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EPOXYWORKS®

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If you have completed an interesting project, or developed a useful technique or found a practical or unusual use for epoxy, tell us and your fellow epoxy users about it.

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Planer Chip Diverter built with G/flex®

By Stephen Clark

Back in the '70's I bought a 10" INCA jointer/planer. It came with a molded plastic chip diverter for use when set up as a planer. Back then, there were no thoughts on the designer's part of attaching a dust collector to the diverter. The diverter simply spewed chips out the front, right onto the work piece being fed through for thicknessing.

A few years later, I got a new dust collector. I cobbled on a section of 3" galvanized duct pipe connecting the diverter to the suction end of my new dust collector. It worked fine until the plastic diverter finally died a couple of months ago.

These INCA tools haven't been available here for decades, yet there are a few remaining sources for parts like the original chip deflector. Unfortunately, they're EXPENSIVE as well as old, and the original plastic doesn't seem to age well. I'd have to find a way to fabricate a new diverter.

I knew I wanted to use clear polycarbonate to build the diverter. I had also recently became aware of G/flex® 655 Thickened Epoxy Adhesive's durability and its great reputation for bonding to many types of plastics. I set about building myself a new chip diverter using those materials.

Planer chip diverter, custom built from polycarbonate and G/flex epoxy.

The diverter assembly would consist of:

1. A tube that would collect the chips and attach to my dust collector.

2. Two guards to help direct the chips into the tube.

3. Two side panels to hold the assembly together.

I started my build with the two side panels. I routed shallow, circular grooves in each piece to hold the collector tube in place. I also routed two slots to hold each of the two flat guard pieces. The guards direct the chip stream into the round collection tube and also serve to provide some added rigidity to the assembly. I then routed a rectangular aperture in the collector tube to allow the chips to enter.

For my initial assembly, I used G/flex to create fillets for joining the polycarbonate pieces. Gougeon's technical articles on G/flex explained the simple preparation needed for dealing with polycarbonate. I merely sanded the surfaces to be epoxied with 80-grit sandpaper before assembling.

Once assembled, it was apparent the aperture in the collection tube wanted to 'close up' from residual stresses in the plastic material. This left a gap between the tube and the guards.

I had recently built a Chesapeake Light Craft Waterlust expedition canoe. Through the process I became proficient in using the stitch'n'glue building technique. I used the 18-gauge copper wire left over from the stitch'n'glue kit to hold that aperture open, bringing the tube flush with the guard pieces. Then I tacked it with G/flex.

Once the G/flex had cured solid, I removed the copper wire and did another fillet over top to fill in any remaining gaps. From here, all that remained was to salvage the two small, steel spring clips that served to hold the previous chip diverter onto the planer's outfeed table to use in the installation of the new diverter.

As you can see, the result speaks for itself!

Scan the QR code to ***check out the diverter in action***.

Amine Blush

By Jeff Wright – GBI VP of Technical Services

It has been several years since we wrote an article about amine blush. We mention amine blush repeatedly in our instructions and related *Epoxyworks* articles, but it is a common question from our customers. A clear, more detailed discussion seemed worthwhile.

What is Amine Blush?

WEST SYSTEM® Epoxy is a two-part system consisting of a resin and hardener. The hardener component has a high percentage of chemicals that can be described as amines. There are many classifications of amines, which our chemists understand in-depth, but what's really important to most epoxy users is understanding how these amine compounds react with moisture and carbon dioxide in the atmosphere, and what we can do to deal with amine blush.

After mixing WEST SYSTEM resin and hardener, there is a time period we call open time. This is when the resin and hardener have not completely reacted. During this time, the hardener molecules (which include amines) that are on the surface are able to react with both the resin and the atmosphere. The carbon dioxide and moisture in the air will react with the amines forming a wax-like film referred to as amine blush. The film does not affect the strength or properties of the cured epoxy because only a very small percentage of the hardener that was exposed to the atmosphere was consumed creating this very thin layer of amine blush. Amine blush is only a concern when there will be additional applications of epoxy, a final finish of paint or varnish will be applied, or when clarity is important. Polyurethane final finishes can be sensitive to amine blush preventing them from drying and blush may cause the cured epoxy to look slightly cloudy. Also, the secondary adhesion of epoxy can be reduced by amine blush.

Amine blush does not always form consistently; it is dependent on the amount of carbon dioxide in the air, ambient temperature, humidity level, and the duration of the cure. The longer the epoxy is uncured the more time amines can react with the carbon dioxide and moisture present in the air. Cooler temperatures and thinner films will be more likely to generate blush. The amount of carbon dioxide can be increased in the air when open flame heating sources such as torpedo-type kerosene heaters are in operation. A damp cool day will generally produce more amine blush than a hot dry day if the same hardener is used and the application is the same thickness.

Removing Amine Blush

It is very easy to remove amine blush because it is water soluble. After the epoxy has cured, a 3M® Scotch Brite™ scrubbing pad and water is the best way to remove amine blush. Strong solvents are not needed or recommended. Simply scrub with water and a Scotch Brite pad and then dry off the water with a white paper towel. This process will result in a surface that is much easier to sand and ensure excellent adhesion of the next epoxy application.

Preventing Amine Blush

Although it is not hard to remove blush there are two easy ways to prevent its formation. One option is to use 207 Special Clear Hardener® which is a non-blushing formulation. We have the word "Clear" in the name because the lack of blush results in a clear finish regardless of the environment. It is strongly recommended to use this hardener with 105 Epoxy Resin® on all brightly finished wooden boat applications or if laminating carbon fiber that will be finished clear over a surface. The other option is to use WEST SYSTEM 879 Release Fabric. This is not a good option for coating applications, but if you are performing a composite repair or other fiberglass work, consider applying a layer of release fabric onto the laminate as a final layer. Once the laminate cures, the release fabric can be pulled which removes any blush that formed on the surface.

Another way to avoid removing blush is to apply additional coats of epoxy or laminates before the previous one has cured. If the previous layer is still tacky, the next application of epoxy will comingle with the previous layer, creating a chemical bond and eliminating the detrimental effects of the amine blush on secondary adhesion.

Amine blush is something to be aware of but is easily dealt with. Just keep water, Scotch Brite pads, and clean white paper towels nearby, and any amine blush that forms can easily be removed.

Patching up Shenanigans

By Ray McCarthy

The 1980 Sunfish, Shenanigans, fully repaired with a fresh coat of paint and new sail.

Previous patch attempts were rough. They needed to be reinforced and ground fair with the hull.

Top deck and hull surface before being painted.

A friend gave me his well-used 1980 Sunfish sailboat, *Stinkin' Tuna*. He and his brother had learned how to turn the boat (tacking) by ricocheting off rocks on Long Island Sound. Over the years they had kept the wreckage floatable with the application of non-hydrodynamic fiberglass patches. Though they made the boat functional, they hindered the boat's performance.

I ground down their patch attempts with a right-angle grinder fitted with a 60-grit flap wheel, so they were more or less flush with the hull. Some of the more poorly patched areas required extra material to be removed to get down to a good solid surface. One of the damaged areas on the chine was so deep that I needed to reinforce the inside of the hull before patching. I applied a layer of 10 oz. fiberglass cloth to the inside, using WEST SYSTEM® 105 Epoxy Resin® and 206 Slow Hardener® to back this hole.

Then it was time to tackle patching the holes from the outside, using 4 oz. fiberglass. On each hole I built up three increasingly larger layers of the 4 oz. fiberglass. Once that had cured, I went back and sanded everything fair and smooth.

I attached a five-foot piece of Sunfish Aluminum Trim (from Sun Fish Direct) to replace the damaged rail, bending the rail as I went.

The top deck and hull surface needed to be refreshed. I painted them with Rust-Oleum® 207000 Marine Coatings Topside Semi-Gloss White paint. Being an Irish American lad, I added the Irish flag stripes and christened the like-new vessel "Shenanigans" according to my wife's suggestion.

I used the damaged original sail as a pattern to cut and sew the new Dacron® sail.

Now that I had a boat, I needed a trailer. I got a free Seadoo® trailer from my niece and stretched it with a piece of three-inch square steel tubing to hold a 14' boat. Holding one boat was not enough. I dreamed of sharing boating fun with my grandkids, nieces, and nephews. I bolted heavy-duty conduit to the trailer creating racks to hold a total of three boats—the Sunfish, a Lincoln canoe, and a Nutshell Pram we made with WEST SYSTEM back in 1998.

The pram made the trailer too tippy for highway speeds on its first voyage, so I traveled the 150 miles to Cape Cod with only the Sunfish and the canoe. Hours of fun ensued, especially after my 13-year-old grandson got the sailing bug. I cannot wait till my 4-year-old nephew is ready to sail.

Lightweight Camper Build for a Pickup Bed

By Paul Butler

As a boat builder and designer, I often look at things and think to myself, "I can build that, only lighter and stronger." That's exactly what happened with my latest project. I needed a new camper that would fit in the bed of my Tacoma pickup truck that would be lightweight and have low windage. I wasn't happy with what I was finding commercially, so I decided to build it, and build it better.

The new camper I designed is for midsize trucks, with lightweight being the number one priority. It weighs 380 pounds empty. This is about one third the weight of most commercial versions, which average around 1,000 pounds empty. The payload on my stock Toyota® Tacoma TRD Sport 4x4 is 1,150 pounds. With a full tank of gas, plus driver, I can add almost 600 lbs and still remain under the gross vehicle weight rating.

To reduce the camper profile and minimize windage, I opted for the interior headroom to be a few inches over five feet. This allows for standing if you bend your neck, but we're mostly sitting in the camper anyway. Due to the light weight and low profile of the camper, we got great gas efficiency on recent trips in Montana. We set the cruise control at 68 mph, with AC on, and we were never under 19 mpg… sometimes we even got as much as 21 mpg.

I built the camper primarily out of 4 and 5.5 mil hardwood ply, which were all sealed with WEST SYSTEM® Epoxy. I put a layer of 6 oz. fiberglass cloth on all of the exterior surfaces, plus 10 oz. fiberglass tape on all of the corners. All of the surfaces are covered with 1 ½" structural foam for insulation.

We carry a Goal Zero® 1500 lithium battery which has an inverter to run 110 appliances, like our hot plate. It also runs fans, powers lighting, recharges phones and computers, etc. Because of the small size of the camper, and insulation boards, we can run a small 110-volt heater for less than five minutes to warm the interior on a chilly morning.

ABOVE:

Paul's prototype camper fit perfectly in the bed of his truck with minimal windage.

BELOW:

The interior affords a lot of space to be outfitted according to the builder's needs.

Scan to see more of Paul's work or visit his website.

We decided to keep our interior layout very simple, but if you wanted to build one yourself, the interior can be tailored to suit individual needs. You could finish it off for solo camping, family use, leave it open for hauling, or have removable modular furniture as needed. Bunks can be on each side or sideways and they can be adjustable or removable. There is space for a child's bunk overhead on each side if desired, with feet extending into the cab-over section. Options abound with a little creativity.

Doors and windows are an individual choice from single or multiple side windows of preferred size and a small or large entry door. We installed a 19 x 19 overhead adjustable marine hatch which provides excellent ventilation with side windows open, and there is still space on the top for two solar panels.

I am still considering developing building plans available for purchase based off of my prototype, but have not yet decided. The new project can be seen on my website, *butlerprojects.com*.

Note: Paul Butler is an avid WEST SYSTEM user and seasoned boat designer/builder. With over 40 years of experience, he has built a legacy of DIY amateur boat construction since his beginnings with his first article published in Popular Science back in 1979. Since then he's published over 200 project articles, three DIY boating books, and built 100+ boat prototypes. Paul's designs range from traditional classics to pioneering ply/epoxy constructs—emphasizing user-friendly plans for amateur builders. Beyond boats, he extends plywood/epoxy techniques to various projects ranging from furniture to houses.

Kite-Foiler Winning with WEST SYSTEM®

By Lorraine Duckworth – ATL Composites

ABOVE:

Australian kite-foiler, Breiana Whitehead, builds her competition boards using WEST SYSTEM Epoxy. She has already been selected by Australia to compete in the 2024 Olympic Games.
Photo: Beau Outteridge

It's a long way from Townsville City, Australia to the 2024 Olympic Games in Paris, France. Australian Olympic kite-foiler, Breiana Whitehead is relying on a collaboration with ATL Composites and WEST SYSTEM Epoxy to give her the winning edge in July 2024.

She is working with her dad, Murray, and the team at ATL Composites perfecting the design and construction of the boards that will give her an advantage on the waters of Marseille, France.

Breiana has the distinction of being the first kite-foil sailor to be selected for an Australian Olympic Team and the first sailor officially selected for the Paris 2024 Australian Olympic Team.

Breiana has a good understanding of, and a strong interest in, composites. She's had a lot of hands-on experience repairing her own gear over the years. She is also a qualified Mechanical Engineer and has been involved in every step of the board building process: shaping, cutting, using the router, making changes to the CAD drawings and testing the boards along the way.

To Breiana, the board and board design is an extremely important ingredient to racing well. She explains, "The board affects how the body connects to the foil, how much force I can push through the foil, and therefore the speed I can get out of it when racing."

Both Breiana and her brother, Scott, have Australian and International titles to their names. Both are forces to be reckoned with in the extreme sport of kite-foiling.

Kite-foil is a new Olympic class making its debut at Paris 2024. Kite-foil sailors can reach speed in excess of 38 knots (44 mph/70 km kph) as they maintain their balance and manage racing tactics, competitors' lines, kites, and the challenges of waves and wind.

The 23-year-old athlete has just competed in Sail Melbourne and Sail Sydney, before returning to Europe for more training and regattas pre-Olympics in Marseille.

Murray Whitehead, a boat builder by trade, has always been in and around water. Murray says that both Breiana and Scott "were involved in sailing from a young age. I built a 45-foot Adams/Radford yacht launched when Breiana was about two-and-a-half, and as a family we cruised the Great Barrier Reef, the islands, including Papua New Guinea.

"Both the kids have enormous on water experience which led to sailing little dinghies, then racing Sabots, Flying 11s, 29ers, Lasers at an Australian level – so they have a solid background."

"But all these sailing experiences pale in significance compared to the excitement and speed of kite-foiling," Murray attests. He describes kite-foiling as "the F1 of sailing".

“It’s a relatively new sport. The most common form of kiting is twin tip riding largely reaching in the shallows or waves, but for racing it’s with a foil in the water and ram air style kites of spinnaker cloth style material that can achieve great angles to the wind and incredible speed, in order of up to four times windspeed,” Murry explains.

Originally popularized in San Francisco, kite-foil racing gradually developed. Then carbon foils changed the game to go faster and racing took off around the world.

“In the beginning, it was basically ‘bring your own home-made gear, do whatever you like’,” Murray says. “It was virtually an arms race, and expensive. People were buying all the best gear, and it was all about who you knew or what you could build. Now it’s a more level playing field and while there’s no ‘one design’, you do have to register your designs.

In the past seven or so years, kite-foiling has evolved under the direction of Markus Schneider, who has become an advocate for the sport, promoting its speed, skills and spectator appeal to the attention of the IOC to make a class now called Formula Kite.

The kite-foiling set-up is comprised of three main pieces of equipment: the mast, the foils (wings) and the board. “The slightest pin hole in the foil, a scratch or fingerprint with sunscreen will cause ventilation, where air bubbles are trapped on the surface of the foil, and this causes the foil to lose lift and become unsteady, and throw you off – this can be very dangerous,” Murray explains.

“Only a limited number of people are able to make the foils in quantity to the specifications required by the International Kite-boarding Association (IKA) and adopted by World Sailing. Several companies registered, then it came down to two companies: Austrian Levitaz and Italian Chubanga.”

A crucial part of the gear is the board, and that’s where ATL Composites became involved. From his many years in boat building, Murray knew of ATL Composites and was a seasoned user of the range of WEST SYSTEM Epoxy products.

“The board is a crucial element. Its shape is critical to getting up on the foil and interacting with the water through waves and manoeuvres so as not to throw the rider off,” says Murray.

“We made boards freehand like surfboards, and we experimented a lot over the years. When you compete internationally, you need strong, light boards that don’t throw you off when you hit a wave, a fish or debris and they need to last, as you can’t just duck back to Australia and get another one.

“Some of the commercial boards were too weak. I have repaired a lot of boards for riders, and over that time, I’ve observed the failures and stress points with all the designs, so we set about to make a design that would last a whole European season. We devoted many hours of studying how they work, with both Breiana and Scott’s significant rider input and feedback… and hours of watching the board-water interaction from the tender.”

Breiana’s boards are made entirely of carbon over a core of foam. This provides structural rigidity, prevents water absorption, allows shaping to a fine finish with crisp lines, provides a tuttle (socket to attach the foil to the board) that won’t crack, and foot-straps that don’t pull out.

“There’s a lot involved,” Murray states. “Aside from the dimensions to create a volume that you need to get all this rigidity, the tuttle has to be made and inset with an extremely tight fit with the mast, exactly in the right location and at right angle. That’s the trickiest part of the equation.

“Knowing that we would need more boards pre-Olympics, Australian Sailing engaged the Australian Institute of Sport (AIS) in Canberra with very accurate scanning equipment to create data files of our best and most recent board.

“Then we looked at what materials we could use. Divinycell foam core is a great product in boat building, but a little heavier than spray foam, which almost all commercial boards are made from. It provides better structural rigidity, doesn’t absorb water and can adopt crisp complex shapes by hand or CNC, all a plus over styrene.

“We got in touch with ATL and they researched a foam grade that would suit. We provided the file, and ATL CNC-milled it to final finish.”

LEFT:

A crucial part of the gear is the board. That's where ATL Composites became involved. The board shape is critical to getting up on the foil and performing maneuvers during the race.

Kai-Yih Lee from ATL Composites was part of the technical team who worked with Murray, Breiana and her coach, Shane Smith. “Considering their parameters, the lightweight Divinycell H45 foam core was chosen as the core material to allow for maximum weight saving, and WEST SYSTEM 105/206 as the laminating resin,” Kai-Yih explains. “Divinycell H is ideal for applications subject to fatigue, slamming or impact loads.”

“We knew that our 5-axis flatbed CNC machine wouldn’t be able to machine the board in one go as it requires the board to be flipped to machine both the top and bottom face. And with some brainstorming, Breiana suggested that we add some temporary supports to the model which will allow the board to sit flat and stable once flipped. These supports can then be removed after machining. Once machined, we sent the board to Murray for final finishing.”

Murray and Breiana were rapt with the results. “ATL Composites’ CNC milling took the time for making the core and shaping the board from a week down to three hours which is a huge saving,” says Murray. “No more gluing layers together to get rocker, measuring old boards to replicate and the trial and error of freehand. We had an accurate base to start with, and then fine-tuned it.

“We used WEST SYSTEM Fillers to crisp up the lines, tinted the 410 Microlight® with WEST SYSTEM 502 Black Pigment to look the same as carbon. Then over the top, we sealed with WEST SYSTEM 207 Special Clear Hardener®. It’s so versatile. We don’t paint the boards. We get a pretty good finish with the clear coat over the faired laminating resin. High-level racing is a bit rough and tumble, so if damage occurs it’s a simple prep and epoxy repair. I always have a WEST SYSTEM Epoxy repair kit on me!”

Now, with the 2024 Paris Olympics in her sights, Breiana is training hard and refining her knowledge of board building. “She brings skills I don’t have—able to manipulate the CNC data files and a definite view of how to improve our design. I think it’s great that she wants to learn how to use every hand and machine tool so that she can repair her own boards. I’m fussy, but she is next level!” says Murray with pride. “She has an affinity for it,” he continues. “Her drive is to make the design better each time. Between the two of them [Breiana and Scott], it’s a complete circle – a real team effort.

Breiana comments, “I really like building the boards. I find it’s a really creative thing to make something really functional and pretty out of a block of foam and some sticky resin. I love the process of continual improvement and refinement of what we are doing.

“There has been a lot of trial and error to get to the top,” she continued. “We don’t give other people our boards. It’s the only area of the game you can get a definite advantage. The boards we made for this year are still all in one piece and looking good. We’re ready to make the next one.

“I look forward to continuing working with ATL. It is great to be able to get expert advice on quality products and concepts to continue to develop the board I’m racing on. For me, it’s really important to have trust in all of the equipment. When I know the gear is reliable, I can push it to the limits. Being able to make a board I can trust, with reliable products, is key to me when I’m racing. I look forward to further refining the process in the future working with ATL.”

“We don't paint the boards. We get a pretty good finish with the clear coat over the faired laminating resin. High-level racing is a bit rough and tumble, so if damage occurs it's a simple prep and epoxy repair. I always have a WEST SYSTEM Epoxy repair kit on me!” – Murray

To learn more about Breiana Whitehead, scan the code.

Replacing the Wet Core in Another Spade's Rudder

By Don Gutzmer – GBI Technical Advisor

LEFT:

The repaired rudder with a gray tinted epoxy coat, ready for primer and paint.

BELOW:

Initially the rudder didn't look bad from the outside, except the crack around the rudder shaft. Sounding the rudder, it became clear that the core was saturated with water.

What happens when the core of a water-damaged rudder can't be saved? Completely replacing the core of a rudder may need to happen for a variety of reasons. There may be an inability to dry the core and still maintain the structural integrity, or the repair may need to be completed in less time than just letting it dry. This rudder, from a C&C 32 sailboat, had a wet foam core that is beyond saving. Here are the steps I used to restore this rudder.

Investigating Damage

As with any repair, determining the extent of the damage is paramount. One must embody a marine surveyor's mindset to determine the underlying issue, then devise an effective repair that will also prevent the problem from returning. The first step I took was to "sound" the rudder with a hammer to determine the extent of the wet areas. Sounding is the tapping of a hammer over a cored laminate, listening for the quality of the sound it produces. With the rudder in question, a dull sound was produced when tapping on both sides. With this information, I determined that the entire foam core had gotten wet or was deteriorated to some extent. Next, I drilled several holes into the rudder to determine the integrity of the foam. In some of the holes, the foam came apart easily, even dripping wet. Due to this condition, the foam in the rudder was no longer structurally supportive and past the stage of being saved by simply drying over time. Upon further inspection, I discovered a crack around the top shaft that was likely the culprit of the moisture intrusion.

Removing the Laminate

In order to remove the damaged and waterlogged foam core, I needed to cut away some of the laminate to gain access. To maintain the original shape of the rudder, only portions of the laminate were cut away. This left the general shape intact while also granting access to the inner portion of the rudder. The other advantage to leaving some laminate in place was to have enough surface area to grind a 12:1 bevel angle for adhering the new fiberglass. As seen in the pictures, three sections of laminate on each side of the rudder were removed.

I marked off the area with masking tape and used a vibrating multi-tool to remove the laminate, exposing the foam. A sharp wood chisel and hammer worked well to remove the foam. A small section of laminate was cut away on the leading edge of the rudder to remove additional foam. Once a majority was removed, I placed the rudder in a large oven at 120°F for 24 hours to ensure any remaining foam, and the empty cavity, was thoroughly dry. Alternatively, I could have dried the rudder with heat lamps, but since I have access to an industrial oven with temperature control, I opted to use that.

Determining Replacement Foam

During the demo process, I had set aside an intact section of foam and dried it in the oven with the rudder. I then trimmed this into a 1-inch cube, weighed it, and calculated the density. The density of the foam in the rudder was 6 lbs./ft^3. I decided to use an 8 lbs./ft^3 polyurethane expanding foam as a replacement, which was more than adequate.

Applying Foam

On the inside of the rudder, there is a metal plate welded to the stainless shaft that runs the length of the rudder. There was rust on the metal plate, so I chose to apply a rust converter called Corroseal® before pouring the foam.

After sanding the metal plate with 36-grit paper, I was ready to test the new expanding foam. I mixed a small test batch and brushed it on the plate to test the strength of the bond. After it cured, I tried to scrape the foam off with a wood chisel. The foam failed, but part of the foam adhered to the plate stayed attached, which indicates good adhesion.

Now that the concept was proven, it was time to actually fill the rudder. Taking advantage of gravity, I flipped the rudder upside down to fill the top portion with foam. The foam cured with a smooth, sealed surface. I used a vibrating multi-tool to remove the sealed surface exposing the textured foam underneath. The smooth surface of the foam could jeopardize good adhesion between layers and eventually separate causing issues later on.

The next area I filled with foam was the leading edge. I stood the rudder up on the leading edge and taped the opening to help contain the foam in the cavity. Once cured, I again removed the smooth surface.

The steel plate in the middle of the rudder worked well as a partition for filling the remainder of the rudder. This way I could fill just one half at a time. All the plate needed was a little tape to cover the hole. I filled half of the rudder with the expanding foam until it rose above the surface of the rudder. Then I let it cure, flipped it over and filled the other half.

Shaping the Foam

The foam that expanded above the surface of the rudder needed to be removed. I used a Japanese pull saw to cut the foam flush with the surface. The sharp saw cut the foam easily and a 6" pneumatic orbital sander helped to smooth the areas quickly. There were some areas that the foam did not fill and left some pinholes. I mixed a batch of epoxy, thickened with WEST SYSTEM® 410 Microlight®, to fill the imperfections and any low spots. The resulting surface was fair with the original laminate.

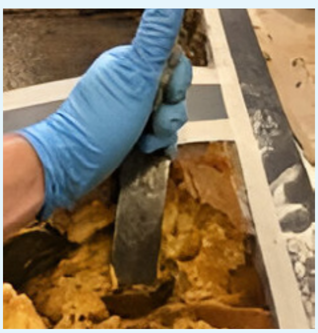
Rudder with a few drilled holes to check the foam's integrity.

Masking tape used to mark the area that would be cut away.

Vibrating multi tool cutting fiberglass laminate.

Exposing the wet foam core.

All three sections of laminate removed.



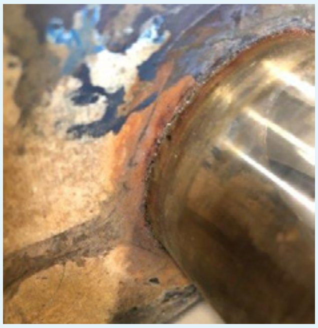
Removing foam with wood chisel.

Exposing metal plate.

Foam dripping wet.

All wet foam is removed from the inside of rudder.

Leading edge of the laminate is cut away.



Crack around shaft is an indication of water intrusion.

Brushing on rust convertor called Correseal®.

Rust convertor is applied to entire plate.

Foam is poured into top of rudder.

Rudder is laid on its side and leading edge is filled with foam.

Shrink wrap tape is used to contain the foam into the open cavity.

Recessing and Beveling

I needed to recess the foam in the openings I had cut into the rudder to accommodate the new skins. The original fiberglass laminate measured ⅛" thick. I used a router set to that depth to remove the extra foam. The foam needed to be a consistent depth across the entirety of the opening because the fiberglass would follow the contour of the surface below. Any small bits left were removed with a grinder.

The next step was to grind a 12:1 bevel around the perimeter of each opening. At laminate thickness of ⅛", this meant the bevel would need to be 1 ½" wide. I decided to increase the bevel to 2" wide to provide ample bonding surface area. I used a 36-grit flap disc to grind the laminate close to the desired bevel angle. I finished refining the bevel using an orbital sander with 60-grit and a little hand sanding.

Laminate Schedule

You may ask, “why didn’t you reuse the old fiberglass laminate instead of installing new fiberglass?” The areas being removed were fairly small, so it was easier for me to layup new fiberglass fabric. This avoids some of the additional grinding that would be required to bevel the old fiberglass panel. I would also still have to layup new fiberglass to bridge over the cut line to make the skin one piece of fiberglass again. If the repair was large, it may have been a smart choice to save the existing fiberglass laminate that was cut off and reuse it on the repair.

As previously determined, the old fiberglass laminate measured ⅛" thick, and I would be creating a new fiberglass skin to the same dimension. I referenced the WEST SYSTEM *User Manual & Product Guide*. In the Reinforcing Materials section, the layup thickness chart helped me determine I would need approximately two layers of 10 oz. Glass Fabric (745) and three layers of 17 oz. Biaxial Fabric (737). This was a good starting point.

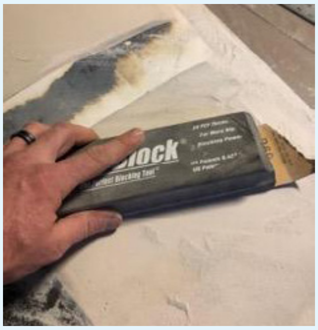
I laminated a small sample with one layer of 10 oz. fiberglass fabric, three layers of 17 oz. fiberglass fabric, and one additional layer of 10 oz. fiberglass fabric on top to know exactly what thickness I would achieve. There’s a level of variability in the hand layup process so not everyone achieves the exact same results. After measuring my test sample, I realized it was slightly too thick. I opted to swap one layer of 10 oz. fiberglass fabric for a layer of 6 oz. Glass Fabric (742) to achieve the desired ⅛" thickness.

Expanded foam is cut with multi tool to remove sealed surface.

Expanding foam is poured over the surface and expands above the surface of the rudder.

Japanese pull saw is used to remove foam that is above the fiberglass laminate.

Foam is sanded below the surface of the laminate.



Sanding block is used to remove any epoxy that is higher than the fiberglass laminate.

Surface of the rudder is faired with epoxy.

⅛" thick G-10 is used as a guide to set router depth.

The router is moved over the epoxy to remove a majority of the epoxy to maintain 0.125" depth.

Fiberglass Application

I created templates to mark out the fiberglass layers for each opening. I chose to use thin paper so I could see the outline of the largest layer through the paper. For each subsequent layer, I marked my template a ¼" shorter along the perimeter. This gave me what's called a ply drop, creating a gradual transition onto the existing fiberglass laminate. As I cut each fiberglass layer using my templates, I labeled them with an indelible marker. For the first opening, I labeled the pieces 1-1 through 1-5, the second opening was 2-1 through 2-5, and so forth until I had pieces cut for all of my openings.

To have enough working time to layup one whole side of the rudder, I chose WEST SYSTEM® 105 Epoxy Resin® and 206 Slow Hardener®. I applied each layer of fiberglass wet on wet, starting with the largest layer and working to the smallest. After I had all the layers applied, I waited for the epoxy to set up a little and become tacky. At this stage, I spread a layer of fairing compound (epoxy thickened with 407 Low-Density Filler) over the entire surface without having to do any additional surface preparation. Having the thickened epoxy on the surface helps fill the weave of the fabric and acts as a starting point in filling any potential low spots. I applied a layer of release fabric over the thickened epoxy and used a plastic spreader at a low angle to smooth the surface. Once cured, I could repeat the same process on the opposite side of the rudder.

Fairing

Having a smooth surface and a fair surface are two different things—like comparing an apple to an orange. Fairness refers to the shape of the surface, while smoothness refers to the texture of the surface. As a point of reference, a wood batten can be used to judge a fair surface, while the friction you feel running your hand across the surface can help you determine if a surface is smooth.

After removing the release fabric, I had a textured, unfair surface. Not to worry. The next step was to make the rudder surface fair again. I needed to use a long sanding block (longboard) to remove any high spots. The low spots on the rudder are left unsanded due to the longboard bridging across from high spot to high spot. Because of the addition of the filler coat at the end of my fiberglassing process, I did not have to go back and refill any low spots with additional fairing compound.

Orbital sander was used to create the final profile and flattened bevel angle.

Surface is sanded in preparation for epoxy.

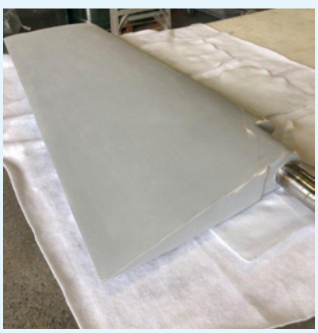
Epoxy is poured on the repair and faired to a uniform surface.

Tinted epoxy over entire surface of rudder.

Rotary tool used to increase surface are around top shaft of rudder.

G/flex-650 is applied with a small syringe.

Surface is coat with tinted epoxy to seal top surface of rudder.



Rudder ready for application of paint.

Repairing the Cracking

Up until this point, I had largely ignored the crack in the fiberglass around the rudder shaft. Having filled the rudder with foam, and the fiberglass skin now repaired, I felt the rudder was stable enough to begin work on the crack. I used a rotary tool to open up the crack. I made sure to open the entire length of the crack so it did not continue to grow after I finished the repair. By opening the crack, it increases the surface area for better bonding.

I chose to use G/flex® 650 Toughened Epoxy because of its superior abilities to bond dissimilar materials—the fiberglass, the foam and the stainless-steel shaft. I mixed up a small batch and filled in the opening I had made with the rotary tool. Once it had cured, I sanded it fair to the surrounding area.

Tinted Epoxy Coating

The rudder needed a final coat of epoxy after fairing to seal the surface and fill any pinholes that may have been exposed in the process. I mixed a batch of 105/206 tinted with 503 Gray Pigment. I leveled the rudder and poured a thin layer of the tinted epoxy over the entire surface. This created a uniform coating. I passed a propane torch flame over the wet epoxy to remove any air bubbles within the coating.

After the epoxy cured, I grabbed my trusty longboard to do a final sanding pass. Then I rolled and tipped a couple last coats of tinted epoxy.

To prepare the surface for paint, I used an orbital sander to dull the epoxy's surface, per the paint manufacturer's specifications. For this step, I used an orbital sander because I was simply creating the desired texture on the surface, not sanding for fairness.

Professional Repair Method

The process taken to repair this rudder is commonly practiced in boatyards. Trying to dry the foam over time can be sufficient, but it is also unpredictable in terms of drying time. With this in mind, boat yards can't accurately bid a job and achieve an effective repair in a timely manner. It may take weeks to dry the core, compared to just removing the foam and finishing the repair in a few days. Without breaks, this repair took about 10 hours of labor, plus the cure time of the epoxy and drying the foam in the oven.

The repaired rudder looks good as new and is ready for paint. The owner of the rudder will not have an issue with water intrusion in the future.

Repairing Bow Damage on a Lightning Sailboat

By Terry Monville – GBI Technical Advisor

My daughter crashed a Lightning at a regatta last fall. Yup, she was on port tack.

Getting started on any project is half the battle. This could not be truer when it comes to an unexpected fiberglass repair. Every crashed boat is different; making every repair a bit different. Some repairs are straightforward, textbook repairs. The damage occurs on a flat area of the hull that is a solid fiberglass laminate. A little grinding, a little fiberglass and you're done. What happens when the repair is not so simple though?

Let's take a look at the next step beyond the basic repair. My daughter crashed a Lightning sailboat last fall and took a huge chunk right out of the bow stem. For the sailors in the group, yup, she was on port tack. This repair took a little more creativity to maintain the complex shape of the bow and build a good, solid laminate.

Making a Plan

The first step in the repair was investigating how big the repair area would be after removing all the damaged fiberglass. This involved checking the inside and outside of the boat for cracks and delamination. Don't pull or cut the fiberglass apart just yet. It may be needed for shaping the repair.

By crawling into the bow with a flashlight, I was able to determine that most of the damage was in the solid fiberglass extending only slightly into the cored section of the hull. Later I found out that there was only about a square inch of core damaged on either side.

I was also able to determine the makeup of the laminate in different areas of the boat surrounding the damage. The hull of the Lightning was cored, but the core stopped just short of the bow. Those same core sections transitioned into solid fiberglass laminate just below the rub rail. At the bow, the fiberglass overlaps from both the port and starboard sides, making the bow's center (the stem) twice as thick as the sides. I was able to confirm this later when cutting it apart.

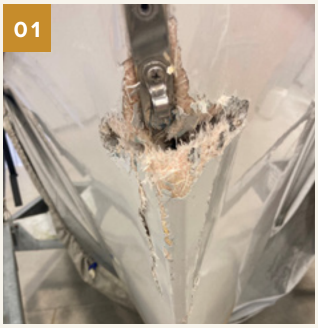
Now that I had a good idea of the extent of the damage and the makeup of the laminate, I knew how much material needed to be removed from the bow. The section of the bow stem to be removed spanned from just below the deck line down to the water line, and then it extended back onto the hull about 4" on either side.

The bow stem on this boat is not the typical consistent V shape from top to bottom. The bow stem is about 1" wide and flat at the top, then tapers down into a ½" radius at the bottom. Before removing the damage and leaving a gaping hole, I needed a plan on how to rebuild this complex shape. The bow was large enough for me to be able to crawl inside to see the damage, but not large enough that I would be able to reach to work on the repair from the inside. Therefore, I needed a repair plan that could be done completely from the outside.

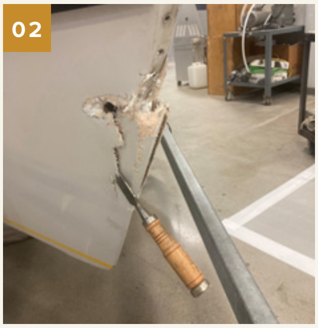
Chapter 4 of our WEST SYSTEM® *Fiberglass Boat Repair and Maintenance* manual shows how to use a fiberglass backing plate, glued to the backside of the hole on a flat surface, for repairing a small hole. I utilized this concept for my repair project, however mine would be a little more complicated due to the damage being right on the bow stem.

Making the Backing Plate

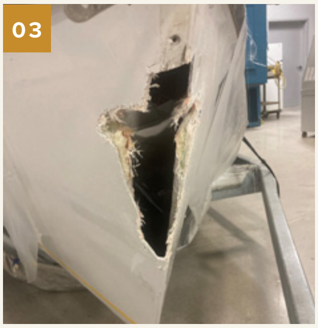
I used the boat itself as my mold to create a backing plate. I made a couple of cuts in the damaged fiberglass laminate to relieve stress so I could push it back into its original shape. I used some Great Stuff™ spray foam to fill in open areas and to help support the broken pieces in the proper position. After the foam hardened, I sanded it and the fiberglass, fairing it back to the original shape of the bow. Now that the bow was back to the original shape, I covered the area with clear packing tape to act as a



Damaged bow straight on.



Damaged bow from starboard.



Damage removed.

Foam used to recreate bow shape.

Foam mold removed. Test fitting backer plate.

release agent for building my fiberglass backing plate.

To build the backing plate, I used a couple of layers of 732 Fiberglass Tape (9 oz.) over the packing tape area. I used WEST SYSTEM 105 Epoxy Resin® mixed with 205 Fast Hardener®, applying 879 Release Fabric over the top. When making a backing plate, it's always good to make it bigger than you plan on using. Even with good investigation, when you begin removing damaged material, you may find there was more damage than you thought. After the epoxy had cured, I popped the backing plate off the bow and set it aside for later.

Now the fun begins. I marked out the area of the hull that I planned on cutting out. I used an oscillating saw to cut through the fiberglass along my marked area. I'm always conservative on how much I remove, but especially on this project. I don't want to get into the cored area any more than I have to. You can always remove more material if you discover there is more damage than you first thought, but it's best not to start by removing material you didn't need to.

Preparing for the Backer Installation

The hole was large enough to reaching through, allowing me to perform the interior surface preparation work from outside the boat. I used 80-grit sandpaper to sand a couple inches back from the edge of the hole, all the way around the perimeter.

While removing the damaged material, I had to remove a small section of foam core towards the top of the hole. Since it was such a small area of core, rather than replacing it, I opted to cut the edge of the remaining core at a 45° angle. Then I sanded around the area with 80-grit in preparation for fiberglassing over it later to replace the missing skin.

The next step was to cut and fit the backer. Being made of two layers of pre-laminated 9 oz. fiberglass, I could cut it to shape with quality scissors. Having areas with core and flat areas of just fiberglass laminate created contours that made fitting the backer smoothly against the inside of the hull. There were a few areas that I could not get completely flush, but they were small enough to be filled with epoxy later.

I drilled a couple of holes in the center of the backer and tied kite string to it. This would allow me to push the backer through the hole and let it hang on the string while I applied the epoxy. Then later I could tie the string off, holding the backer in place while the epoxy cured.

Installing the Backer

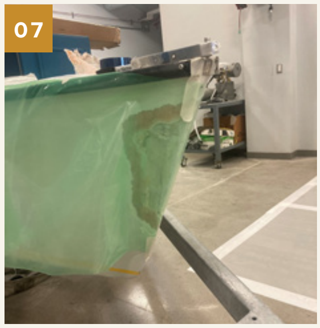
I started my epoxy application by working on the areas the farthest reach through the hole, and then worked my way back out. This meant applying fiberglass over the exposed core inside of the boat first. I used two strips of 727 Biaxial Tape (17 oz.) to repair the inside skin. I ran the strips vertical over the exposed core inside the hull. I applied a little extra epoxy where the backer would be in contact with the 727 Biaxial Tape to ensure a good bond.

Next it was time to begin work around the hole. I began by applying a 2" wide epoxy coating around the perimeter repair area, on the inside of the hull. I used a thin mixture of 105/206/406. The 406 Colloidal Silica Filler gives the epoxy a little body and gap-filling ability

06

Six10 Thickened Epoxy Adhesive was used to bond the backer to the hull.

07

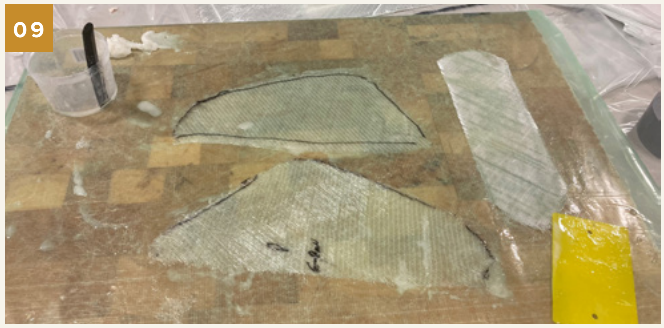


Tracing the pattern for the repair area.

08

Cutting out the fiberglass pieces.

09



Wetting out fiberglass.

to help prevent air voids between the hull laminate and the fiberglass tape I would apply next.

On a plastic-coated work surface, I wet out 727 Biaxial Tape with unthickened 105/206. I applied the wet-out, 4" wide 727 Biaxial Tape strips to the inside of the hull. I positioned the strips in the 105/206/406 mixture so they overlapped the fiberglass by about 2" and extended into the center of the opening by about 2". I cut multiple strips of the 727 Biaxial Tape so it was easier to manipulate the strips to follow the opening.

The hole was now ready to be sealed closed with the backer. I used Six10® Thickened Epoxy Adhesive to apply a heavy bead of epoxy all the way around the backer. Six10 is mixed as it passes through the mixing wand. This allowed me to apply the epoxy to my backer with minimal disruption to my wet biaxial tape strips.

Pulling on the kite string, I drew the backer firmly into place, then tied off the string to the trailer. This would hold the backer in place until the epoxy cured. I used an 808 Flexible Plastic Spreader to gently smooth the 727 Biaxial Tape flat against the backer, removing any air bubbles. After that, I let the epoxy cure.

Preparing for the Fiberglass Patch

Cured epoxy can sometimes form an amine blush that can inhibit bonding. I washed the blush off with water and a 3M™ Scotch-Brite™ pad. I then sanded the surface of the backing plate and the bond line to remove any imperfections. This way my next layers of fiberglass would lay smooth.

I needed to increase the bonding surface of the new patch. Having a larger bond surface allows loads to pass seamlessly between the two laminates. Over the years, Gougeon Brothers has found that a 12:1 taper is a good rule of thumb for fiberglass repairs. With the bow area now supported by the backer and the biaxial tape, I could grind/sand the edge where the hole had been. This repair, however, had different thicknesses of fiberglass – from a thin layer over the cored area to the thick, overlapping fiberglass at the bow. It would be difficult to keep track of where each of these thicknesses were on the repair and adjust my taper accordingly. Since a 12:1 taper is a minimum recommendation, I opted to keep all the taper lengths the same. My thickest laminate was about ⅛" thick, so I used a 2" taper length as my guide.

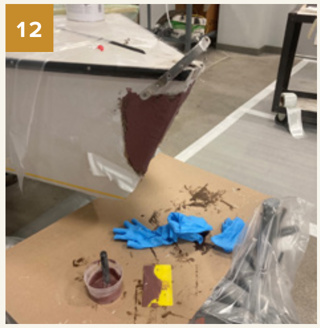
The grinding exposed voids in the core created by the damage. I hand sanded these areas, then gave a final sanding to the entire area. Now the entire surface was prepared for epoxy and fiberglass.

I now had the final shape for the fiberglass patches. Based on my thickness measurement of the original laminate, I planned to use three layers of 737 Biaxial Fabric on each side of the bow, overlapping them at the stem. This would produce a laminate thickness equal to what had been removed. I taped a piece of clear plastic over the repair and used a marker to trace the outline of the area to be patched. I now had my template.

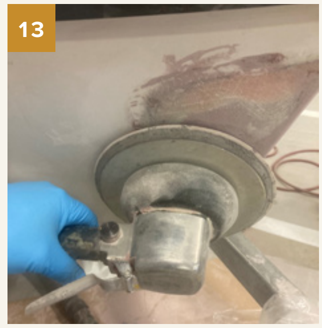
I cut the first piece of 737 Biaxial Fabric the same size as the template. Each subsequent layer was cut slightly smaller. I marked each one with the order I planned on applying them (largest first), which way was up, and which side of the boat it would go. Cutting each fiberglass piece slightly

Grinding in preparation for fiberglass.

Applying the fiberglass.



Applying fairing compound.



Sanding fairing compound.

Epoxy coating before gelcoat.

Completed repair.

My daughter, Hannah, racing with her friends at the regatta before the crash. Photo: William Crawford, Harbor Pictures Co.

smaller is very helpful: You stay truer to the original shape of the hull; it saves a lot of time and effort in the fairing process; and it minimizes waste.

Applying Fiberglass Laminate

I brushed a thin coat of WEST SYSTEM 105/206 epoxy, thickened to a catsup consistency with 406 Colloidal Silica, onto the repair area. Wetting the surface with the thickened epoxy helped the fiberglass bond to the hull better and filled any small imperfections. After this coat, I added more 406 to my epoxy, bringing it to a peanut butter consistency. I used an 808 Flexible Spreader to force the thickened epoxy into the small voids left by the missing core and any other larger imperfections.

Time to wet-out my 737 Biaxial Fabric. Most of the time when I do a fiberglass repair, I like to wet out the fiberglass on a piece of plywood coated with plastic, then apply the already wet-out fiberglass to the repair area. I find this makes less mess and it is easier to get to the ideal 50:50 epoxy to fiberglass ratio by weight. Plus, I can wet out my fiberglass more comfortably at a work bench, then easily carry the plywood to where the repair work is being done.

I started with the largest piece. I wet it out and then applied it to the repair area, following the markings from when I cut the fabric earlier. Then I repeated the steps for the largest piece on the opposite side of the bow. I worked my way down to the smallest piece continuing to alternate sides as I went.

I let the epoxy cure for about an hour. This allowed the epoxy to cure to a gel stage. The epoxy was firm, but I could still push my thumbnail into it. At this point, I mixed up a batch of epoxy, thickened to the consistency of peanut butter with 407 Low-Density Filler. I spread a thin coat over the entire repair area. Doing this gave me a jump-start on the final fairing process. If you want to let the epoxy cure all the way, and start fresh the next day, you have two options: You could either wash the amine blush off before sanding, or use our 879 Release Fabric. When removed, the 879 Release Fabric pulls off the amine blush and leaves a textured surface behind that is ready for sanding or recoating.

Fairing the Repair

The next day I washed off the amine blush and started sanding. I used 36-grit sandpaper on my 8" dual action sander and my air file. Using a larger sander helps distribute pressure more evenly over a larger area to minimize highs and lows, and can span from the repair onto the original hull assisting in guiding fairness. I can get the proper basic shape quickly with the power tools, but a hand sanding block is important to hone the finer details. As I progressed with my fairing, I worked my way down to 80-grit sandpaper.

Once I had the shape I wanted, I brushed/rolled on a couple of sealer coats of epoxy-tinted with our 503 Gray Pigment. This helps in two ways.

1. Having the repair all one color shows surface imperfections

2. The gray epoxy will work as a primer color for the gelcoat to follow

It's a little hard to tell from the pictures, but the hull color is actually light gray. Of course, if the boat were white, I would have used 501 White Pigment instead.

Once the seal coat becomes tacky, you can fill in pinholes, low areas, and any other spots that might need a little extra attention with epoxy. For nonstructural applications, I often use the partially cured epoxy left from the seal coat for my touchups. It has the consistency of taffy, which can work for you or against you. It has a thicker viscosity, so it will cling better, but this also means it can be stringy and sticky. Care needs to be taken because it's easy to make a bigger mess than you are fixing.

After the epoxy cured, I wet sanded the epoxy to prepare it for the gelcoat. I kept an eye open for any imperfections. At this stage, you need to fix anything you see. Do not think that gelcoat, or paint and primer, are going to fill in a pinhole or divot.

Time to Gelcoat

Regardless of how great of a repair you make, it all comes down to the finish. Typically, fiberglass production boats have a gelcoat finish…which includes this Lightning. Unfortunately for me, the hardest part of gel coating a repair is the color match. Not my strength.

For many production boats, matching gelcoat can be ordered. Sadly, the Lightning has low enough production volume that pre-tinted gelcoat was not an option. Now I could order gelcoat and pigments and match it myself, but it would be time-consuming and a pain in the butt.

I ended up calling an old friend Steve Schnettler, the owner of Mid-Michigan Fiberglass here in Bay City, MI. Steve is matching colors on a daily basis. He whipped me up a pint of matched gelcoat, gave me some clear Dura-Tech™ to help with blending, and some pointers. I have not done gelcoat work in over a decade, so I welcomed all the assistance. Other supplies needed for gelcoat work include a cheap high pressure/low volume (HPLV) spray gun, Polyvinyl Alcohol (PVA), thinner, and fine grit sandpaper.

I sanded beyond the repair area into the surrounding gelcoat to blend the two gelcoats together. I taped the spray area out and covered the rest of the boat to keep the overspray off it. Then I did my last 2-step solvent wipe to make sure the area was clean.

I thinned a large enough volume of gelcoat for my first application. Then I mixed in the catalyzer and sprayed a couple of coats of gelcoat to cover the repair area only. I did not want the spray to extend into my sanded blending area. While waiting for the gelcoat to become tacky, I cleaned the spray gun to prevent the gelcoat from hardening in it. I mixed up a batch of gelcoat and Dura-Tech and sprayed three more coats for blending. The first coat was sprayed just beyond where I stopped at the edge of the repair. I sprayed each additional coat a little farther onto the sanded gelcoat in my blending area. Once again, I did a thorough cleaning of my spray gun.

I had to wait a few hours for the gelcoat to cure most of the way. Gelcoat cure is inhibited by exposure to air, so to have a hard, sand-able finish, I needed to brush on a coat of PVA. The PVA dries quickly and forms an airtight seal over the gelcoat. This allows the gelcoat to cure to a hard finish. After a day or so, I came back and washed the PVA off with clean water. Then I wet sanded the new gelcoat smooth and blended it into the old. I used a buffer and rubbing compound to bring back the shiny gloss. I reinstalled the bow hardware and we are ready to race… well, once the ice thaws that is.

Planning was the Key

A thorough evaluation of the damage before doing any work is critical in determining the process for your repair. For this repair, I could not work from inside of the hull, so I had to design a repair process that could be executed from the exterior of the boat. Molding a backer plate to build the repair on, was an important step that needed to occur before the damage was removed. This is counter to the process we often follow when doing repairs. Charging ahead and cutting out the damaged section before developing the process for the repair would have made a challenging repair a whole lot more difficult. It also would have produced less-than-ideal results. Though it was a lengthy, multistep process, the damaged area looks good as new.

If you're stumped on how to approach your next project, please contact the Technical Service staff at WEST SYSTEM to help you in developing your repair plan.

Watch the video

To see a timelapse, of this repair, scan the QR code.

Scan the QR Code to download the WEST SYSTEM ***Fiberglass Boat Repair & Maintenance Manual*** and learn how to repair cracks, holes, damaged skins, cores, keels, rudders, and gelcoat, as well as how to install hardware and teak veneer decks.

All you ever wanted to know about WEST SYSTEM Epoxy Shelf Life

By Don Gutzmer – GBI Technical Advisor

"What Is the Shelf Life of WEST SYSTEM® Epoxy?"

The short answer is: It depends, but usually a really long time.

…but you didn't come here for just the short answer. Did you?

One of the big advantages of WEST SYSTEM Epoxy is that the shelf life can be many, many years when stored properly. If you have used polyester resins, you'll know that their shelf life is only about six months before it turns to a useless jelly-like substance. This is not the case with our WEST SYSTEM Epoxy. This stability of our 105 System and specialty epoxies makes it much easier to buy epoxy in larger quantities, at a more cost-effective price, to be used in a variety of projects, or just kept on hand for when the need occurs.

Expiration Date vs Minimum Shelf Life

We do not state an expiration date on our product containers. The epoxy doesn't suddenly go bad and stop working due to old age. We do, however, sometimes state a minimum shelf life. The minimum shelf life is three years after the manufacture date for resins and two years after for hardeners. This minimum shelf life is solely based on how long we hold on to the retained samples.

Being an ISO 9001-2015, we keep a quality control sample from each batch of resin and hardener that we manufacture. This sample undergoes a strict quality control process to ensure the product will perform as expected once it leaves the facility. After testing, this sample gets stored in a controlled environment for two to three years, depending on whether it's a resin or a hardener. This allows us to pull to an actual sample of the material from that exact batch (that has been properly stored) should any customers ever have an issue within that timeframe.

What Happens Beyond Two-Three Years?

The bad news: We no longer have a retain.

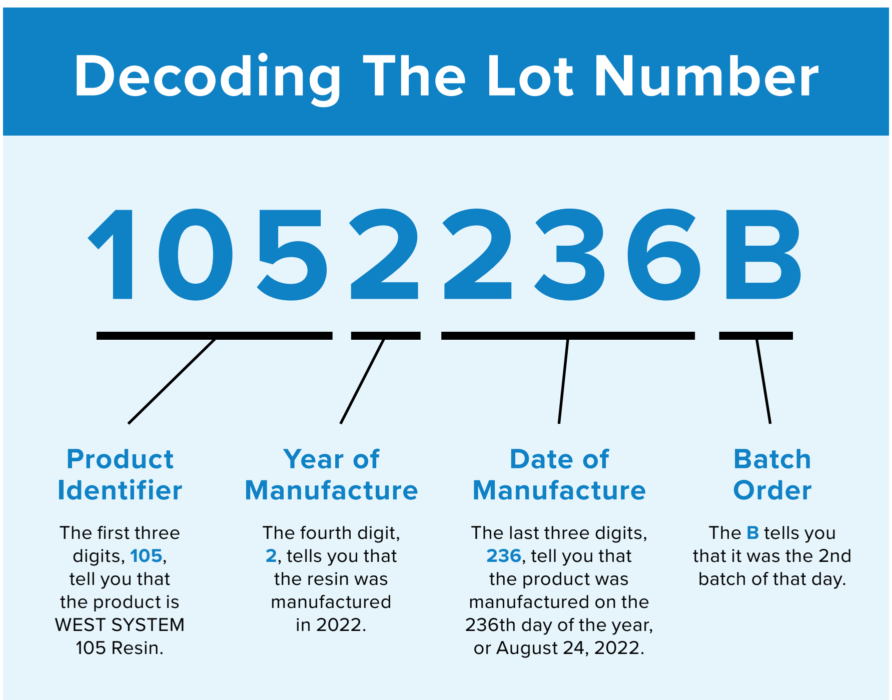
The good news: It should still be just fine for most general applications. You just need to do a simple test.

If a customer calls beyond that two-three year window, we would recommend they mix a test batch to ensure the epoxy cures within the specifications on our technical data sheets. This would tell you if there was some sort of contamination to either the resin or hardener. For any critical structural applications, we recommend using a hardener that is no more than two years old to be safe. Otherwise, as long as the test batch is successful, the epoxy will work fine for most general applications.

How Do I Determine the Manufacture Date?

All WEST SYSTEM® Resins and Hardeners are identified with a lot number comprised of seven numbers followed by a letter. You can determine the date of manufacture by decoding the lot number.

- **The first three digits** identify the product.
- **The fourth digit** identifies the year of manufacture.
- **The last three numbers** are the date of manufacture, expressed as a Julian Date. These numbers can range from 001 to 366. 001 would indicate that the date of manufacture was January 1. 366 would indicate that the date of manufacture was December 31, in a leap year.



Shelf Life for Critical Structural Applications

For critical structural applications we recommend using resin that is less than three years past the date of manufacture and hardener that is less than two years past the date of manufacture. The resin and hardener should be stored in its original sealed container. The mixed epoxy can certainly still achieve full strength properties well after these dates, however the likelihood of contamination being present increases the older the epoxy gets and if the product has been opened and used for other projects previously.

These time frames are applicable to the 105 System as well as our specialty epoxies (G/flex®, Six10®, and G/5®). Our fillers and additives are good for an indefinite amount of time, provided they stay contaminate free.

Understanding Older WEST SYSTEM Epoxy

The reason why we are a little vague on giving an exact shelf life is that the epoxy can be useable for many years, depending on the application. We've tested epoxy over 10 years old that cures without any issues. There are some traits that will change over time, purely due to age, that you should be aware of:

- Physical properties will reduce slightly, therefore it's always best to use fresh product for critical structural applications.
- The hardener can darken in color. The 205 Fast Hardener® and G/5 hardener are known to sometimes darken to a reddish-purple. Though it is purely a cosmetic issue, it does sometimes surprise people.
- Increased viscosity of the resin is the primary change in the handling characteristics of older epoxy.

When resin has a higher viscosity due to age, it becomes more difficult to meter and mix properly. If you warm the resin, it will help lower the viscosity and make it easier to handle. We recommend spending additional time mixing to ensure the resin and hardener are thoroughly blended.

Prolonging the Life of WEST SYSTEM Epoxy

Temperature fluctuations during long-term storage can make resin susceptible to crystallization. The ideal storage temperature is above 50°F (10°C). Fluctuations below that 50°F (10°C) threshold promote the growth of epoxy crystals. The resin is much more tolerant of heat, and it can withstand storage at 100°F (37°C) without a problem.

Crystallization can make the resin thicker and can make the resin appear milky or cloudy. Crystallization can be reverted by simply heating the resin to around 120°F (49°C). The simplest approach is placing your container into warm water and occasionally gently stirring within the container until all the crystals disappear. If heavily crystalized, they can take several hours to disappear.

Another issue with aging products is moisture contamination. If hardeners are left open, they can take on moisture over time. The moisture will act as an accelerator and make the epoxy foam when curing. It's best to store your epoxy with the cap secure to prevent contamination.

How Should I Test My Older Epoxy?

You can do a simple test to see if your epoxy is still good. We call this a pot life test. For a pot life test, you want to mix 100 grams (or 4 fl.oz.) of epoxy (total resin and hardener) in a 2" diameter container. Start your timer and mix the epoxy for two minutes. At the two-minute mark, stop mixing, but leave the stick in the container. As you get close to the expected gel time, move the stick to see if the epoxy flows back into the depression left by moving the mixing stick. Repeat until the epoxy no longer flows back into place. This is considered the gel time. This is when you would stop your timer.

The frequency with which you test the epoxy will vary with the speed of hardener you are working with. On the WEST SYSTEM Technical Data Sheets, we provide pot life values. These can be used as a guide to determine when to start checking if the epoxy has gelled, and ultimately whether the epoxy passed the test. If your test time is slightly off, your epoxy is still fine to use for general applications. If the gel time is drastically different, or foams, you will probably want to discard it.

Our test is performed with 100 grams (4 fl.oz.) of epoxy at 72°F (22°C). Keep in mind that temperature will dramatically affect the result of a pot life test. An increase in temperature of 18°F (10°C) above 72°F (22°C) will cut the pot life time in half.

What's the Takeaway?

Though the minimum shelf life is only a couple years, WEST SYSTEM Epoxy can have a very long shelf life when properly cared for. Keeping your epoxy in a relatively warm environment, in sealed containers will prevent two of the biggest issues that affect epoxy's lifespan: crystallization and contamination. Looking after your epoxy will keep it useable for many projects to come.

WEST SYSTEM® Epoxy *User Manual & Product Guide*

The WEST SYSTEM *Epoxy User Manual & Product Guide* is the definitive guide to using epoxy safely and effectively. This fully illustrated manual is available for free download in multiple languages.

Tips for Clear-Finished Wood

By Don Gutzmer – GBI Technical Advisor

The beauty of naturally finished wood on a boat is appealing to many boat owners, but the maintenance of clear wood finishes is an ongoing task. One way to reduce this task is to stabilize the moisture content of the wood with epoxy. In Michigan or Florida you may need to varnish yearly. Here are some tips to successfully apply WEST SYSTEM® Epoxy and fiberglass to wood surfaces for a clear, bubble-free finish.

Advantages of 207 Special Clear Hardener®

In our WEST SYSTEM product line, we have developed a clear epoxy specifically for use as a clear finish on wood surfaces. This product is our 105 Epoxy Resin® paired with our 207 Special Clear Hardener®. Many epoxies have an amber tint as a result of being developed to achieve specific performance requirements. However, 207 Special Clear Hardener is formulated to remain clear and still offer excellent physical properties.

105/207 can be used for structural bonding, in addition to coating. The viscosity is low enough that it will release entrapped air bubbles effectively and self-level. We have formulated 207 Special Clear Hardener so it does not leave a waxy amine blush during curing. The only surface preparation that needs to be done once the epoxy is cured is to lightly sand the surface dull before recoating. If you are recoating within six hours of the previous application, at 72°F (22°C), no surface preparation is required. Another advantage of the 207 Special Clear Hardener is that it is compatible with many UV-stable top coats, so there are many options for your final UV coat.

Accurate Mix Ratio and Maximizing Working Time

With any epoxy system, the epoxy needs to be on ratio and fully mixed for optimal performance. As you mix 105/207, it is helpful to mix at a steady pace, scraping the sides and bottom of the container. Avoid lifting the mixing stick to minimize entrapping more air bubbles in the epoxy.

The epoxy will start to crosslink as soon as you begin mixing, generating heat. To avoid the epoxy generating heat too quickly, which can cause the epoxy to cure too fast, it is best to mix smaller batches that can be used within a short period of time. Fresh epoxy has a lower viscosity and is easier to apply to your surface. To maximize your working time, once the epoxy is mixed, you should spread it out over a larger area to increase surface area, like transferring it into a roller pan.

Preventing Air Bubbles

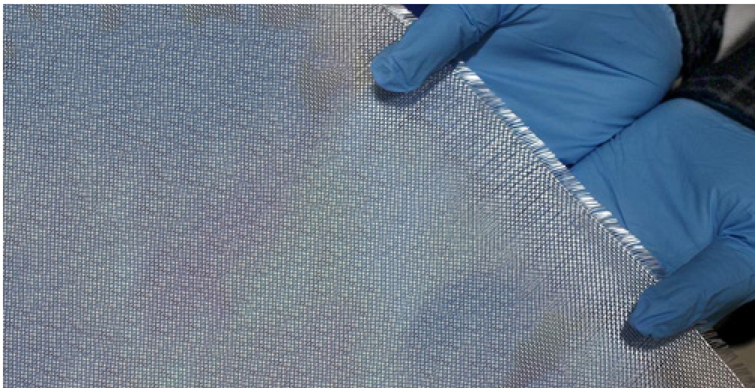
There are a variety of ways air can become trapped in your epoxy. Stirring too vigorously or lifting your mixing stick can introduce bubbles into your epoxy. Air can also be introduced by transferring the epoxy, outgassing from a porous surface, or applying a thick coating.

When transferring epoxy from my mixing container to my roller pan, work surface, or another container, I find it helpful to pour the epoxy onto my mixing stick, directing the epoxy into the pan. This helps minimize air bubbles.

Porous surfaces, like wood, can outgas into your epoxy. This is caused by the wood warming up due to the increasing temperature of the epoxy during the curing process. I recommend pre-sealing your surfaces with a thin seal coat of epoxy. Once cured, the epoxy coating will be a barrier, preventing out-gassing. This coating should be lightly sanded before applying more epoxy.

If you want a thicker coating, like a bar top finish, our 809 Notched Spreader could be used to maintain a uniform thickness. Another effective option, to avoid trapping air bubbles, is to apply multiple thin coats to build up to your desired thickness. Our 800-2 Roller Covers have an extremely low nap that makes them an excellent option for applying thin coats of epoxy.

If you plan to apply fiberglass cloth over wood, it's best to use fabrics that are 6 oz./yd^2 or lighter. Heavier fabrics tend to show, even after being fully wet out with epoxy.



Bristle can be cut shorter to increase stiffness for application.

Rolling with 800 Roller Cover and tipping with foam brush.

Misting with Denatured Alcohol to remove air bubbles.

Using a propane torch to remove air bubbles.

Removing Air Bubbles

Once the epoxy coat is applied you may find air bubbles entrapped in the wet epoxy. A foam brush, or a section of the 800 Roller Cover, can be lightly dragged over the wet epoxy to help remove those air bubbles. Using a heat source, such as a propane torch or heat gun, can also help remove air bubbles near the surface. The heat temporarily lowers the surface viscosity of the epoxy allowing the air to escape. Releasing the air involves passing your heat source over the surface at a rate of approximately 12" per second to prevent scorching the surface. Another option to remove these bubbles is to lightly mist the surface with denatured alcohol. The alcohol lowers the surface tension, allowing the air to escape from the epoxy.

If your 105/207 coating cures and you still have entrapped air bubbles, you really only have two options. You can sand or grind the epoxy down to expose the offending bubbles, or just live with it. If the bubbles are located on the surface of a small area, or there are many entrapped air bubbles, you may consider sanding the entire surface until you expose the bubbles. The alternative is to grind away the epoxy just where the bubbles are located until the bubbles are exposed. In either scenario, once the bubbles are exposed, use compressed air or a vacuum to remove any sanding debris within the air bubble cavities. Then apply more 105/207 with a spreader at a low angle to force the epoxy into any voids. After a few hours, you can continue recoating the entire surface to build up to your desired thickness.

Fiberglass Cloth for Clear Finishes

If you plan to apply fiberglass cloth over wood, it's best to use fabrics that are 6 oz./yd^2 or lighter. Heavier fabrics tend to show, even after being fully wet out with epoxy.

Strip plank construction with thicker planking, or unstable woods, have a greater degree of wood movement. In these applications, it is beneficial to orient the fabric at a +/- 45° angle. This minimizes the possibility of the fiberglass buckling if there is wood movement. If the wood does move over time, it is possible to see small white hash marks from the fiber bundles breaking and buckling.

Another tip is to avoid any pooling of epoxy under the fabric. This can cause your surface to look like it has a hump or waves. Also, if you're sanding the surface, you are more likely to cut into the fiberglass with your sandpaper. This can leave white marks where the fiberglass is damaged, even if you recoat with epoxy. To ensure your fiberglass is flush with the surface, use a squeegee to press it firmly against the surface. You should still see the weave of the fabric after you have wet out and applied your fiberglass. If it looks shiny, you have too much epoxy on the surface, and you should remove it with your squeegee. After that coat begins to gel, you can continue applying multiple thin coats of 105/207 to fill the weave of the fabric.

Recoating Window for 105/207

An advantage of 105/207 is that you can recoat within six hours, at 72°F (22°C), without any surface preparation between coats. At this temperature, the ideal recoat time is around three hours to avoid sanding between coats. If you can touch the surface of the epoxy with your gloved finger, and you can leave a mark on the epoxy without the epoxy transferring onto your glove, you know you can recoat. If you wait until the next day to recoat 105/207, you will need to sand the epoxy dull to get good adhesion. Make sure the epoxy sands to dust and does not clog your sandpaper, if it is too soft you will want to wait for the epoxy to increase in hardness ideally waiting 24 hours for the epoxy to cure.

I hope these tips are helpful, and I wish you the best of luck on your next clear coating project. If you have any questions please take advantage of our technical support line at 866-937-8797.

To learn more about our **207 technical specifications** scan the QR code.

Why Choose
WEST SYSTEM® Epoxy?

By GBI Technical Department

As we wrap our show season, our Technical Service Staff reflects on how each of us would answer a common question from attendees, "Why should I use West System Epoxy?" We often forget to mention several reasons in person, so here is a list to help demonstrate why West System Epoxy is your best choice.

Legacy

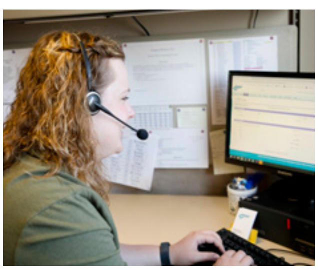
Meade and Jan Gougeon developed the product line over 55 years ago and it was quickly adopted by the best boat builders. The list of world-class boats built with WEST SYSTEM is long and illustrious including high-powered sportfishing boats and extraordinary luxury yachts. Builders of acrobatic stunt planes and wind turbine blades have used WEST SYSTEM Epoxy with excellent results.

Consistency

We always appreciated when a customer would comment on how our product handled and cured the same way each time they used it. This is not by accident. We are an ISO9001:2015 certified company, which means we have a quality control system that meets the standards of commercial aerospace companies. Just one part of this quality control is that every batch we manufacture is individually tested to tolerances that are imperceptible to our customers. When using WEST SYSTEM Epoxy, you will always have predictable and repeatable results.

Instructions

We have thousands of pages of instructions available online, in print, and through *Epoxyworks*, with new information being added regularly. Weight and volume mixing ratios are on our containers for those who don't want to use our pumps. Our kit products have detailed instruction inserts in every package. In addition, our videos on YouTube are available for even more explanation and of course, we literally wrote the book on boatbuilding, The Gougeon Brothers on Boat Construction. For those sailing abroad, many of our publications have been translated into multiple languages.



Technical Service

If you prefer to discuss your project, or have a unique challenge, you can talk to an experienced Technical Service expert. We're available weekdays 9:00-5:00 EST/EDT. We staff our phones so we typically have very short hold times and are happy to spend as little or as much time as the customer requires to make their project successful. Additionally, we handle emails through the webform on our website and respond to inquiries through our WEST SYSTEM social media channels.

Our Technical Service Staff includes expertise in building and repairing boats and airplanes, fabricating advanced composite structures, and engineering. All of this expertise is included in the price of WEST SYSTEM Epoxy.

Datasheets

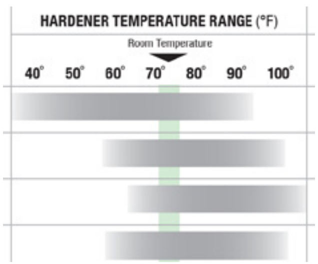
We report all of the physical properties of each resin hardener combination on Technical Datasheets (TDS). This is often more information than is needed, but it is available for advanced users or professionals who need to have documentation for the product they have specified.

Safety

Our website and published literature have many pages of information on how to use our epoxies safely. It is an important topic to be educated on before using any epoxy. All of our Safety Data Sheets (SDS) are available online with just one click from the home page. We do not require you to register to obtain them and they include a substantial amount of information so customers are well informed.

Versatile Product Line

WEST SYSTEM Epoxy's 105 System of products is amazingly versatile. Buying separate laminating resin, adhesive, barrier coat resin, and fairing compounds is unnecessary. All projects can be completed with 105 Epoxy Resin® by simply selecting a hardener, and if needed, a filler. Our additives can be used to modify the 105 Resin combination for specific applications. The 105 System also includes 207 Special Clear Hardener®, which provides a blush-free cure and structural properties.



Wide Temperature Range

The hardeners offered in the WEST SYSTEM line, which are used with 105 Resin, enable you to work in in temperatures between 40°F and 110°F. You can simply select the appropriate hardener based on the temperature, and you can use the same resin, fillers, and additives.

Minimal Odor

Many of our customers switched from polyester and vinylester products to WEST SYSTEM, just so they didn't have to deal with the high percentage of Volatile Organic Compounds (VOC) which create that strong smell. WEST SYSTEM Epoxy emits nearly 0 VOC and has a very low odor. In most applications, a respirator is not needed.

Availability

WEST SYSTEM is readily available at hundreds of brick-and-mortar stores and websites. This provides options to ensure you are getting the best price and service. Plus, when you need more, you know you can source it quickly.

Packaging

WEST SYSTEM Epoxy has a very long shelf life, but to take advantage of this, the container also needs to be durable. Our steel cans do not shrink, leak, or become sticky. The plastic containers used for large quantities have very thick, industrial-grade construction. The stiff, wrapped cardboard tubes used for fillers won't tear or weaken with age and the tight-fitting plug top keeps the contents dry and prevents contamination. The printing on the cans won't fade or smear so the ratios are always legible. Our high-quality packaging also ensures that you will receive our product in great condition and eliminates the need to return because of damage from handling.

Strength and Reliability

When asked "Why is WEST SYSTEM Epoxy better than its competitors?", we believe the customer often expects us to begin explaining that it is stronger. Most competitors do not provide as much information on the cured properties of their products so making a comparison can be difficult. We have done extensive moisture uptake, fatigue, and creep stress testing. We have not seen our results replicated by our competitors. WEST SYSTEM is specifically formulated to achieve excellent adhesion and high strength with a room temperature cure. Understanding that other epoxy products may require specific curing processes or manufacturing methods is important. WEST SYSTEM can be used in real-world conditions, is easy to use, and achieves high strength ensuring a successful project. This provides us with a pedigree that is unmatched in our industry.

Community Support

From the early days of our company, our founders instilled a culture of giving back. We allocate 3% of our profits to the Gougeon Employees Foundation, which is managed by a team of our employees. This team carefully selects local charitable and educational organizations within our community to support. Additionally, we fund scholarships at multiple universities for individuals pursuing careers in composites or science. We offer significant support to a selection of schools with well-established boat building or composites programs and operate an educational support initiative that offers discounted products to hundreds of students. Furthermore, we contribute to sponsoring regattas and other events on a national scale. The purchase of our products helps support the much larger marine and composites industries.

Why Use WEST SYSTEM?

Our perpetual dedication to quality, versatility, technical support, outstanding legacy, and community support are many of the things that make WEST SYSTEM great. However, it is the culmination of all these aspects that make it easy to succeed with WEST SYSTEM. When you consider the cost of the materials, time and effort that goes into your project, choosing WEST SYSTEM Epoxy is an easy decision for success.

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**.

WEST SYSTEM User Manual & Product Guide

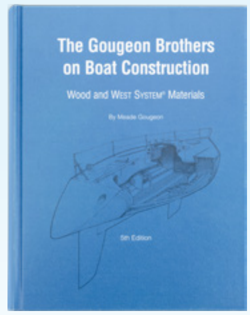
Detailed guide to all the WEST SYSTEM products. Includes an epoxy selection guide, basic use instructions, handling information, and common errors problem solver. Essential for WEST SYSTEM Epoxy beginners.

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, teak deck installation, gelcoat blisters, final fairing, and finishing.

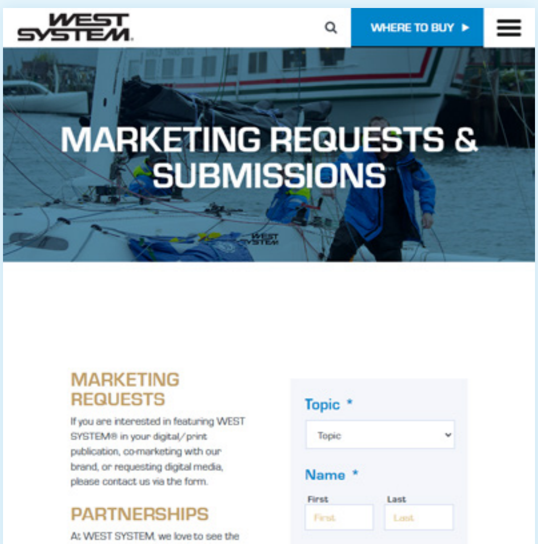
Wooden Boat Restoration & Repair

Illustrated guide to structural restoration, reducing maintenance, and prolonging 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.



The Gougeon Brothers on Boat Construction

A must for anyone building a wooden boat with WEST SYSTEM Epoxy. Fully illustrated composite construction techniques, materials, lofting, safety, and tools. 5th Edition, revised 2005.



Completed a project? We'd love to hear about it!

We couldn't produce *Epoxyworks* without the submissions from passionate individuals like you. Share your projects with us and you might be featured in an upcoming issue of *Epoxyworks*. For more details, visit our new submission page, or contact us at info@epoxyworks.com.

Contacts by Region

North and South America, China, Japan and Korea

WEST SYSTEM

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Europe, Africa, the Middle East and India

Wessex Resins & Adhesives Ltd.

wessex-resins.com

Australia and Southeast Asia

Atl Composites Pty. Ltd.

atlcomposites.com

New Zealand and Southeast Asia

Adhesive Technologies Ltd.

adhesivetechnologies.co.nz

Sindhu Belki is the Project Manager at Alabama Rocketry Association. ARA builds solid and liquid propellant rockets. His team does the composite manufacturing and their top choice for epoxy is WEST SYSTEM. They have been using WEST SYSTEM® products for years and are very happy and satisfied with the outcome. This is a photo of their final product.

Jon Shackelford, a faithful reader of Epoxyworks, recently built a 16'6" strip kayak made from Bear Mountain's Resolute plan using WEST SYSTEM® 105 Resin®/207 Special Clear Hardener®. The hull is western red cedar; the deck is Sitka spruce with mahogany accents and white oak trim. The white oak was darkened with ammonia fumes.

We began working with Unionville-Sebewaing Area High School's Robotics Electric Racing in 2019. They were working on their first attempt at building an electric car. Since then, they have continued utilizing WEST SYSTEM products in their builds. On this vehicle, the students used WEST SYSTEM Epoxy to build fiberglass body pannels. "The students have learned a lot already and took a lot of pride in what they produced" says mentor Jason Beagle. We look forward to watching their program grow.

After running into a crosstie, the cowling on John Harter's John Deere® cracked. The break was so severe he thought about replacing it. After pricing out the cost of a new cowling, he decided to put G/flex® Thickened Epoxy Adhesive to the test. He cleaned the parts with denatured alcohol and went to work. He spread a little G/flex on the parts, then laid a stainless steel screen in the wet epoxy for reinforcement. He then applied a little more G-flex to ensure the screen was fully embedded in the epoxy. Clamping was the most challenging part.

After the epoxy cured, he reassembled it just like new! From the outside you can't really tell it was broken. After almost two years, and all the vibrations of the engine, it's STILL holding! G/flex epoxy is best!

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Share your work and fuel your creativity

Submit your projects to info@epoxyworks.com