in *Epoxyworks* and other Gougeon Brothers print and online publications or promotional presentations.

**Mailing address** *Epoxyworks*

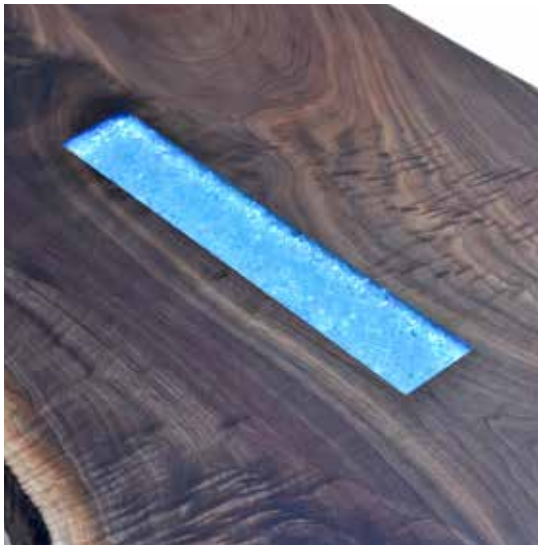
P.O. Box 908

Bay City, MI 48707-0908

**Email** epoxyworks@gougeon.com

## *Epoxyworks* Online epoxyworks.com

Browse back issues or look for specific topics.



The Marita is a modern, live edge coffee table made out of a solid 2.25" thick slab of Canadian Black Walnut salvaged from Essex County, Ontario. The void in the center of this curly black walnut slab was filled with broken safety glass and WEST SYSTEM Epoxy. The table is lit from below with a wireless RGB LED to allow for any color light to be selected. One-of-a-kind, this coffee table is an eye catching conversation piece.

This project was submitted to us by Steve Pomerleau, Wood Architect at Flow Hardwoods. To see more of their beautiful work, visit their online portfolio at [flowhardwoods.com](http://flowhardwoods.com).

Cover Photo: The Marita, live edge coffee table.



# Bronze, Glass, and Epoxy Sunflowers

By George Gish



*The completed glass and bronze sunflowers. A rotation of the petals over two degrees changed how the glass reflected light. No two were installed in the same plane.*

My sunflower project began after I'd brought home from the farmer's market three sunflowers planted in a small barrel. I placed the flowers on the patio outside my kitchen's sliding glass door. Every time I sat at the kitchen table, I looked out at this bright splash of color and felt pleasantly relaxed. That happy, soothing view ended two days later when deer ate the sunflowers. I wanted my view back, but knew that buying more flowers would just provide another meal for the deer. I decided to re-create the flowers in something they couldn't eat: glass and bronze.

I began by making a few rough drawings to get an idea of what I wanted. I would make two stalks, each with three limbs and three leaves. I drew life-sized flowers, stalks, limbs, and leaves on cardboard and adjusted angles and limb placement to find a design I liked. Next, I made a model of my flowers out of 4'x8' sheets of foam insulation. I placed the foam model on a 2,000-pound boulder I had selected for the base and made more adjustments until, when I stared at it from my kitchen window, the flowers finally "felt" right.

For the flower parts, I bought two 1-1/8" diameter silicon bronze rods for the stalks, two 5/8" bronze rods for the branches, and sheets of bronze of varying thicknesses from Atlas Metals in Colorado. A small local foundry bent the bronze rods to exactly match the bend in my foam model. The bronze-to-glass bonding brackets were cut out

for me by a waterjet company. I'd had some work done with lasers, but preferred the way the rougher edge, created by the waterjet, accented the dyes.

From Kokomo Opalescent Glass Company I ordered six yellow glass petals for each flower (with four extras in case I damaged some), and eight pieces of green glass for the leaves. Getting these petals made took a number of months. Each petal is 10" long, 5 1/4" at its widest point, 2 1/2" at the thickest point, and weighs about six pounds. Each leaf is 10 1/2" long, and 6 3/4" at the widest



*Model of my flowers made of foam insulation on the 2,000-pound boulder to be used as the base.*

point,  $2\frac{3}{8}$ " at its thickest point, and weighs 7 pounds. The brown seed head in the middle of the sunflower is  $8\frac{1}{2}$ " in diameter, 3" thick in the center and weighs  $9\frac{1}{2}$  pounds.

Holding a glass petal toward the sun, I determined that any movement over two degrees changed how the glass reflected light. In my final plans, I made certain that no two glass surfaces were installed in the same plane. The appearance of the sunflowers should change every few minutes as the sun passes by and the angle to the sun changes.

How can I make sunflowers out of all this incredible raw material? Simple. I took three semesters of welding classes at Macomb Community College and bought MIG and TIG welders. From Sculpt Nouveau in California, I bought acid to spray on the bronze and turn it green. Various dyes and stains were used to further color the bronze. Using small sheets of bronze, I made a "storyboard" (like wood finishers use) to record exactly what I used to attain each of the colors I wanted so I could replicate them on the sunflower parts.

I drove to Gougeon Brothers, Inc. to meet with Tom Pawlak, who became my learned and experienced advisor. After talking with him, I decided to use G/flex 655 Thickened Epoxy Adhesive for smaller parts of the flower like the golden fringe around the glass seed head, as well as the petals and leaves. G/flex will flex appropriately with changes in temperature and will withstand movement caused by high winds.

The sunflowers actually do flex, in fact, they appear to dance in the wind. I took some parts to Gougeon Brothers, Inc., including some pieces I had epoxied together, so Tom could strengthen the joints. The glass and bronze parts for each flower, excluding the stalks, weigh about 80 pounds. Each flower with stalk and leaves weighs about 160 pounds, so the stresses are substantial. The sunflowers will be outside in very cold weather, very hot weather, rain, snow, ice, and wind.

With Tom's expert advice and a little field experience, I learned that adequate surface preparation is essential. Rubbing 80-grit sandpaper on glass is not enough. The epoxy has to have something to "key" into, as Tom would say. I bought and tried diamond drills, diamond hole saws, Dremels, engraving tools, angle grinders and anything else I could find that would scratch bronze and glass. I changed my original design for epoxying leaves and petals to bronze after learning how components can peel apart under extreme stress.

I showed Tom some bronze holders I made to epoxy the leaves and petals in place on all sides. These bronze-to-glass brackets were welded to the

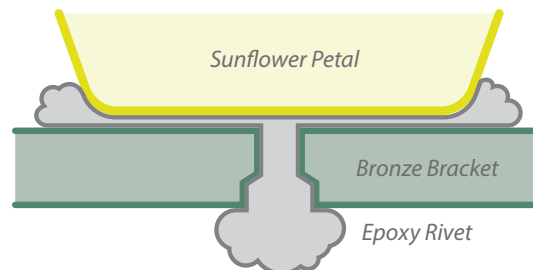


*I drilled a few holes in the base of these holders, then used a larger bit to drill halfway through the back of these same holes. This allowed the epoxy to form a head, kind of like an "epoxy rivet" which helps prevent peeling.*



*Using a syringe, I injected epoxy into small openings in parts of the flowers.*

limbs and the sunflower frame to fix the petals and leaves in place. I drilled a few holes in the base of these holders, then used a larger bit to drill halfway through the back of these same holes. This allowed the epoxy to form a head, kind of like an "epoxy rivet" which helps prevent peeling.



The bronze brackets, after acid and dye had been applied, enhanced the appearance of the sunflower. I also welded hundreds of random beads of metal onto the bronze stalks and limbs to provide texture and create a more organic appearance. I dyed the tops of these beads darker for accent.

*The bronze holders I made provided stability and more surface area for epoxying the leaves and petals into place.*



Every surface that was to be epoxied was first deeply abraded using a combination of sandblasting, scratching with diamond-impregnated bits, and small saws. With magnifying glasses, I inspected all surfaces for adequate abrasion. I wiped and cleaned the surfaces with acetone before applying epoxy.

Using a syringe, I injected epoxy into small openings in parts of the flowers. The weight of the glass provided sufficient clamping pressure. I turned all bronze surfaces straight up, applied epoxy to the bronze and the glass and then lowered the glass onto the bronze, wiping off any excess epoxy immediately. It worked extremely well. No mechanical clamps were required.

It's best to apply acid and other dyes before applying epoxy. The acid runs when you spray or brush it on. The dyes are also not epoxy friendly. I applied all finishing media before applying epoxy, and avoided spraying acid or using other hazardous

finishes indoors. For spraying, I went outside and wore goggles, a high-quality mask with filters, and protective gloves.

After the finishing and welding were done, the flowers were screwed onto the stalks. Threaded holes were drilled in the tops of the stalks and the bottom of the structural bronze on the base of the flowers, and a  $\frac{9}{16}$ " threaded stainless steel rod was screwed into the tops of the stalks. The flowers were then screwed onto the stalks. The joints were welded for additional strength.

Before drilling holes in the boulder for installing the stalks, I placed wooden stakes in the ground at exactly the angle I wanted so I could slant my drill at the correct angle. I drilled a slightly larger hole than needed and gouged the sides of the hole to create small epoxy reservoirs to hold the heavy flowers in place without slippage. This also left room for excess epoxy to escape from the hole.

I covered the boulder to keep epoxy from spilling on the rock surface. Tom advised me to pour epoxy into the hole before installing the stalk, and let the excess epoxy run out. I'd saved some boulder dust to mix with the epoxy to patch the gaps between the bronze stalk and the sides of the hole. It matched well.

The best advice I can give for a project like this is to think everything through. Surprises and problems are the last thing you want when applying epoxy to glass and bronze. I made task lists so, at 77, I would not forget some critical step. One slight mistake can take a heavy toll on your work.

When I finally finished this three-year project, I invited some friends to see the flowers. The completed sunflower display is 9'  $\frac{1}{2}$ " tall by 8' 4" wide. One lady who saw the sunflowers from my kitchen said, "Oh, they look so happy—like they're dancing. They make me happy." Even squirrels run up the stalks to try to eat sunflower seeds. Redemption! Maybe all this work was worth it.

I will make a time lapse video this summer as the sun passes overhead so people can see the light show. I plan to donate the sunflowers to a hospital for children to see and enjoy.



*The happy sunflowers, completed and dancing in the sun.*

# Clamping Basics

By Don Gutzmer

When using WEST SYSTEM Epoxy as an adhesive it is important to make sure pieces are held in position while the epoxy cures. Here are some tips for best results when clamping.

There are many different forms of clamps: spring clamps, c-clamps, quick clamps, pipe clamps, bar clamps, and parallel clamps to name a few. All are designed to hold objects together. Knowing the functions and limitations of different types of clamps will help you choose the correct style of clamp for the job at hand.

There are many ways to hold pieces in position, but the important considerations when working with epoxy are:

- Even clamping pressure
- Avoiding excessive clamping pressure
- Ensuring some epoxy squeezes out from the joint

Even distribution of clamping pressure over a large area helps create a reliable bond. This can be accomplished by making a caul (pad) out of pieces of wood to be placed between the clamp jaws and the stock.

Inserting a caul between the clamp and the stock being clamped will prevent clamp marks from appearing in the face of the stock. When applying clamp pressure, tighten the clamps slowly until some adhesive squeezes out. There is no need to apply excessive clamping force (as with yellow glue) to an epoxy glue up. In fact, excessive pressure can squeeze too much glue from joint, leaving you a glue-starved joint.

A simple clamping fixture utilizing wedges (Figure 1) is an effective way to get even pressure

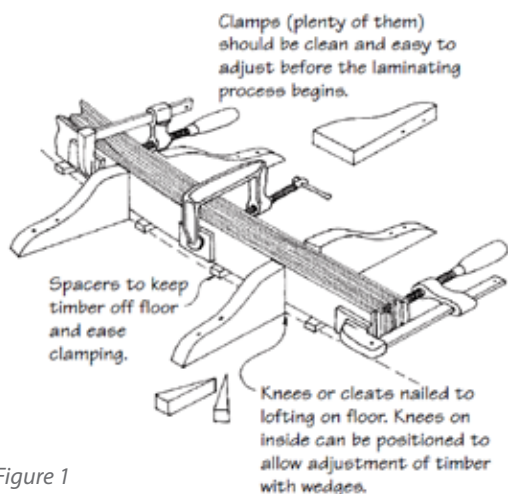


Figure 1

over the entire glue joint. You can use screws or staples to prevent materials from slipping while clamps are being tightened.

Holding a piece of curved stock in place with clamps (as shown in Figure 2) will help distribute clamping pressure evenly across your joint. If you have lots of scarf joints to clamp, it may be worth laminating a curved caul.

The degree of curvature involved when gluing bent laminations will determine how much clamping pressure is needed

to overcome the natural tendency of the substrate to resist the bending forces. To generate enough pressure to pull the bonding surfaces into contact, drill pilot holes through the clamping strip and scarf joint into the receiving member, then insert wood screws. Use washers to further distribute the pressure. Applying wax or another release agent to fasteners will make them easier to remove after the epoxy cures. Covering the clamping strip and receiving member with polyethylene plastic sheeting or clear shiny packaging tape will allow for their removal later.

All assembly and clamping should take place during the open time (while the epoxy is still wet and workable) to ensure a dependable bond. Structural, gap-filling thickened WEST SYSTEM Epoxy makes it possible to laminate materials with little clamping pressure. It is good practice to pre-coat all bonding surfaces with unthickened epoxy prior to applying thickened epoxy. This method is called 2-step bonding.

When clamping pieces together a small amount of the epoxy mixture should squeeze from the joint, indicating that the epoxy is making good contact with both surfaces (Figure 3).

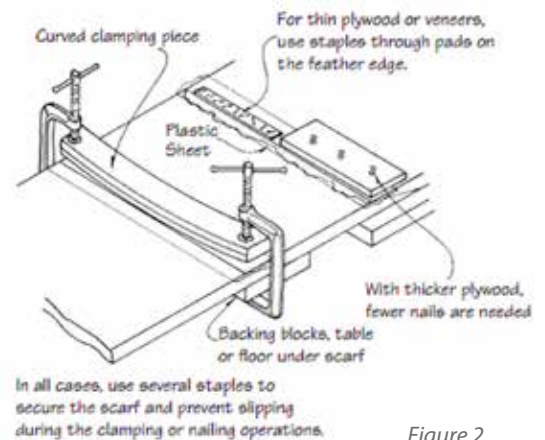


Figure 2

A small amount of epoxy will squeeze out of the joint with just the right amount of thickened mixture and clamping pressure.

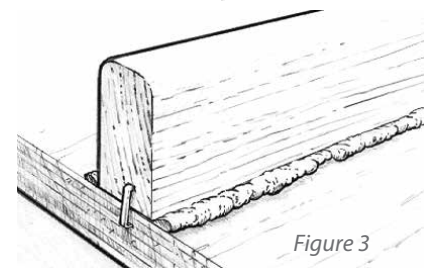


Figure 3



*The wagon has traveled over 13,000 miles, attracting many curious souls along the way.*

# Building the Modern Vardo

By Greg Ryan

This was an exciting project and design collaboration with my friend Jill. Recently retired, she and her husband were looking for adventure and a home away from home.

Jill and I studied vardos (Romani wagons), modern RV's, train cars and tiny homes, borrowing elements from each. This vardo is only 8' x 12' yet has a queen size bed, bathroom, refrigerator, hot and cold running water, holding tanks, a furnace, AC/DC electricity, a fold-down porch, and plenty of storage. It is solar-powered and completely self-contained. The wagon is insulated as well.

One of the primary design objectives was to

keep it light. This was not an easy task given that it contains nearly everything you would want in a home. At 2,700 pounds we felt we did pretty well.

We designed the roof to look like old canvas by folding the Dynel® synthetic fiber fabric to create overlaps that had more of a traditional look. This was applied with WEST SYSTEM Epoxy. The roof was then painted with good quality porch and floor enamel.

WEST SYSTEM Epoxy was used throughout. The vardo is built using traditional mortise and tenon joinery with all critical joints epoxied with 105 Resin/205 Fast Hardener. (I am currently building another wagon and I find the 206 Slow Hardener extremely helpful when I'm working alone and need more time.) The exterior shell is  $\frac{3}{8}$ " tongue-and-groove strips of Douglas fir, traditionally referred to as "pennyboarding." The fir was dyed with aniline dye, fiberglassed with 105 Resin/207 Special Clear Hardener, and finished with three coats of Epiphanes® high-gloss marine varnish followed by two coats of matte varnish. This created a beautiful, lightweight, and extremely strong waterproof shell.

The arched roof rib-to-wall attachment was critical as the wagon had to withstand cruising down the highway at 65 mph. The thought of something flying off... well, let's just say that wasn't an option. Here, I embedded bolts into oversized holes in the top wall plate and filled them

*Kitchenette with hot and cold running water.*







*Dining area with custom stools.*



*Bedroom with a queen size bed.*

with WEST SYSTEM Epoxy. This allowed me to bolt the roof on. When this process was complete, I felt confident that the roof was not going anywhere. This process was based on information found in the incredibly useful book, *The Gougeon Brothers on Boat Construction*.

The ledge brackets were designed and hand forged by a friend, artist Scott Kessel. It is particularly tricky to get the proportions right on a dwelling this small. The windows and doors had to be scaled to fit visually. So did the hardware. I ended up making the hardware for all of the windows because we couldn't find what we wanted. At one point I was even grinding nail heads to give them a smaller, less uniform look.

The wagon has traveled over 13,000 miles, attracting many curious souls along the way. The owners have described the wagon as "magical."



*The tapered end makes filling easier and neater.*



*The 810 Fillable Caulk tube allows you to lay down a consistent bead of epoxy.*



*Jack's fast filleting tool is perfect for creating fillets in one pass.*

## Faster, Neater Fillets

*By Tom Pawlak*

When creating lots of epoxy fillets, a faster way to apply the thickened epoxy is with an 810 Fillable Caulking Tube. It takes a bit of time to transfer the epoxy into the tube, but it is wonderfully efficient for applying epoxy to the joints. Compared to other application methods, it's also less messy.

Once a bead of thickened epoxy is applied, it must be spread into a smooth, uninterrupted fillet.

We cut the open end of the Fillable Caulk Tube at a taper to make it easier and neater to fill. The enlarged opening allows neater and faster transfer of the thickened epoxy from the mixing pot.

Cutting this tapered end uses up some of the tube's available volume, but less epoxy in the tube reduces the chance of the epoxy getting too hot, which it does when a larger volume is confined.

Jack's fast filleting tool (a modified 808 Flexible Plastic Spreader) simultaneously cleans the margins on both edges of the fillet. This is our favorite tool for efficiently making fillets.

Excess epoxy stays in front of the spreader to fill in deficient areas, preventing gaps and creating a uniform, smooth surface. If there are gaps, apply more thickened epoxy over the area and draw the spreader along the joint again. Most times though, a perfect fillet can be achieved in one pass.

# Obsessing about *Obsession* A Wooden Boat Makeover

By Greg Hatten

Greg Hatten putting *Obsession* through its paces in a technical river section.

In the past few years my river dory, *Obsession*, has traveled a thousand rocky river miles in all kinds of weather, dodged a million rocks (and hit more than a few) while running rivers in Yellowstone, Tetons, Olympic, Rocky Mountain, Rainier and a dozen other National Parks.

This dory has run backward through a rapid on the Rogue River, run sideways through a rapid on the McKenzie River, and slammed into a wall at Mule Creek Canyon on the Rogue River so hard

*Obsession* with a bare bones interior.



that it split a rib, shattered an oarlock, and was put out of commission for a month.

*Obsession* has given me more pleasure and pride than just about anything I have done in my life. It has taken me to wild and scenic places I never dreamed existed. It connects me to the river with a bond that comes from having built, rowed, wrecked, and repaired this boat with my own two hands. I used lots of WEST SYSTEM Epoxy in the original build, as well as in every single repair I've made over the years.

*Obsession* has given guests on my boat experiences they will remember for the rest of their lives.

This handcrafted drift boat is built of wood. Every mark on it represents a story of adventure and a brush with disaster. My dory has spent a lot of time at the intersection of Chaos and Calm—where worlds collide on the rivers out west. The test of nerve and skill in a boat made of wood is a challenge that I'm as passionate about now as I was the very first time I rolled *Obsession* down the boat ramp—more than ten seasons ago.

River rocks and granite walls are unforgiving. Unfortunately, it's my boat that pays the price and takes the beatings. Things happen. Those mishaps cause stress fractures, hairline cracks, and holes in the boat that must be repaired. The sides need to be varnished annually, and the everyday



scrapes, dings, and dents are sanded and fixed on a regular basis.

This winter, I decided I would treat my boat to a full-service makeover. I declared this off-season The Season of Repair. As part of the *Obsession's* tune-up, I removed every piece of wood that was removable, stripped the hull down to a shell, then restored, rebuilt, and refinished every single piece. You might say I got a little obsessive.

First, I took the boat off the trailer and turned it upside down. I removed about 70 stainless steel screws and the ¼"-thick UHMW plastic shoe from the bottom of the boat so I could repair a few cracks, checks, and "push-ups" in the wooden bottom. I was relieved that there were no serious holes or dead spots.

I drilled out and plugged every screw hole in the bottom of the boat. Every screw represents a point of entry for water. Eventually, water will find a way to seep in and rot out the wood around the screws.

After lots and lots of sanding, I resealed the wood bottom with two coats of WEST SYSTEM Epoxy, making the bottom smooth as glass. With the bottom sealed, I reattached the plastic shoe by drilling fresh holes and fastening it with new stainless steel wood screws bedded in marine caulk.

Next, I flipped the boat right-side up and went to work on the interior. First, I repaired and reinforced hairline cracks in three of the Alaskan



yellow cedar frames—#1, #2 and #9. As part of that process, I removed the oak dashboard with the mahogany knee braces and stripped and refinished every inch of it. I also removed the mahogany fly deck in the front of the boat and stripped and refinished that.

On the inside bottom of the boat, I stripped the weather-faded Durabak™ polyurethane protective coating (truck bed liner) on the floor,

*Obsession's hull undergoing repairs before being resealed with WEST SYSTEM Epoxy.*

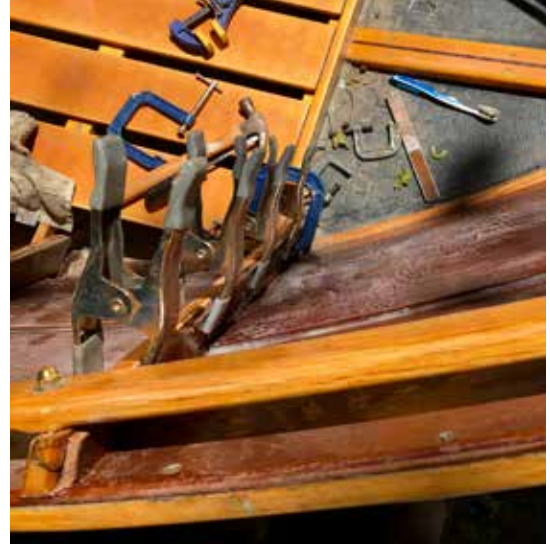
repaired all the inside “push-ups” by sanding down the checking, and repaired it with WEST SYSTEM Epoxy. When it was smooth as glass, I reapplied a fresh coat of Durabak with a roller and paint brush.

I repaired and refinished the fun stuff—the cup holders, passenger bench, mahogany rod holder, and the fly boxes on the rowing thwart. I reworked the oarlock pins and rebuilt the mahogany drawers on the rowing bench.

Then, I did something I’ve wanted to do for several years. I redesigned the rowing seat and raised it up two inches by adding a solid piece of mahogany to the braces on each side. The result is an elevated platform with a better view of the river over the heads of my passengers in front. To finish it off, I restrung the rowing seat with brand new black marine rope.

The yellow cedar floorboards in the front and back needed work. I sanded these down and refinished them. I also added a floor lock to the floorboards in back to keep them from flopping around, something else I’d wanted to do that for years.

*Obsession is put back together and ready for her next adventure.*



*Reinforcing the braces of the rowing seat with a solid piece of mahogany so it could be remounted 2" higher.*

The “bar in my boat” gets a lot of use. I originally designed and built it to give my feet something solid to push off of for greater leverage and power when I really need to move the boat. While I loved the patina and tarnish of the brass bar, I gave it a new look by polishing the brass and refinishing the support braces.

The mahogany front stem was looking a little beat up as the first line of defense when my boat hits high rocks or canyon walls. I built it as a replaceable piece so that when it becomes too damaged I can build a new one and replace it. I’m not quite ready for that... but close. This time, I repaired and restored the original front stem

The last thing I did was lightly sand the entire boat and apply three coats of Pettit Z-Spar Flagship Varnish inside and out.

It took almost 100 hours of attention, one gallon of WEST SYSTEM 105 Resin with 207 Special Clear Hardener, a cartridge of Six10 Thickened Epoxy Adhesive, one gallon of Pettit Z-Spar® Flagship Varnish, two quarts of Durabak protective coating for the floor, 40 feet of rope, 75 discs of 220-grit sandpaper, 120 new stainless steel 1" wood screws, seven paper dust masks, a ton of patience, and a little obsession.

I have a busy season of boating ahead and a number of National Parks on my agenda including the Buffalo National River, Teddy Roosevelt National Park, Glacier National Park, and the Wild and Scenic Middle Fork of the Salmon River in Idaho. Many of *Obsession's* scars remain visible and most of them have a story to tell. Every single mark or dent is evidence of heroic runs, colossal blunders, lucky breaks, bad timing, or close calls in a boat that has visited some of the most beautiful and treacherous rivers in North America. They are marks of character, and I’m kind of proud of each one.

# Penetrating epoxy— legend or myth?

By Bruce Niederer

I'm fast approaching my 22nd year of working here at Gougeon Brothers, Inc. From my first day on the job, I have lived the controversy surrounding penetrating epoxies vs. high-solids epoxies in general and WEST SYSTEM® Epoxy in particular. I have met with the formulator and founder of a popular brand of penetrating epoxy and talked to him many times over the years. He is a nice fellow and passionate about his product, but in the end we had to agree to disagree.

It only takes a quick search online to find way more information, arguments, and name calling than any rational person would care to participate in. I've never claimed to be rational—so let's just get right to it.

We are not enamored of penetrating epoxies. In fact, we don't agree that there's a need for a penetrating epoxy. At least, not as far as many folks seem to perceive them: "I just want the strongest bond possible to the wood" or this favorite of mine, "I have dry rot I need to consolidate." Well sure, OK, because rotten wood covered in weak, porous epoxy is really very strong—just like new!

I'm sorry for being a bit sarcastic. I couldn't resist. But I have good reasons to chide. One thing I have to admit is the manufacturers of the leading penetrating epoxies are masters of marketing. I'm not going to name names, but it's not too hard to understand if someone believes them when they say "Our Penetrating Epoxy is made from wood products and so it's more compatible with wood" or "Our penetrating epoxy is a 'high solids' epoxy." As ol' P.T. Barnum said, "There's a sucker born every minute."

A quick look at the SDS (Safety Data Sheet) of a penetrating epoxy reveals all you need to know—if you're a chemist. I happen to be a chemist and here's what I found.

## A look at Penetrating EPOXY A

One of the bestselling penetrating epoxies, which I'll call EPOXY A, is fully 69% solvents. That means just 31% of this product is made up of epoxy resin and amine hardener. EPOXY A's resin and hardener come from typical chemical sources: NANYA, Olin or any number of worldwide manufacturers. But EPOXY A doesn't list any of the standard epoxy components like Bis-A resin,

polyamines or nonyl phenol. All they list are the minimum ingredients of hazardous solvents, as required to meet government regulations. The Volatile Organic Content (VOC) is 675 g/ltr, which exceeds the legal VOC limits anywhere in the US. It is possible to legally sell the product because of the first ingredient on the hazardous list, mysteriously called "aromatic hydrocarbon 64742-95-6." We know how to identify compounds like this by their CAS (Chemical Abstract Service) number. It turns out that mysterious "aromatic hydrocarbon" is #1 Naptha, commonly known as white gas or Coleman® fuel. #1 Naptha is an exempted solvent. EPOXY A includes enough in its formulation to make it legal to sell in the in the U.S.

Aromatic naphthas are made from coal and coal tars, which come from wood, so there's a grain of misleading truth in the claim that their penetrating epoxy is made from "natural and earth-friendly" sources. The problem is the "natural" or "wood derived" part of EPOXY A is from solvents like Naptha and isopropyl alcohol, not the epoxy portion as implied.

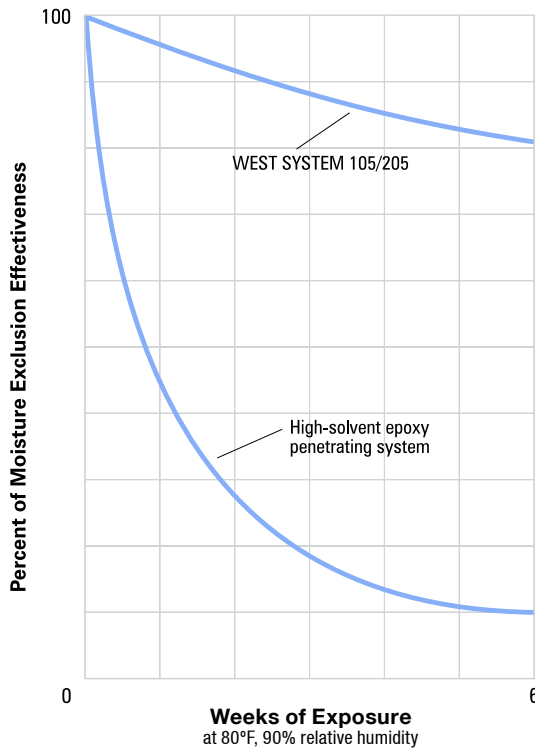
Naptha penetrates wood cells easily. Unfortunately, this solvent also separates from the epoxy so the epoxy does not move into the wood along with the solvent front.

## A look at Penetrating EPOXY B

Now let's look at EPOXY B, a newer "high-solids" penetrating epoxy on the market. The claim "high-solids epoxy" implies two things. First, that the product is not solvented and second, that it's as strong as true high-solids structural adhesive epoxies like WEST SYSTEM and others.

The SDS of EPOXY B is more detailed than that of EPOXY A, but it reveals an epoxy resin and hardener content in only the 40%–60% range. The other ingredients—while not nearly as flammable, toxic or nasty as the solvents in EPOXY A—are considered non-reactive diluents meaning they don't react with the solids in epoxy or become part of the cured epoxy matrix. EPOXY B does not constitute a true high-solids epoxy.

What EPOXY A and EPOXY B have in common is poor moisture exclusion properties. Some of these



solvents have long-chain molecules and since they are non-reactive and/or volatile, they will find their way out of semi-cured and even cured epoxy coatings. This leaves behind “wormholes” which water, with its small H<sub>2</sub>O molecule, can easily penetrate.

While I would expect EPOXY B to be somewhat better at moisture exclusion than EPOXY A, neither can compare to the WEST SYSTEM unsolvent epoxy.

We did a test to compare the moisture exclusion properties of penetrating epoxy and WEST SYSTEM 105/205. The test is done by coating coupons of prepared and dried plywood with 3 coats of 105/205 or high-solvent epoxy (EPOXY A) then measuring the weight gain when exposed to a 80°F/90% relative humidity environment over time. The graph should be understood as follows: The high-solvent epoxy (EPOXY A) coupon gained 90% weight. This is more than four times the amount of moisture absorbed by the 105/205 coupon. Obviously, solvented, penetrating epoxies are not effective moisture barriers at only 10% effective after six weeks of exposure.

### Getting Soaked

What about the epoxy “soaking in” deeper for better adhesion? WEST SYSTEM and other true high-solids, quality epoxies have never relied on so-called deep

penetration to make an effective bond. Our products provide strong, effective bonding and moisture-resistant coating that keeps the wood’s moisture content stable. Dry wood is strong wood. The basis of our philosophy is that wood makes an excellent structural engineering fiber when it’s kept dry. We have 47 years of history to back this up. A prime example is Meade Gougeon’s 35’ trimaran *Adagio*, launched in 1970. *Adagio* is arguably the oldest wood/epoxy structure on the planet, and not a drop of penetrating epoxy was used in her construction or maintenance. The important thing to remember is this—to create an effective moisture barrier the epoxy does not need to penetrate deep into the wood. WEST SYSTEM Epoxy, as well as other full solids epoxy adhesives, penetrate deep enough to force wood failure in both tensile adhesion and shear stress tests.

### Maximum Penetration

Over the years we’ve learned a couple techniques to get maximum penetration using standard WEST SYSTEM resin and hardeners. The first is to simply use the 209 Extra Slow Hardener—the longer open time of 3-4 hours as opposed to 90–110 minutes for 206 Slow Hardener allows the epoxy to soak in more.

Another way to maximize penetration into wood is to heat the wood first. Get it a good 30–35°F hotter than ambient temperature with a heat lamp or heat gun. As the wood heats up, the air inside the wood cells expands and escapes. This is called outgassing. So heat the wood and mix your epoxy. When the wood gets to temperature, remove the heat source and apply the epoxy to the cooling wood. Two things happen: when the epoxy hits the hot surface its viscosity drops. Then, as the wood cools, the air in the cells contracts pulling the thin, warmed epoxy with it. Keep in mind, heating the epoxy will shorten the open time.


### Comparison Test

I did some comparison testing of EPOXY A and WEST SYSTEM, adding various solvents to WEST SYSTEM 105/206 at 5% by weight. I used clear Douglas fir blocks at 3/8", 5/8" and 7/8" thick, cut from the same board with the grain running through the thickness, like end grain balsa. I weighed 10g of mixed product and applied it to the tops of the blocks. The blocks were set on pieces of plywood while the epoxy migrated through the block and into the plywood before curing. All of this was done at room temperature (~72°F).

To the left we see EPOXY A and WEST SYSTEM 105/206. First, we see the shiny coating of 105/206 on top vs. the dull top of the EPOXY A blocks. In the test result table on the right, the bottom of the EPOXY A blocks look just like the tops for the most part vs. the bottoms of the 105/206 blocks with dots of epoxy that made it through to the end



The shiny coating of 105/206 on top vs. the dull top of the EPOXY A.

Epoxy	Block Height / View of Bond Failure			Cured Adhesion Strength
	3/8"	5/8"	7/8"	
<b>Penetrating EPOXY A</b>				lifted off the plywood easily—bond failure
<b>WEST SYSTEM 105/206</b>				tapped off with a hammer—plywood failure
<b>WEST SYSTEM 105/206 Thinned with 5% Solvent</b>				
<b>2333N</b>				tapped off with a hammer—bond failure
<b>Denatured Alcohol</b>				tapped off with a hammer—bond failure
<b>Lacquer Thinner</b>				tapped off with a hammer—bond failure
<b>Acetone</b>				tapped off with a hammer—bond failure

grain. This might lead one to think the EPOXY A really did penetrate deeper into the wood. But does it? Despite appearances, the EPOXY A blocks lifted off the plywood easily—no adhesion at all. Had any epoxy solids made it through, it should have bonded somewhat to the plywood. But it did not.

On the 105/206 blocks, even though it looks like less epoxy made it through, enough came through to force wood failure (rather than glue line failure) of the plywood it sat on. These samples had to be tapped off with a hammer.

These results support my long-held theory that in so-called penetrating epoxies with a high solvent content the epoxy portion does not move through the wood with the solvents. My theory is further supported by the fact that none of the solvented examples of WEST SYSTEM 105/206

failed the plywood base like the unadulterated WEST SYSTEM. They had to be tapped with a hammer, indicating some of the epoxy moved with the solvent front, but not enough epoxy to fail the plywood surface. Keep in mind, this happens with only 5% solvent added to WEST SYSTEM 105/206 while EPOXY A is 70% solvent and EPOXY B is at least 40% diluent and could be as high as 60%.

As you can see, the wet or stained areas appear pretty large in the WEST SYSTEM samples. But again, not enough structural high-solids epoxy penetrated through these blocks to glue them to the plywood.

In conclusion, only the unsolvented WEST SYSTEM 105/206 was strong enough to cause the plywood base to fail. I toss the question back to those who support the notion that penetrating epoxies are the cat's pajamas. Cats don't really wear pajamas, do they?

# Epoxied Porch Columns and Railings

By Tom Pawlak



*The railing after 15 years...and still going strong.*

About 15 years ago we did a major exterior facelift on our home. A large component of the facelift was a new covered front porch. It was fun to see the new look take shape as the eaves were extended and the porch roof installed.

When the contractor started installing large 8" square posts to support the new porch roof, I immediately disliked their bulkiness and clunky appearance. A few days earlier while on vacation, we had stopped at a lumber yard during a rainstorm and saw three beautiful, round, hollow

wooden columns that would be perfect on our new porch. I made the 140-mile round trip to purchase them.

The next day, I coated the outside and the inside (including end grain) with 105 Resin and 206 Slow Hardener. I applied a second coat on the outside and end grain and three hours later I applied a fast-dry primer called Cover Stain Primer-Sealer (made by Zinsser) over the partially cured (rubbery) epoxy. I had used this primer in a similar manner previously in a test that performed well on my old porch railing so I was confident that it would work on the new wood columns as well. The following morning I sanded away any raised wood grain and quickly applied another coat of Cover Stain Primer-Sealer. An hour later it was ready for the top coat of house paint.

Once the columns were installed, I measured the distance between columns for the new porch railing that I intended to build. The railings and spindles were constructed from well dried re-sawn



*A spindle after two coats of 105/206, one coat of primer and sanded.*





*The handrail with end grain coated.*

common 2x8 and 2x10 construction-grade lumber. I felt comfortable using this low-cost lumber because I would be cutting around large knots and sealing all the wood in a couple coats of epoxy. This would stabilize the wood's moisture content, minimize the potential for warping and twisting, and protect against rot.

The spindles ended up being 1½" x 1½" in cross section with the four edges each fluted with a ⅜" inside radius router bit. I was surprised at how this simple edge detail significantly dressed up the appearance of the spindles.

I made an assembly jig that was laid out on a 4'x8' sheet of OSB (oriented strand board) covered in plastic to hold the spindles at the correct distance apart. Temporary blocking held in place with drywall screws allowed the rail top, rail bottom and spindles to be accurately positioned to keep the spindles square to the rails and equally spaced for gluing. The bottom of the top rail and the top of the bottom rail featured a 1½" wide x ¼" deep dado that the spindles and spacer pieces were glued into with the epoxy. There are no fasteners in the railing sections other than a few brad nails to hold the small wood fill pieces between the spindles while the epoxy cured.

Where the railings tied into the columns, I used a saber saw to cut a slight concave radius that matched the curve of the round column it would be attached to. The ends of the top and bottom rail were sealed with two coats of epoxy then held in place with a couple of stainless steel deck screws.

Well, 15 years later I can attest to the benefits of coating and sealing the wood with epoxy prior to painting. Last year I repainted the columns and railings for the first time. I repainted only because I had taken chunks of wood out with my snow shovel and wanted it to appear uniform rather than looking touched up where the snow shovel had damaged it.

I recently found a section of top rail and a few leftover spindles in my garage rafters. I've dry assembled them so you can see how they were put together. Everything was glued with old WEST SYSTEM Epoxy left over from previous jobs.



*Small wood fill pieces were placed between the spindles to maintain even spacing.*

One other detail worth mentioning is I made sure the top and bottom of the wood columns were vented.

To keep bees and wasps from taking up residence inside the columns, I used G/5 Five-Minute Adhesive thickened with 403 Microfibers to glue a layer of fiberglass window screen at the top and bottom of each column.

In retrospect, I can say it was well worth the time and effort to glue and seal all the common lumber pieces with leftover WEST SYSTEM Epoxy. There was not the slightest incidence of cracking or peeling paint in any of the columns or sections of railing after more than fifteen years of exposure.



*The freshly repainted railing with its decorative fluted spindles.*

# Bubble-Free Casting in Knotholes and Cracks

By Don Gutzmer

Customers often ask us to recommend a WEST SYSTEM product for filling cracks and knotholes in wood. The best choice is 105 Resin and 207 Special Clear Hardener. Used properly, this product combination produces a strong, transparent casting. I will use large logs with huge voids to demonstrate the best practices for achieving a clear, bubble-free casting with 105/207.

## Dam the cracks

The first step is damming the cracks and voids; I used multiple layers of duct tape. This will contain the epoxy in the log's cavity. Take your time to make sure the cavity is well sealed. Speaking from experience, it's a real pain to see your epoxy dripping on the floor as you rush around trying to seal an area now coated with wet epoxy.

To seal a crack or knothole in the wood, you can use duct tape or just about anything that is flexible enough to cover the crack, hold the wet epoxy in, will stay put when exposed to wet epoxy, and can be removed after the epoxy cures.

## Coat the casting surfaces

Unsealed grain may trap air bubbles along the edges of the wood. Wood can also "outgas" or release gasses as it warms, creating bubbles that get trapped in the epoxy. To prevent this, brush one or two thin coats of epoxy onto the wood's surfaces. Don't coat any higher than you plan to cast within

*Multiple layers of duct tape are used to contain the epoxy in the log's cavity.*





Brush one or two thin coats of epoxy onto the wood's surfaces and allow it to cure about 6 hours. To avoid sanding, don't coat higher than you plan to pour over the next 18 hours.



Pouring epoxy onto a mixing stick directs the epoxy into the bottom of the cavity.

18 hours of this seal coat's cure, unless you don't mind sanding the seal coat between coating and casting.

Allow the seal coat to cure for about 6 hours, or until gelation.

### Preventing uncontrolled exotherm

As epoxy cures, it generates heat due to an exothermic chemical reaction. (See Controlling Exotherm in *Epoxyworks* 39.) A mass of uncured epoxy can quickly get out of control, smoking, bubbling, and spoiling your project. Even if it doesn't get completely out of hand, excess heat can discolor the epoxy.

To reduce the amount of heat the epoxy can generate, plan on pouring multiple thin layers of epoxy at about 1/4" deep per pour and allowing the epoxy ample time to set up between pours. For narrower cracks (1/4" wide or less), you can pour the epoxy to 1/2"-3/4" deep per pour because this smaller amount of epoxy shouldn't overheat.

Consider the temperature of your work area when deciding how deep to pour. At warmer ambient temperatures, the epoxy will cure faster and generate more heat. Limit the depth of each pour, especially when working in warm conditions.

*A stir stick marked at 1/4" will make it easier to measure the depth of your pour.*



Before pouring, be sure the piece of wood is level so that the epoxy casting depth will be uniform and won't build up a heat-generating epoxy mass on one side.

### Minimizing bubbles

To minimize the bubbles introduced while mixing the resin and hardener, keep your stir stick against the bottom of the mixing pot. Mix thoroughly for one minute, but don't lift the stir stick as you scrape the bottom and sides of the pot. To remove any air bubbles after mixing, pour the epoxy onto the slope of a roller pan and quickly pass a propane torch flame over the epoxy as it runs to the bottom of the pan. Pour the bubble-free epoxy from the corner of the pan into the prepared crack or void. To direct epoxy into the bottom of the cavity, pour it along the mixing stick.

### Colored castings

The epoxy can be tinted with pigments or dyes. At a 2% loading by weight, most dyes, tints, and liquid pigments have little or no effect on the bonding strength or hardness of our cured epoxy systems. See "Adding Pigments to Epoxy" in *Epoxyworks* 21 for details.

### Control pour depth

It can be hard to judge a 1/4" depth by looking into a 3" cavity. To prevent pouring too deeply, mark a stir stick at 1/4" and use it to measure each pour. Let the epoxy run down the stir stick to direct the material into the cavity.

### Remove bubbles from poured epoxy before cure

A handheld propane torch can be used to break the epoxy's surface tension and help remove air bubbles. First, give the poured epoxy a couple of minutes to self-level. The bubbles should rise to the surface. Then move the heat source rapidly over the area (at roughly one foot per second) to avoid



Bubbles rise to the surface of epoxy following a pour. Using a propane torch you can break the epoxy's surface tension, removing air bubbles. Using the multiple pour technique, the result is a 3½" deep casting of 105/207, free of bubbles.

overheating the epoxy. You don't want the heat source to make the epoxy gel or smoke.

### Minimize the need for sanding

To avoid sanding between pours, make your next pour 3 to 12 hours after the previous pour (when working in temperatures of 70°F-75°F or 21°C-24°C). Adjust these times per the cure-time/temperature guide on the hardener container.

### Final finishing

For best clarity, allow the final epoxy pour to cure for 24 hours before sanding. The epoxy should sand to a dust. 105/207 is compatible with many varnishes and polyurethanes. If your casting project will be exposed to sunlight, you'll want to add the UV protection of a good varnish or 2-part polyurethane topcoat.

After many pours over multiple days, I'd filled cracks ranging from 3.5" to 7" deep in my logs with clear epoxy. With the proper techniques, WEST SYSTEM 105 Resin and 207 Special Clear Hardener is a great option for clear epoxy casting.

Surface of the log coated with 105/207



Reader Eric MacKeigan is a scroll cut artist. He cuts his signs on a scroll saw and then uses WEST SYSTEM Epoxy dyed with a little food coloring to fill the voids and create works of art. More of his work can be found at [fretwoodmack.com](http://fretwoodmack.com).

# Large Wooden Vessel Repair

By Tom Pawlak

In the spring of 2016, several US Coast Guard vessel inspection officers from the east coast attended our 2-day Professional Fiberglass Boat Repair Workshop. Afterward, they asked if we would consider creating a document that they could hand out to commercial boat owners, captains and vessel reps that would provide guidelines for proper use of WEST SYSTEM products for repairing and maintaining larger wooden vessels subject to Coast Guard inspections. They were having an increasingly difficult time because a number of commercial boat operators were repairing their own vessels using techniques that caused concern. The reasons given for using these questionable procedures vary from trying to save some money to the short supply of qualified wooden vessel shipwrights who could complete work in a reasonable amount of time. To make their case that their repairs were appropriate, some operators handed the Coast Guard Inspection Officers the WEST SYSTEM *Wooden Boat Restoration & Repair* manual. Unfortunately, some were cherry picking information and techniques intended for repairing smaller recreational wooden craft, and not following all of the recommended procedures for avoiding problems.

The Coast Guard showed us pictures of some of the questionable repairs and asked for our thoughts and guidance. They were trying to work with the vessel owners to keep costs in check, but not at the expense of human safety.

The Navigation and Vessel Inspection Circular (NAVIC) document, which the Coast Guard is obligated to enforce, allows for temporary repairs that can eventually be approved as permanent if the repair remains viable and strong after multiple scheduled inspections. We agreed to collaborate with the Coast Guard to develop guidelines for using WEST SYSTEM Epoxy products for permanent repairs on wooden vessels larger than 40'.

We consider it a work in progress.

---

## WEST SYSTEM, Inc. Best Practices for Application on USCG Inspected Wooden Vessels

---

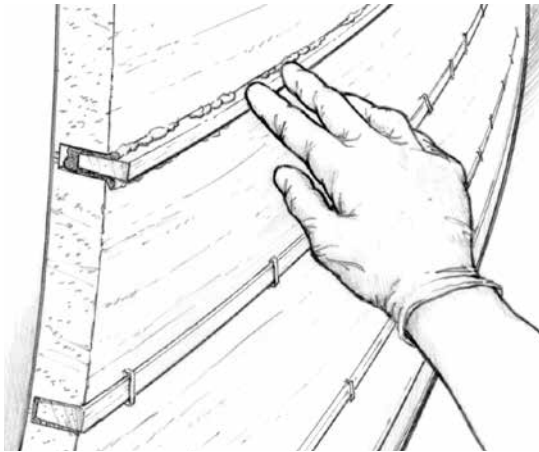
### Introduction

- WEST SYSTEM Epoxy is a versatile, two-part, marine-grade epoxy that bonds and coats fiberglass, wood, metal, fabrics and other composite materials to provide superior strength and moisture resistance. WEST SYSTEM also provides extensive instructional materials that include the 002-970 *Wooden Boat Restoration and Repair Manual*, which is often used by commercial vessel operators.
- The WEST SYSTEM *Wooden Boat Restoration and Repair Manual* is intended to offer repair methodology for wooden vessels designed for recreation and racing. These vessels have thinner planking and lighter framing than vessels designed for commercial use. The heavier construction of commercial vessels and the long duration between haul outs



*Gflex is a toughened, versatile epoxy that is a bit more flexible than standard epoxies but stiff enough to make structural bonds that can absorb the stress of expansion, contraction, shock, and vibration.*

Gluing in a wooden spline. Illustration from the WEST SYSTEM Wooden Boat Restoration and Repair Manual.



results in structures that have higher moisture content and more movement due to moisture content changes. In addition, shipwrights who are skilled in recreational vessel repair may not fully understand the loads and stresses on a heavier built commercial vessel.

### Achieving Maximum Adhesion Strength

- The moisture content of wood needs to be within 8%–12% for best adhesion when using WEST SYSTEM Epoxy 105 Resin/20x Hardener. If the moisture content is between 12%–18% use WEST SYSTEM G/flex® Epoxy.
- G/flex Epoxy is a two-part toughened system that is more flexible than 105 Resin-based epoxy. G/flex is available in two formulations, 655 Thickened Epoxy Adhesive and 650 Toughened Epoxy (which is a liquid version). It is recommended as an adhesive when working with a traditionally constructed wooden vessel below the waterline. G/flex Epoxy is also well-suited for repairing planking or interior structure that is greater than ½ inch in thickness. G/flex Epoxy is a tough/high elongation epoxy adhesive and should be considered for all bonding/gluing applications.
- To get the best adhesion, wood should be sanded with 60–100 grit aluminum oxide sandpaper; hardwoods benefit from course sandpaper (40–60 grit). Avoid using tack rags and anti-clog sandpaper as they can contaminate the surface and interfere with adhesion.
- Oily woods and white oak benefit from 70%–91% isopropyl alcohol wipe, using a wipe on/wipe off approach with paper towels.
- When using WEST SYSTEM 105 Resin-based epoxy as an adhesive for bonding, it is advised

to pre-coat all bonding surfaces with neat (un-thickened resin and hardener mixture) epoxy prior to applying epoxy thickened with high-density filler to bridge gaps.

- Thinning WEST SYSTEM Epoxy with solvent is not recommended because this significantly reduces strength and moisture exclusion effectiveness. (See “Penetrating Epoxy—Legend or Myth” on page 11 of this issue).
- All WEST SYSTEM Epoxies are compatible wet on wet. After it cures, clean with water and an abrasive pad, then sand the epoxy dull to get good adhesion.

### Considerations when Applying Sheathing

- Sheathing should be considered only if planks are dried and edge-glued together.
- For wooden vessels over 40 feet, we strongly recommends consulting a naval architect when sheathing the hull.
- WEST SYSTEM Epoxy is not recommended as a coating on a traditionally built wooden vessel in a bilge area that is designed to swell. The danger is trapping moisture in the planking, stringers, floors, and frames leading to potential rot/decay. Only vessels that are edge-glued together, sealed on the outside with epoxy and planks epoxied to frames (cold molded construction) can be coated on the interior. All other traditionally built vessel interiors should not be sealed with epoxy.
- When fiberglass sheathing is used on a wooden hull with edge-glued and sealed planks, a +45° fiber orientation will better accommodate potential wood movement. The fiberglass provides chafe protection and hull reinforcement.
- When multiple layers of fiberglass fabric are required, it is good practice to stagger the seams and edges from layer to layer by at least 1 inch.

### Seam Concerns

- Significant gaps in planking, stems or transoms may indicate poor connections to hull framing that may require refastening. The techniques listed in this document do not address these concerns.
- WEST SYSTEM Epoxy should not be considered a seam compound (i.e. rope caulk and oakum, or 3M 5200 marine sealant). Epoxy can be

used to reduce the overall gap between planks by making a spline (a long and narrow piece of wood) of the same wood species then gluing the spline to the edge of the plank with G/flex 655, effectively widening the plank and reducing the gap. A conventional gap should be left alongside the plank to facilitate/accommodate rope caulk and seam compound.

- If a temporary fiberglass wrap is desired to strengthen or reinforce plank ends at the stem or transom, the plank ends and edges should be reefed and filled ahead of time with G/flex 655 Epoxy or, if the gap is greater than ½ inch, with wood splines glued in with G/flex 655.
- Fiberglass sheathing can be applied over splined planks that are sealed with epoxy. Fiberglass fabric is ideally positioned at +-45° fiber orientation to decrease stiffness and allow more movement. The fiberglass may provide adequate reinforcement for temporary and possibly long-term repair as long as fiberglass buildup is thick enough, extends back onto the planks at least 10–12 inches from plank ends and extends onto and wraps around the stem timber. Each fiberglass layer should be an inch or two back from the previous layer to create a gentle transition.
- G/flex 650 can be used to wet-out light fiberglass fabrics (12 oz. / sq.ft. or less per layer) to decrease stiffness and allow more movement.
- WEST SYSTEM 105 Resin/20x Hardener can be applied over partially cured G/flex Epoxy as long as the epoxy is still tacky (like masking tape) to create a chemical bond between the two epoxies. This approach might be used to wet-out heavy fiberglass cloth with a low-viscosity epoxy (for faster wet-out of the fabric) after G/flex is initially applied to the wood for its superior toughness and flexibility.
- If WEST SYSTEM 105 Resin/20x Hardener have been used previously and have cracked at or near an epoxy joint, repair with G/flex Epoxy.
- If heavier fabrics (more than 12 oz./sq.ft.) are used, the 105 Resin-based epoxy is required to wet them out properly.

#### Additional Guidelines for Scarfs

- See the WEST SYSTEM *Wooden Boat Restoration and Repair Manual* for an overview on scarfing.
- WEST SYSTEM recommends a minimum 12:1 bevel ratio for most wood repairs below the

waterline, along with using a screw and G/flex Epoxy glue approach.

- When fitting graving pieces or a Dutchman the glue line should not exceed a ½ inch thickness of epoxy to bridge the gaps.

#### Fairing Compound Application

- Epoxy based fairing compound can be used over stable pieces of wood that have been epoxy coated. The epoxy coating acts as a sealer/primer allowing the fairing compound to adhere well.
- Using epoxy fairing compounds on traditionally constructed wooden vessels will prevent the wood from absorbing moisture and swelling to tighten the seam.

#### Rotted Wood

- Maximum of a ½ inch thickness of epoxy should be used to consolidate rotted wood.
- For applications greater than ½ inch use a Dutchman. See the previous section “Additional Guidelines for Scarfs.”
- Excavate the rotted area. Dry the wood and use a wire brush parallel to the grain to remove remaining punky wood prior to applying liquid resin and hardener mixture.



*Thunderbird is a wooden boat restored with WEST SYSTEM Epoxy.*



# Hot Canary Becomes Vivacious

By Alex Boelkins

For readers of *Epoxyworks*, the name *Hot Canary* should ring a bell. Constructed in 2011 by an employee team at Gougeon Brothers, Inc., she was built as a winning platform for the Everglades Challenge. Having completed several of these self-supported, expedition races, and with the sad passing of Jan Gougeon, the highly customized

i550 *Hot Canary* was listed for sale, ready for new adventures.

My wife Rachel and I had been searching for the “perfect” first boat since early 2016. Along the way, I discovered and fell in love with the i550, but had always told my wife to never, ever let me build a boat. After watching the time lapse of one being built (coincidentally, it was *Hot Canary*), I actually needed very little convincing to not build one. So now what? Well, the next step seemed

clear after I discovered that the venerable *Hot Canary* was actually for sale.

Logistically, purchasing *Hot Canary* didn’t make a ton of sense. She was languishing under the Florida sun and had been listed for nearly a year. Something was probably wrong with her, and even if she was in great shape, how would we get her back to Michigan? Figuring we would sort out these details later, we wrote a heartfelt, personal letter to Meade Gougeon, and made an offer on the boat. Amazingly, he accepted and we suddenly found ourselves the new owners of a ridiculously awesome little boat.

I flew down for a quick survey (which I performed) and prepared the boat for the 1,300-mile journey. Using an eBay®-like website called uShip™, we arranged for a truck to trailer her north. I breathed a huge sigh of relief when I saw her pale yellow hull being backed into our driveway. She had made it back to her Michigan roots.

Having arrived in October, we had time for a single test sail on a blustery fall day in Muskegon, Michigan. Our death roll under spinnaker proved that the boat had a steep learning curve, but we

*Vivacious in its former life as Hot Canary with Jan Gougeon at the helm.*







*Vivacious on a camp-cruising trip through the North Channel.*

were head over heels for this little sportboat. To make the boat our own, we committed to an off-season refit with fresh paint and new non-skid.

We had some great warehouse space available, so the boat was moved there. The first step was to remove all of the deck hardware so it would be easy to sand. Having been built by the gurus at Gougeon Brothers, everything was bedded in epoxy, so a soldering gun was used to heat the fasteners and break the tenacious bond. The four stanchion bases were especially hard to break free, but we eventually had all of the hardware removed, bagged, and labeled. Numerous photos were taken so we could remember how it went back together.

At some point in her illustrious racing career, *Hot Canary* had taken a pounding on a Florida beach, so we began by filling and fairing dozens of small chips in the deck and hull.

Taking advantage of several sunny spring days, we moved the boat outside and sanded her down. What a loud, messy job. The non-skid was removed with 60-grit paper and the entire hull was sanded with 150-grit. Back indoors, we flipped the boat over so we could sand the bottom.

We removed the old bottom paint using a random orbital sander and 80-grit, then filled various dings with WEST SYSTEM Six10 Thickened Epoxy Adhesive. It was a little harder to fair, but I felt more confident with the WEST SYSTEM product below the waterline. With the boat completely sanded, faired, and wiped down, it was finally time to paint.



She was previously painted with Interlux® Perfection®, but in order to save some money, we decided to coat her with Interlux Brightsides®. I had read good things about the ease of application, and it was about half the price of Perfection. (Hindsight being 20-20, it was a mistake to be cheap on painting supplies when we invested so much time in the preparation). The technical folks at Interlux said we could paint directly over the old Perfection finish, so we rolled and tipped on Brightsides paint with acceptable results. With one person rolling and the other brushing, Rachel and I could add a coat of paint in about an hour. We discovered that our felt rollers were leaving hairs behind, so we switched to cabinet style foam rollers with much better results. Sanding between coats, we built up a quality finish in a lovely color called Ocean Blue. Four coats required two quarts of paint.

With the beautiful blue hull complete, we taped the waterline and painted the bottom with “environmentally friendly” Pettit® Hydrocoat™. Simply rolling on the bottom paint yielded a surprisingly good finish. At this point, we started to see the rewards of all the sanding and prep

*Enjoying a sunny spring day while preparing the boat for paint.*



The first coat of blue hull paint in the transformation from Hot Canary to Vivacious.

work. Finally ready to paint the rest of the boat, we carefully flipped her back over. A couple of forklifts made this precarious job easier.

The entire deck was coated in Interlux PreKote® primer to ensure that these high-use areas would be especially durable. I always thought gray non-skid and white cabin tops looked classy, so that is what we decided on. We painted the white areas first so we could then overlap the gray non-skid. This allowed us to tape the non-skid areas only once. Three coats of white Brightsides paint were applied, with sanding between each coat.

Taping the non-skid areas on the deck and in the cockpit was time-consuming, but the radiused corners added a custom touch. To keep things simple, we used different tape widths to offset the edges. While our first coat of gray was still wet, we used a salt shaker to apply the Pettit® Specialty 9900 Skidless Compound (basically, a fine silica). It took a bit of practice to apply this consistently, but it worked well enough. Returning the following day, I realized we were going to have a very aggressive non-skid unless we built up some more layers of paint. Interlux Brightsides is a high-gloss polyurethane paint, and when combined with the non-skid, it really highlighted the inconsistencies of the silica application. Somebody suggested adding a flattening

Non-skid painted and deck hardware reinstalled.



With the hull painted, it was time to roll the boat over and paint the rest of the boat.

agent, so the next two coats were significantly flattened. This proved to be a great solution.

Finally seeing the light at the end of the refit tunnel, we bribed some friends with pizza and beer to help us reinstall the deck hardware. Once again, the Six10 Epoxy came in handy as we mixed small batches on a piece of cardboard and went around bedding the new fasteners. The *Gougeon Brothers on Boat Construction* book provided great instruction for these steps. Just for the heck of it, we used a pallet jack scale to weigh the empty hull. She tipped the scale at only 471 lbs. With the 180 lb keel, rudder, and running/standing rigging, that put the complete boat at a little over 700 lbs. Class displacement is 800 lbs, so the Gougeon team definitely did something right.

The final step in our refit was to paint the keel and rudder “distress orange.” I’ve always liked the look of bright foils, and it would be a good safety feature if we ever capsized.

In honor of her spirited and lively manner, we renamed her *Vivacious*, although we affectionately call her *Viv* for short. She has already proved herself on an 8-day camp-cruising trip through the North Channel. And we intend to explore Beaver Island this summer, and enjoy some fast, downwind sails on Lake Michigan.

Even with her new name and colors, we are amazed by the number of people who recognize and know her as *Hot Canary*. We’re honored and excited to be a part of this boat’s story, and we look forward to the coming years of small boat adventures.



For information about WEST SYSTEM® products or technical information for a building or repair project, Gougeon Brothers offers a range of detailed publications that can help you get started. These publications are available at your local WEST SYSTEM dealer or by contacting Gougeon Brothers. They are also available as **free downloadable PDFs at westsystem.com.**

### Free literature (US and Canada only)

Visit westsystem.com to order online or call 866-937-8797 for the WEST SYSTEM free literature pack. It includes:

**002-950 WEST SYSTEM User Manual & Product Guide**—The primary guide to safety, handling and the basic techniques of epoxy use. Includes a complete description of all WEST SYSTEM products.

**000-425 Other Uses—Suggestions for Household Repair**—Repairs and restoration in an architectural environment. Many useful tips for solving problems around your house and shop with epoxy.

Also included are the current price list and stocking dealer directory.

### How-to publications

For sale at WEST SYSTEM dealers, free downloadable pdfs on westsystem.com or by calling our order department, 866-937-8797.

**002 The Gougeon Brothers on Boat Construction**—A must for anyone building a wooden boat or working with wood and WEST SYSTEM Epoxy. Fully illustrated composite construction techniques, materials, lofting, safety and tools. 5th Edition, revised in 2005.

**002-970 Wooden Boat Restoration & Repair**—Illustrated guide to restore the structure, improve the appearance, reduce the maintenance and prolong the life of wooden boats with WEST SYSTEM Epoxy. Includes dry rot repair, structural framework repair, hull and deck planking repair, and hardware installation with epoxy.

**002-550 Fiberglass Boat Repair & Maintenance**—Illustrated guide to repair fiberglass boats with WEST SYSTEM Epoxy. Procedures for structural reinforcement, deck and hull repair, hardware installation, keel repair and teak deck installation. Also, procedures for gelcoat blister diagnosis, prevention and repair and final fairing and finishing.

**002-898 WEST SYSTEM Epoxy How-To DVD**—Basic epoxy application techniques, fiberglass boat repair and gelcoat blister repair in one DVD.

## Contacts for WEST SYSTEM product and technical information

### North and South America, China and Korea

GOUGEON BROTHERS, INC.  
P.O. Box 908  
Bay City, MI 48707  
westsystem.com  
Phone: 866-937-8797 or 989-684-7286  
Technical Services/Health & Safety  
Phone: 866-937-8797 or 989-684-7286  
Order Department  
Phone: 866-937-8797 or 989-684-7286

### Europe, Russia, Africa, the Middle East and India

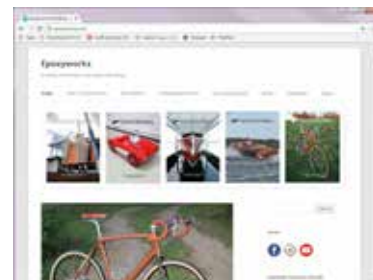
WESEX RESINS & ADHESIVES LTD  
Cupernham House, Cupernham Lane  
Romsey, England SO51 7LF  
wessex-resins.com  
Phone: 44-1-794-521-111  
E-mail: info@wessex-resins.com

### Australia and Southeast Asia

ATL COMPOSITES Pty. Ltd.  
P.O. Box 2349/Southport 4215  
Queensland, Australia  
atlcomposites.com  
Phone: 61-755-63-1222  
E-mail: info@atlcomposites.com

### New Zealand and Southeast Asia

ADHESIVE TECHNOLOGIES LTD.  
17 Corbans Ave./Box 21-169  
Henderson, Auckland, New Zealand  
adhesivetechologies.co.nz  
Phone: 64-9-838-6961  
E-mail: enquires@adhesivetechologies.co.nz



### Look for Epoxyworks online

If you are a new subscriber to *Epoxyworks* or haven't diligently saved every issue in a three-ring binder, you can find back issues of *Epoxyworks* at epoxyworks.com. You can also click on the "Epoxyworks" logo on the westsystem.com homepage.



# Michael A. Barnard

1987-2017

*Mike, beaming ear to ear, after his first week on the job as a Gougeon Technical Advisor.*

The family of Employee Owners at Gougeon Brothers Incorporated lost Technical Advisor Mike Barnard, who passed away on 7/28/17. Our customers who had the opportunity to work with Mike will know that we lost an incredibly friendly, educated, and patient young man. I had the wonderful opportunity to be Mike's manager for over 6 years, and hoped to keep him challenged until I retired. But fate took our favorite Eagle Scout well before we should have had to say good bye.

We recruited Mike from Winona State University in 2011. Mike would be quick to point out that this college had the only accredited Composite Material Engineering degree in the country. He was proud of his alma mater, home state of Minnesota, and even the Vikings when they (often) lost. Mike viewed his career as a material engineer as a family legacy. His grandfather worked with wood, his father worked with metals, and Mike chose a career in advanced composite materials.

We knew he was our guy when, during his interview, he explained that when he worked at a Target store as a sales associate in college, his favorite part of the job was "helping people find what they needed." His composites degree and a helpful attitude guaranteed that Gougeon Brother's outstanding technical service would continue for another generation. We and our customers were not disappointed. Mike quickly learned both of our product lines (WEST SYSTEM and PRO-SET) and could easily support our retail customers and advanced commercial users. Countless boat builders, DIY retail customers, and professional material engineers were supported by Mike and I am confident he contributed to the success of their projects. He even earned the American Composite Manufacturers

Association's Certified Composite Technician certification on his first try. Mike performed testing that was specific to the United States Navy's need to repair cracked aluminum deck plates; laminate testing for aircraft certification; and unique applications for submersibles, along with so much more. He performed work that was advancing the use of composites and he was not even 30 years old. Our industry lost a young engineer who would have developed the use of advanced materials. We will never know what notable improvements he could have made or problems he may have solved, but I know I hoped to have been his manager when it happened and would have enjoyed seeing his humble pride glow.

The only challenge when managing Mike was matching his enthusiasm and passion for innovation. His desire for continued learning is evident in his many EPOXYWORKS articles, in particular his article on how to earn the Boy Scouts Composites Material Merit Badge. Mike always had an idea for a new product, testing procedure, or customer service improvement. Mike's desire to grow and better our company was only matched by his respect for our senior staff's experience. It does not get much easier for a manager than having someone like Mike on your team.

By the time this is published, our hearts will have begun to mend and we will have continued supporting our customers. Although Mike cannot be replaced, we know he would want us to continue his excellent work and to be successful—and we will. For our customers who worked with Mike, just know we miss him enough for you, too.

Thanks Mike. I hope wherever you are, there are materials more advanced than you ever dreamed of and the Vikings win the Super Bowl.

—Jeff Wright  
Technical Director, Gougeon Brothers, Inc.

