FREE

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EPOXYWORKS®

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Contribute to Epoxyworks

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.

Visit our website for submission guidelines.

Auxiliary Rear Station Build

By Alvin Gall

From past fishing experiences, I've learned that quick changes in speed and direction are often required when retrieving a hooked fish. Having a control station on the fishing deck of our Trophy 2359 would make for a more enjoyable fishing experience. Since we've been underutilizing our bait well, we chose to sacrifice it and built a new rear station in its place.

In our new rear station, we needed to have controls for our primary motor, hydraulic steering and 20 hp auxiliary motor. Our primary motor shifter and throttle up front in the cabin are electronically controlled, so adding a second set of controls nearer the stern was just a matter of ordering a few parts and connecting them. The same for the hydraulic steering. The 20 hp auxiliary motor, however, is primarily used for trolling, so we decided its only set of controls could be at the rear station.

Not having undertaken a project like this before, there was a lot of information to ramp up on. I read related sections of *The Gougeon Brothers on Boat Construction*, I read through projects in *Epoxyworks*, searched the internet for similar projects, and watched online videos.

The completed rear station installed where the underutilized bait well used to be.

Building a Plug

Armed with my knowledge, I sketched plans and revised again, and again. In my fabrication facility (aka, my garage), I made a mock-up of the dash out of scraps of wood to ensure the wheel, throttle, and shift levers were spaced appropriately. Using an oscillating saw, I cut the live bait well out of the boat about 4" above the deck to allow for a toe kick and 2" from the rear bulkhead to leave a flange for attaching the rear station to the hull.

I cut corrugated cardboard templates to follow the curved contours of the inside of the hull, the inside edge of the gunwale, and the back of the cabin bulkhead. Once I had a perfect fit, I used these templates to cut a plug out of ¾" MDF. I assembled the plug, test fit, and adjusted it until the plug fit perfectly in place.

The cracks and joinery gaps in the plug were filled with WEST SYSTEM® 105 Epoxy Resin® and 206 Slow Hardener® thickened with 410 Microlight® Fairing Filler. I chose 410 Microlight® Fairing Filler so that the fairing compound could be easily sanded with a finer grit sandpaper. This way I would be less likely to abrade the soft MDF plug. Then I applied multiple layers of wax to the plug.

Laminating the Molds

With the plug finished and prepped, it was time to laminate the mold of the plug. The mold was made in four pieces, one at a time. I made sure to mold registration keys into the parting molds using putty. This ensured they would "lock" together in the correct place once they came off the plug. I applied the epoxy compatible in-mold coating to the plug following the manufacturer's instruction. I applied layers of 6 oz. fiberglass cloth saturated with WEST SYSTEM 105 Epoxy Resin and 206 Slow Hardener.

The edges of the molds, and the larger flat areas of the mold, were stiffened with scraps of plywood placed on edge 90 degrees to the surface. They were attached with the same 105/206 epoxy, then I added a fillet of epoxy thickened with WEST SYSTEM 403 Microfiber Filler for additional strength.

After the four pieces were finished, and taken off the plug, I noticed a few tiny bubbles in the mold surface. I assume these were from my brushing technique or irregular gelcoat thickness. I filled those with epoxy thickened with 410 Microlight Fairing Filler and sanded them smooth. Then I waxed, and waxed, and waxed the inside of the mold.

Rear deck before demolition.

Rear station sketch.

Fully assembled plug.

Test fit of the plug.

Application of the in-mold coating.

Pre-cut fiberglass.

The rear station with all blemishes properly patched.

Fitting the controls.

Rear station mock-up using scraps of plywood.

Prepping to laminate the second of the three mold parts.

Filleting the back side of the plywood stiffeners.

Fitting the doors for the battery switch and cabinet.

Casting the Parts

In preparation for laminating the rear station, I precut 6 oz. biaxial cloth and 24 oz. roving into shapes that fit the inside areas of the mold and some pieces of ½" marine grade plywood. The plywood I used for stiffening the larger flat panels and for reinforcing the areas where hardware and attachments were planned. I laid them out in the order of use.

I brushed on the in-mold coating. Then I laid in the overlapping layers of 6 oz. cloth saturated with WEST SYSTEM 105 Epoxy Resin and 206 Slow Hardener. I rolled out the bubbles and let the epoxy get tacky. Then I laid in the slightly heavier layer of fiberglass cloth saturated with epoxy and rolled out the bubbles. While the second layer was still wet, I wet one side of the ½" plywood stiffeners with WEST SYSTEM 105 Epoxy Resin and 206 Slow Hardener slightly thickened with 403 Microfiber Filler. I placed the wet sides in the hardware attachment areas of the mold. Then I coated the exposed side of the marine plywood with unthickened 105 and 206. Once that was tacky, I added a fillet to the edges of the plywood using epoxy heavily thickened with WEST SYSTEM 403 Microfiber Filler. Again, I waited for it to get tacky. The final two layers of epoxy-saturated 6 oz. fiberglass cloth were laid over the entire tacky interior area and left to cure.

When I removed the part from the mold, I found that small areas of the gelcoat stuck to the mold on two of the round outside corners. I patched those blemishes and sanded smooth. Then I polished and waxed the final product. Measuring twice, I cut holes for beverage containers, drilled holes for the steering wheel, for the screws and cables of the control levers, and for the switches for both the primary and “kicker” motors. I made doors for the battery switch and the cabinet from an epoxy laminate. To connect the steering station to the boat I used bolts and screws through the bulkhead, and protruding parts of the original bait well. Any holes that cut through my reinforcing plywood got a coat of neat epoxy to seal the wood. Then I applied a caulk fillet at the joints.

I learned a lot, and I am happy with how my project turned out from both the functional and aesthetic aspects. Research, planning, courage, determination, attention to detail, and the platform of WEST SYSTEM products are all you need to create pretty much anything.

Calculating Epoxy Use When Using WEST SYSTEM® Accessories

By Terry Monville – GBI Technical Advisor

Taking the time to do quick, rough calculations at the beginning of a project can help you save on money and frustration in the long run. This can be especially helpful if you're new to working with epoxy and haven't quite developed the intuition yet for how far your epoxy will go. Here are some numbers we've collected over the years for estimating epoxy coverage when working with our WEST SYSTEM® Accessories.

Spreading Epoxy with a 809 Notched Spreader

The WEST SYSTEM 809 Notched Spreader is a great tool to know how thick you are applying epoxy.

I use the 809 Notched Spreader for spreading neat epoxy on tabletops for an even film thickness or for spreading thickened epoxy when bonding and fairing.

With neat (unthickened epoxy), the peaks will flow out, leaving an even film coverage. Using the ¼" notch side to spread 105 Epoxy Resin® mixed with 207 Special Clear Hardener® on a waxed glass surface, results in about 3.2 oz. of epoxy per square foot, with a film thickness of 35 mils. When coating wood or other porous surfaces, the epoxy would soak in and have a thinner finish unless the surface is sealed with epoxy before doing the flood coat.

The 809 Notched Spreader is also helpful for working with thickened 105/20X and our specialty epoxy systems. G/flex® 655 Thickened Epoxy Adhesive and Six10® Thickened Epoxy Adhesive are pre-thickened. When using the 809 Notched Spreader, it will leave behind V shape ridges in the thickened epoxy. This works great for bonding because it creates a consistent thickness bond line and the grooves will allow air to escape when the parts are assembled.

809 Notched Spreader notch pattern used	655-8 Coverage per 8 oz. kit	Six10 Coverage per 6.4 fl.oz. tube
¼" notches	2.5 ft^2	2.0 ft^2
⅛" notches	3.7 ft^2	2.8 ft^2
1⁄16" notches	6.7 ft^2	5.0 ft^2

Fillets with 804 Reusable Mixing Stick

It is common practice to create a thickened epoxy fillet in corners so fiberglass can make a smooth transition between surfaces. You can use the round end of our 804 Reusable Mixing Sticks to create a nice ⅜" radius for just that purpose.

Hold the stick 90° to the corner to create a nice ⅜" radius fillet. This is a good fillet shape for preventing air bubbles in a corner when applying lightweight fiberglass fabric. If you're holding the stick at 45°, the radius will fatten up and give a more gradual transition for medium-weight fabrics.

Curious how far your epoxy will go? Check out these data points:

	Six10	105/20X with 404, 405 or 406 peanut butter consistency	105/20X with 407 peanut butter consistency
Epoxy Amount by volume	1 Tube or 6.4 fl.oz.	5 Pumps Each 105/20X	3 Pumps Each 105/20X
⅜" Radius fillet length	25'		
Fat ⅜" Radius fillet length	20'		
¾" Radius fillet length	6.7'		

There are three things in particular I would like to draw your attention to from the table:

1. When you double the radius of the fillet (⅜" to ¾"), you use more than twice as much volume of epoxy.
2. Fillets can be done with 407 Low-Density Filler, but it will have about half the strength as they would if using one of our higher density fillers (404, 405, or 406).
3. When using the higher density fillers, the filler does not have much impact on the overall volume of the final mixed epoxy and filler. When using 407 Low-Density Filler to thicken your epoxy, the final mixed volume will increase in size. To thicken 3 fl.oz. of epoxy with 407 Low-Density Filler to a peanut butter consistency, the resulting mixture will be about 6 fl.oz.

Cartridges and Fillable Caulking Tubes

Laying a consistent bead of epoxy is easiest done with a caulk tube. Six10 conveniently comes packaged in a unique, two-part caulking tube that can be dispensed with a standard caulk gun. You can cut the tip for a ¼" bead opening and, if you can lay down a perfect ¼" diameter bead, you will get 16' of epoxy. Though most of us are not skilled enough to lay down a perfect bead, 16' is good enough for estimating.

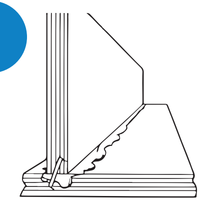
If you want the caulk tube application experience, but Six10 is not quite the epoxy you need, we do offer our 810 Fillable Caulking Tubes. Simply fill the tube with your thickened epoxy of choice, and you can lay down a ¼" bead as easily as you would with Six10. These tubes hold about 10 fl.oz. (as opposed to Six10's nearly 6.5 fl.oz.), so the expert bead layer should be able to get almost 25' out of a ¼" bead using the 810 Fillable Caulking Tubes.

With either of these tubes, do not use a rodless pneumatic caulk gun. These are not compatible and can cause the epoxy to squeeze out the back. With the Six10 tubes, it can also cause the epoxy to be dispensed at the incorrect ratio. If using a powered caulk gun, you need to use one with a physical plunger.

When working with accessories, there's always going to be a fair amount of fluctuation in epoxy use amount due to the individual who's using the accesories. Estimating off the cuff how much is just enough epoxy, without running short, takes years of practice and a bit of luck. However, having some hard numbers to reference will help you build your intuition more quickly, and make you a more efficient epoxy user. Taking a little extra time to do your calculations will pay dividends in the end.

How To Apply A Fillet

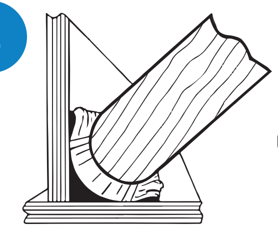
1



Coat and join the parts.

Joint coated with epoxy and temporarily held with staples.

2



Apply and shape the fillet.

Use the rounded end of the 804 Mixing Stick to shape the fillet.

3

Clean away excess epoxy outside of the fillet.

Tangent point of mixing stick produces a clean margin area that aids in the cleanup of excess epoxy mixture.

Making a Hard Top for an H336 Sailboat

By Kevin Lennon

ABOVE:

Kevin showing off his finished hard top and custom canvas.

There are little customizations we do to our boats that set them apart from all the others out there like it. For my Hunter 336, it was replacing the original dodger with a hard top. The dodger was from 1996, and it had so many repairs that it was starting to look shabby. It was the perfect time to upgrade the dodger to a hardtop.

I had done some minor fiberglass work before, but nothing as extensive as this project. Since I was going to tackle this project indoors over the winter, WEST SYSTEM® Epoxy was the best choice for its superior quality, low odor, and ease of measuring. At one pump to one pump with the 300 Mini Pumps, even I can figure that ratio out.

I started by bringing the bows from the dodger home and setting them up in my shop. Because I didn't want the hard top permanently attached to the bows, I wrapped them with masking tape to protect them from the epoxy. Next I attached the foam board core to the bows with copper wire. This would hold the foam in the correct shape, so it contoured perfectly to the bows. Once both sides were laminated, the copper wire would be cut. With the foam board attached, I cut it to size, and shaped it with a sander. The foam cut easily.

Now it was time to apply the fiberglass. I took safety precautions at all steps of this build, but rubber gloves were a must when working with the epoxy. I also wore eye protection and a good dust mask.

I applied two layers of 6 oz. fiberglass all the way around the edge of the foam core using WEST SYSTEM's 105 Epoxy Resin® and 206 Slow Hardener®. The fiberglass extended about 4" onto the top and bottom of the foam to ensure a good overlap. After the edges cured, I gave them a light sand and applied two layers of the same 6 oz. fiberglass to the top, and again allowed it to cure. Time to move on to the bottom side.

At this point, the bows still needed to remain attached to the foam to maintain its shape. I cut a wide strip of fiberglass to laminate all the way across the center bottom of the foam, between the two bows. Once this cured, the foam was stable enough to hold its shape, and the bows could be removed. The final two layers of fiberglass could then be applied over the whole bottom surface.

In retrospect, the only thing I would change up to this point in the process would be to apply three layers of fiberglass instead of two. The overall cost is not that much more and it would give some added strength for a safety factor.

With the fiberglassing complete, it was time to do some sanding. I sanded the hard top to remove all the high spots and start smoothing out the finish. Once the surface was reasonably smooth, it was time to use the WEST SYSTEM 410 Microlight® Fairing Filler. This filler, when mixed with the epoxy, filled in the low spots, giving me a more fair surface. I was getting closer to that finished look, but it took a few rounds of filling and sanding before I was happy.

Because the epoxy is not UV stable, my thought was to do a two-part epoxy paint for the final coat. However, a friend who owns an auto body shop told me I could have any color I wanted, so long as it's white. That made my decision easy. White it is!

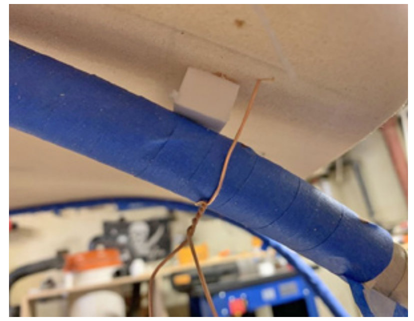
The critique from my friend was that there were some pinholes still left in the surface. A normal person would not see them, but my friend is kind of a perfectionist. Those darn auto body guys. I did one more coat of filler to solve the problem so he could spray away.

Now that it was done, we needed a way to attach the hard top to the bows. I used stainless pad eyes with stainless steel bolts, through-bolted. I used a rubber washer on the top side. I'm sure there are other options I could have used to mount it, but this seemed to work for me.

The last piece of the puzzle—building the new canvas for the hard top. I have been playing around with canvas work for a numbers of years, so I kind of knew what I was doing. Even still, I found the canvas work to be more difficult than the hard top itself.

Now, my H336 has a beautiful hard top, and I've gained a few skills along the way. As someone with little fiberglassing experience, who wanted to tackle a large project such as this, what did I learn?

- Gather as much information as you can. Pinterest, Google Images, etc. it all helps.
- Though intimidating at the outset, somebody with basic woodworking skills could do this type of project.
- WEST SYSTEM products make it easy!



Foam core was attached to the bows with copper wire to help maintain its shape.

Two layers of 6 oz. fiberglass were applied to the foam core.

The hard top was sanded to remove all the high spots and start smoothing out the finish.

Stainless pad eyes with stainless steel bolts were used to mount the hard top.

The finished hard top.

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.

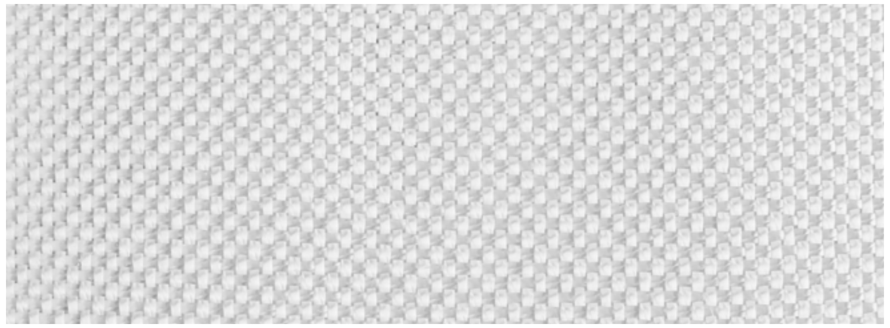
West System® Fiberglass Fabrics

By Jeff Wright – GBI VP of Technical Services

When someone says "fiberglass", people may envision a shiny boat hull or even pink insulation, but a composite repair professional pictures a pure white fabric that could be woven in multiple ways and is available in multiple thicknesses. Specifically, fiberglass is the reinforcing fiber used in most marine composites. When epoxy encapsulates fiberglass, it becomes a Fiber Reinforced Plastic (FRP) material. Since you are reading this article in *Epoxyworks*—and are hopefully enjoying it—let's assume that the plastic component of FRP materials will be West System® Epoxy. This article will focus on the different fiberglass fabrics we offer to use with West System Epoxy.

The fabrics we offer are similar in strength (per unit thickness), but their differences are important to understand so that you can select the most appropriate fabric. Selecting the appropriate fabric can ensure you achieve your desired thickness, weight, and ability to conform to the surfaces to which the fabric is applied.

As I said earlier, they have similar strengths, but that should not be confused with the absolute strength of the entire laminate. I am referring to the "specific strength" of the fiberglass or the stress it can withstand per unit of cross-sectional area. For most applications, using two different fabric styles to achieve the same thickness will result in very similar properties. The fabric style will have more influence on the ability to conform, ease of wet out, and surface finish. To help decide which fabric to use I will discuss the characteristics of West System fiberglass fabrics.



Woven E-Glass

Woven Fabrics

These fabrics are manufactured, just as the description implies, by weaving small individual yarns of fiberglass over and under one another in a tight 0-degree/90-degree pattern called a plain weave pattern. This should not be confused with woven roving which is a fabric where a larger diameter yarn called roving is woven in a similar way but resulting in a much heavier and coarser pattern.

Woven roving is commonly used by manufacturers for hull lamination because it enables them to build thick laminates in areas with a minimal number of layers. The coarse weave does not optimize resin content which is not a significant concern for most production builders. West System does not offer woven roving because it is not suited for many of our customers' applications.

The lightweight woven cloth fabrics are ideal for many types of small wooden boatbuilding projects as well as lightweight FRP applications. The tight weave results in a smooth texture that can easily be filled in by applying one to two additional coats of epoxy. West System Epoxy offers the following woven cloth products.

740

This is a 4 oz. woven cloth, to be specific it is 4 oz./yd^2. It is the lowest-weight fabric we offer and if you refer to our thickness per layer chart, it is the thinnest per layer. It is light enough that when properly wet out it will be transparent, which is an important attribute for strip plank canoes or other bright finished wooden boats that require a layer of fiberglass over their surface. The low weight and thickness also enable this product to easily conform to complex surfaces. If a substantial thickness is required, such as the repair on a solid hull side laminate, a significant number of layers will be required.

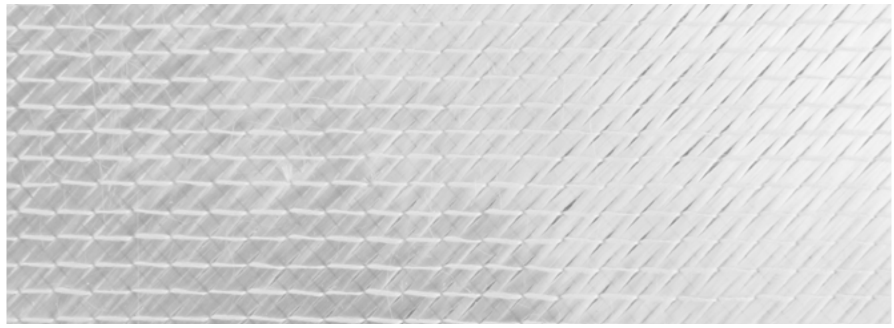
742

At 6 oz./yd^2, this fabric will still provide a transparent laminate with 50% more thickness (and weight) than West System 740. It is still highly conformable, and is well-suited for strip plank construction where a little more thickness and the resulting strength are required.

745

This is a very common fabric in the boat-building world and it is sometimes just called "boat cloth". The 10 oz./yd^2 weight still enables it to wet out easily and has relatively good drapability, but it will not provide a transparent layer. If it is used as sheathing on a wooden boat, you should consider a painted final finish.

A common use of this fabric in production boatbuilding is as a final layer. After a thick laminate is wet out, one layer of 10 oz./yd^2 fabric is simply laid on the laminate without adding resin. This final layer of woven cloth will be wet out by the excess resin and provide a much smoother finish than a coarse woven roving fabric.



Knitted Biaxial Glass

Knitted Biaxial Fabrics

A knitted fabric is a fabric where the yarns are not woven under and over one another, instead they are simply laid on top of one another, then a polyester thread is used to stitch them together. This manufacturing process enables the yarns to be oriented in multiple directions. Orienting two layers of yarns at +45 degrees and -45 degrees to the edge of the fabric makes a very versatile fabric that is referred to as +/-45 biaxial fabric or biaxial for short in the industry. The non-woven nature avoids the crimps where the yarns have to bend over and under one another. This increases strength when the fabric is in tension by eliminating the stress concentrations at each crimp. It also improves drapability, reduces areas where resin can collect (which improves the fiber-to-resin ratio), and provides a smoother finish than a woven roving fabric. West System offers two biaxial fabrics:

737

This is a fabric that weighs 17 oz./yd^2 and the fibers are oriented at +/-45 degrees to the edge of the fabric. Orienting the fibers in these directions gives the fabric good conformability, but it is heavier in weight resulting in greater thickness per layer than a lightweight woven cloth.

This fabric is well-suited for new FRP construction and the repair of common marine laminates. The surface finish is not as smooth as a woven cloth, which is not an issue for most composite repairs because fairing compound will probably be required. Keep in mind that one feature of FRP construction is the ability to mix and match fabrics. For example, it is acceptable to laminate three layers of 737 17 oz. Biaxial Fiberglass to build up the needed thickness and a final layer of 745 10 oz./yd^2 cloth for a smoother finish before fairing.

738

West System 738 fabric is a good example of how fabrics used in FRP structures can be a combination of different fabric types. It consists of the same 17 oz./yd^2 that makes up our 737 fabric and has a ¾ oz./ft^2 chopped strand mat (CSM) stitched to one side. The purpose of the chopped strand mat is to increase the thickness per layer resulting in fewer layers needed to achieve the desired thickness. Since the CSM is stitched, there is no issue with binders that are used to hold some CSM fabrics together which may not be compatible with epoxy resins.

The chopped strand on the mat changes the properties of this fabric when compared to 737. Since the CSM layer does not have continuous fibers, it is not as strong as the 17 oz./yd^2 component. This fabric will be slightly weaker per unit thickness than 737. It is also important to note the difference in how the weights are measured.

Using English units of measure, the continuous fiber portion of the fabric is measured in oz./yd^2 while the CSM portion is measured in oz./ft^2. This is then described with a 4-digit number such as 1815, 1208, 1708 and many others. The first two digits are the weight of the biaxial portion, the third and fourth digits are the weight of the CSM portion. As expected with our English units of measure it gets even more confusing, 0.75 oz/yd^2 is a 3-digit number, so it becomes "08". So, for those that have heard of "1708" fabric, 738 would be considered a 1708 type fabric, 17 oz/yd^2 biaxial with 0.8 oz./ft^2 of chopped strand mat.

Tape

Tape describes a fabric cut into a narrow width between 3" and 12". This narrow width is good for applications such as tabbing structuring into a hull, where the tabbing laminate forms an almost 90-degree angle between the hull shell and bulkhead or stringer. Although you can simply cut a full-width fabric to the desired width, the methods used by fiberglass manufacturers to cut to a specific width result in a very accurate and clean-cut edge.

729, 731, 732, 733

These tapes are 9 oz./yd^2 woven cloth in widths ranging from 2" to 6". The benefit of these tapes is that they are finished on the edge so they will not unravel. Attempting to cut narrow strips from a wide roll of woven cloth can result in frayed edges and yarns coming loose and making lamination more difficult.

727 Biaxial Tape

This 17 oz./yd^2 biaxial tape is 4" wide. An important feature of this tape is the polyester stitching that is used to hold the +/- 45 degree fiberglass yarns together. This stitching runs the length of the tape. Keep in mind that if narrow strips of biaxial tape are cut (perpendicular to this stitching), the tape will not maintain its width, and it will quickly be pulled out of shape.

The fabrics that West System offers are versatile and cover many applications, but there are other fabrics available that can also be used with West System Epoxy. It should also be noted that specific fiber direction in advanced composites can be critical and require unidirectional or tri-axial fabrics that we do not offer. As always, feel free to call our Technical Service staff to discuss your application. I hope this information, and the descriptions in our *User Manual & Product Guide*, make it easier to select the best fiberglass for your next project.

Dormer Window Repair

By Michael Huffman

A couple of years ago, I noticed that the bottom member of the double-hung window in my office dormer had begun to rot.

Knowing it would be difficult to buy a matching replacement, I decided to repair the window using WEST SYSTEM® Epoxy and fiberglass. I removed the sash from the frame and took it to my shop. The first step was to remove the rotted wood. It turned out the damage was extensive, affecting the wood all the way through the bottom member and into the vertical member.

Although the outside surface of the bottom member was flat, the inside surface incorporated a groove about a half-inch wide. Using thin aluminum sheet metal, I fashioned a mold that duplicated the shape of the groove and the bottom surface of the bottom member. After applying mold release, I attached the mold pieces with some sheet metal screws to the good wood outside of the damaged area, then sealed the edges with masking tape.

I then proceeded to wet precut pieces of fiberglass cloth, leftover from another project, with WEST SYSTEM 105 Epoxy Resin® and 206 Slow Hardener®. I laid them into the damaged area. This ultimately filled up the mold completely. I then screwed and clamped the final mold piece in place.

After the epoxy had cured, I removed the mold pieces and found the repair had been successful, accurately duplicating the shape of the repaired area.

I did a small of amount of handwork with a rotary tool to recut the seal groove in the bottom of the window. Then I sanded the repaired areas and applied latex primer and finish paint before reinstalling the hardware. The window looks good as new.

Editors Note: *When working in warm weather, you may want to use 209 Extra Slow Hardener® for filling large voids to prevent excessive exotherm.*

01

The bottom member before beginning the repair.

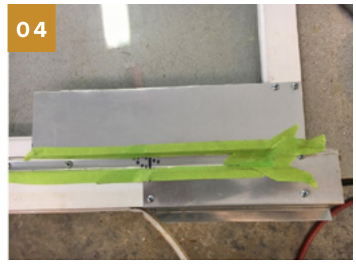
02

The rotted wood has been removed.

03

The mold piece was screwed and clamped in place.

04



The interior view of the taped mold piece.

05

An exterior view of the taped mold piece.

06

Wet-out pieces of fiberglass cloth were placed into the damaged area.

07

The epoxy cured and the mold was removed. Exterior view.

08

The epoxy cured and the mold was removed. Interior view.

09

The repaired areas, were sanded, primed, and painted. The hardware was reinstalled.

10

Reinstalled exterior view.

Jim Brown built this strip canoe in his New Hampshire garage. He used mostly cedar strips with some white pine and IPE on the gunnals. Using WEST SYSTEM® 105/207, he applied two layers of 6 oz. fiberglass to the bottom of his canoe and one layer to the inside.

After selling his Core Sound 17, George Abrams switched to art. He mostly does his art for fun, coming up with some creative projects including this ice cream cone sculpture. These sculptures were built out of carbon fiber and fiberglass using WEST SYSTEM® 105/205 and 105/207.

As a shipwright for 52 years, Mark Johnson has built many boats using WEST SYSTEM® Epoxy. One of which is this Pygmy Osprey standard kit kayak. He used stitch and glue construction. It is about 15 years old, and up until a year ago, it has lived it's whole life outside. Because of this exposure, he used AwlGrip® paint instead of varnish for UV protection. The bottom has WEST SYSTEM barrier coats followed by Bar Rust® epoxy, for a tough bottom. "She paddles like a dream, but tracks very straight, which is why I added the rudder."

Gary Barg has a 2000 Tiara Express 40 boat that had a power uplift table that stored in the engine hatch tub. It was high maintenance. It collected enormous amounts of dirt and bugs. Keeping it clean was always an issue. One fall, he and his wife had it. They pulled out all the mechanisms, stainless steel scissor lifts, hydraulic motors, lead screws, etc. They unfastened the engine hatch and loaded it into their pick-up with the aid of their dock neighbors.

The project moved to their home basement for the winter. They cut the fiberglass tub bottom out and left just enough lip to float the table top flush with the boat deck. They also fabricated a bottom to support the new deck. They used extruded aluminum angle, ¾" plywood and Six10® Thickened Epoxy Adhesive. They attached four jack screws to the bottom of each panel to level them to the existing top deck.

With the advice of the WEST SYSTEM® Technical Advisors, They did three pours of 105 Epoxy Resin® with 206 Slow Hardener®. For the first pour they weighed the four panels down with paint cans to prevent the panels from floating up. For the last pour the Technical Advisors suggested to add filler for softness if any sanding would be required. There was no sanding required. The final pour flowed beautifully. In total, they poured about three gallons of epoxy.

After the gelcoat was complete, the hatch looked like it came straight from the factory. They added insulation on the underside. With the above changes, They added about 10 inches of head room in the engine room.

Want to share?

Write to us at **westsystem.com/contact/marketing-requests-submissions**

RC Model Sailboat Builds

By Mark Borg

I have been using WEST SYSTEM® Epoxy for over 20 years. Over that time my projects have included building carbon fiber bikes and an amphibious robot to test my autonomous navigation software for my PhD in Robotics. Most recently, however, I built RC scale models of the 1995 America's Cup winner *Black Magic* and the Multi70 trimaran, *Maserati*.

Black Magic Build

In 1995 the New Zealand boat NZL 32 *Black Magic* won the America's Cup with a game changing design. The win turned yacht racing on its ear and cemented itself in my memory. 28 years later, I recreated *Black Magic* using foam, fiberglass, and WEST SYSTEM Epoxy.

I cut and shaped the hull from a block of pink insulation foam and covered it with 6 oz. fiberglass. Since this model was built in the warm weather, I used WEST SYSTEM 105 Epoxy Resin® and 206 Slow Hardener®. I reinforced the bow and stern areas with Kevlar® and the same epoxy to withstand bumps with docks. The model is 48" (122 cm) long and 96" (244 cm) high.

To balance the sails, the model has a 10 lb (4.5 kg) poured lead keel. I made the keel by shaping a piece of foam, making a plaster-of-Paris mold, and then pouring the molten lead into it. This is akin to a lost wax mold. Two threaded rods were cast into the lead keel to connect the keel to the hull. Foam pieces were fitted around the threaded rods and shaped to a wing foil profile. Over the foam, I used carbon fiber fabric to support the weight of the keel while the boat is heeling. The carbon fiber was wet out in place with WEST SYSTEM Epoxy and then vacuum bagged to remove any air bubbles.

Maserati Build

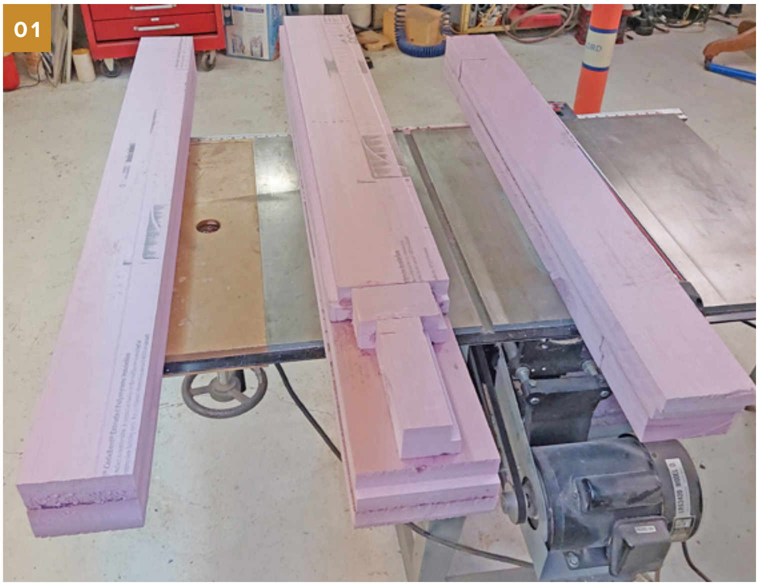
My second boat is a scale reproduction of the Multi70 trimaran, *Maserati*. The model is 53" (135 cm) long, 37" (94 cm) wide, 96" (244 cm) high and only has 3 lbs (1.4 kg) of lead.

ABOVE:

Black Magic and Maserati RC model sailboats.

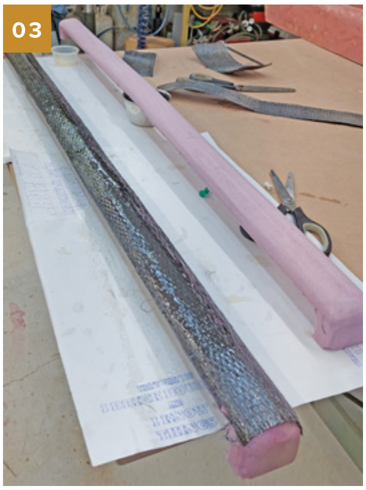
Similar to the monohull, the multihull is hand shaped out of pink insulation. To match the shape of the original boat, I used photos to get the proportion and ratios correct. To shape the foam, I used a hot wire foam cutter, utility knife, automotive style body file, and sandpaper in that order. Wire cutting gave the best finish with the least amount of mess. Unfortunately, almost every surface on the hulls involves a compound curve that required filing and sanding—the messiest ways to shape foam. Filing leaves a less-than-desirable finish since sometimes the file digs in unexpectedly and removes a chunk of foam.

In places where filling of the foam was needed, I used Bondo® Spot Putty or lightweight



The pink insulation foam prior to being shaped.

The foam was cut and shaped to form the hull.



The foam was covered with carbon fiber to form the cross beams.

The shaped foam was covered with two layers of 4 oz. fiberglass.

drywall compound. I used these fillers as opposed to thickened WEST SYSTEM Epoxy since the primary goal for the filler material was to be easier to sand than the base foam and strength was not a concern. This easy-to-sand filler minimized any distortion in the overall shape of the hulls from my sanding.

Once the correct shape was achieved, the hulls were covered with two layers of 4 oz. fiberglass. I used 4 oz. fiberglass and WEST SYSTEM Epoxy on the trimaran as opposed to the 6 oz. fiberglass that I used on the monohull, due to the improved draping capabilities that I required on the sharper hull form of the multihull.

For the cross beams, I used four layers of unidirectional carbon fiber with WEST SYSTEM 105 Epoxy Resin and 205 Fast Hardener®. The top and bottom layers of carbon fiber run longitudinally, and the middle two layers run on opposite 45-degree angles. I used the 205 Fast Hardener because I was using a vacuum bag to consolidate the laminate and I wanted the layup to set quickly. This increased strength was required to provide the support needed for the model to "fly" on one hull.

Additional Details

The sails for both boats are made from nylon spinnaker material (ripstop). The masts utilize ¾" (19 mm) diameter aluminum extrusion. The standing rigging is made from fly-fishing line, and fishing barrel swivel snaps are used to quickly attach all the rigging to the boat. To set the rig taunt, small, homemade guy line tensioners (like ones used on a tent) allow for the rig to be tensioned. The logos were designed with CAD software and cut out of colored vinyl. The logos with multiple colors required perfect alignment so register marks were used.

The rudder and sails for *Black Magic* are RC servo controlled. The trimaran still needs to be kitted out with remote control servos for the rudder and sail plan. In the future I have plans to add a manually retractable skeg and two, manually adjustable, carbon fiber, "C" shaped hydrofoils.

DN Iceboat Building

By David Fortier

The first DN that I constructed was in 1988. My brother, Wayne, gave me the International DN Ice Yacht Racing Association (IDNIYRA) official plans and a gallon kit of WEST SYSTEM® Epoxy to get started. The official plans I believe were the Gougeon® "wedge" design. I was a soft water sailor, racing catamarans in the summer, but the winter of '87, we had discovered these FAST winter sailboats. I would say that it changed my life, this boat and the epoxy. I had used some epoxies previously, but this was my first large epoxy project using WEST SYSTEM Epoxy.

As I said the DN is a racing class. We explored to find ice to race on, and in doing so, stuff happens—pressure ridges, open water, etc. I broke my DN many times but was able to repair it good as new thanks to WEST SYSTEM Epoxy. As far as I know, it is still together, although I know not where.

Prototype Build

In 2004 it was time to build a new DN iceboat. I decided to build a prototype first, and if all went well, I would build more using the same mold. This type of build would require a two-sided mold—one side a strongback, one side a mold for the fuselage sides.

I built the mold from quality ½" plywood, and of course, WEST SYSTEM Epoxy. I covered the strongback/mold with 6 oz. fiberglass and epoxy. Once it had cured, I filled the weave with WEST SYSTEM Epoxy thickened with fairing filler. This gave me a smooth surface. I painted the epoxy with Awlgrip®, so when polished, the vacuum bagged parts would pop off easily. I followed this same process for both sides of the mold.

TOP:

The completed DNs on their first ice. Plymouth Pond, in Plymouth, Maine.

01

Cutting the ⅝" balsa core for the side panels of the fuselage.

02

Cutting the +/-45 biaxial fiberglass fabric.

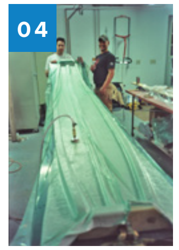
I was having difficulty finding good, clear spruce to use for the side panels. I decided to use ⅝" end grain balsa with fiberglass for reinforcement. Now that I had my mold built, and my materials selected, I could begin the build process.

I tackled building the fuselage sides first. Having a two-dimensional mold to vacuum bag the end grain balsa to worked well. The ⅝" balsa followed the contours well, and any grain that split filled with epoxy. Then I could flip the mold over and use the strong back to assemble the fuselage.

My prototype fuselage was sailed several times in substantial wind, and sometimes I even forgot to install the bobstay post. I believe, if the side panels would have been made of sitka spruce, they would not have survived this oversight. This reaffirmed the balsa wood with fiberglass reinforcement worked. This prototype fuselage is being used today as a wheel boat. After almost twenty years, it's still going strong.

03

Unidirectional s-glass tape was used on the perimeter of the panels. +/-45 biaxial fiberglass was used on the inner and outer surface of the side panels. 6 oz. fiberglass fabric was used on the mold for a smooth, paintable surface.

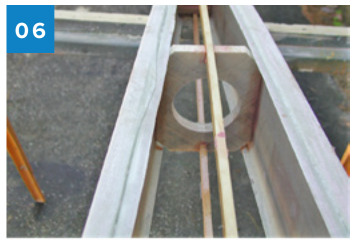


04

The layup of balsa, biaxial, and unidirectional fiberglass fabric was vacuumed to the mold. The blocks at the bow and stern were for exact length. 2x2 polystyrene foam on the side panel created angled fiberglass edges.

05

Stem blocks were installed to allow for the assembly of bulkheads, decks, etc. at a future time.



06

One of the bulkheads bonded in place.

07

Good view of the lower angled fiberglass edge.

08

It was not necessary to fully assemble the fuselage on the strongback. Bonding the stem and stern blocks to the side panels while on the strongback made the fuselage dimensionally stable. This allowed the fuselage to be moved off the strongback and allowed the start of another set of panels. The stem blocks, mast step structure, and bulkheads only weighed 19.5 lbs.

Production Hulls... x4

After two years of testing our 2004 prototype, it was time to begin production. My friend and I wanted to build four new boats. We were both avid competitors in the DN class, and wanted to compete here at home, and in Europe. The fuselage and mast are the most difficult parts to ship to Europe, so we both wanted to build two new fuselages each. This way we could keep one in Europe to avoid that hassle of shipping. Having determined that my construction method was sound, we were able to start on constructing our four semi-identical hulls.

Because of the experience I had with the prototype, I was very comfortable with the strength of this method and the materials. Our goal was to build a fuselage that would be as close to the minimum weight as possible (46 lbs.). We were building four, so we fine-tuned the layup schedules before ordering the fiberglass to be used. Our exact layup schedules have been lost, but I know that we used a few inches wide of unidirectional s-glass on the top and bottom edges of the side panels, +/-45 biaxial fiberglass on both sides of the side panels, and 6 oz. fabric on the mold side for a uniform, smooth paintable surface.

We adjusted the design layout of the fuselage/cockpit also. We retained the full length, height, and width of the cockpit for strength and racing reasons. Full height allows for a stiffer hull. The full length and width allow the skipper to remain in the cockpit for less windage.

We're still as happy with our iceboats today, as the day we made them.

"I broke my DN many times but was able to repair it good as new thanks to WEST SYSTEM Epoxy."

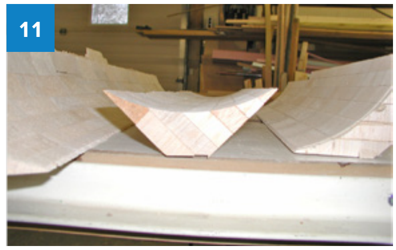
09

The bottom deck (⅛" okoume plywood) was coated with epoxy and placed on the strongback. Thickened 105/206 was applied to the angled fiberglass edge of the fuselage. The fuselage was bonded to the deck, followed by ⅝" balsa core reinforcing the cockpit area, and Baltic birch plywood in the plank attachment area. All layers were coated with thickened 105/206 on both sides using an 809 Notched Spreader.

10

Okoume plywood was placed over top of the balsa core to finish off the cockpit floor. The fuselage side panels were weighed down with runner boxes, and sandbags were used to compress the cockpit floor laminate while the epoxy cured. Pipe clamps and a temporary spacer kept the sides plumb.

11



These are the cockpit stiffeners. They added strength and flotation. They were built 4"x4" out of ⅝" balsa epoxied together. The blocks were ripped diagonally then pushed sideways through a sharp 10" table saw blade to create the curved shape. The opposite corner was ripped off for ease of placing the stiffeners.

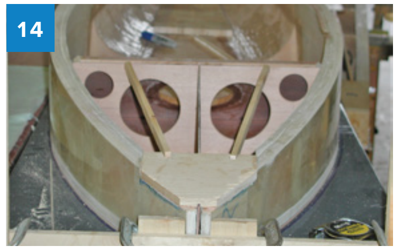
12

The stiffeners were epoxied in place with 105/206/403.

13

To fair the curves, 105/206/410 was spread as smoothly as possible with a plastic spreader.

14



The seat back and bulkhead were epoxied in place.

15

Epoxy thickened with 403 Microfiber was used to bond the epoxy coated okoume deck to the fuselage.

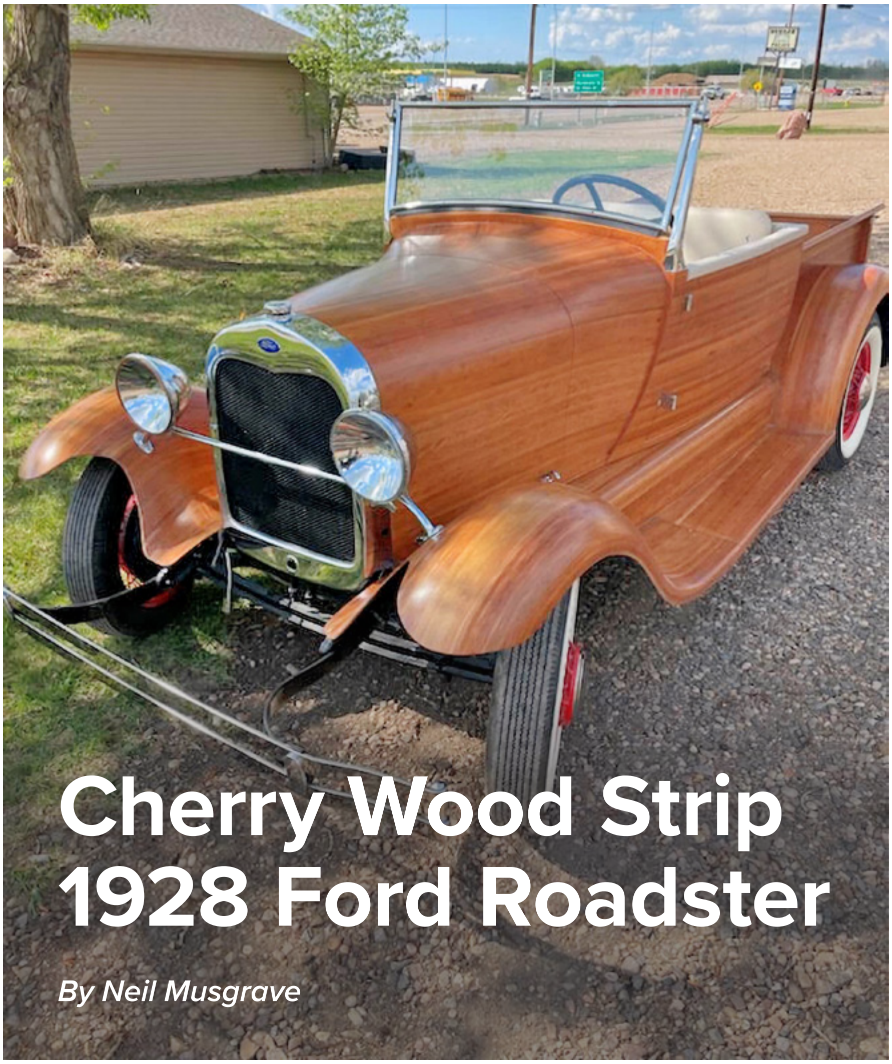
16

The rails are biased toward the inside of the cockpit, supported by the angled fiberglass edge of the side panels and the balsa core epoxied underneath. This was shaped, and ultimately covered with 6 oz. fiberglass.

17

Here are all four hulls together awaiting various finishing touches.

The DNs at speed on Damariscotta Lake, in Jefferson, Maine.



Cherry Wood Strip 1928 Ford Roadster

By Neil Musgrave

I'm a Red Seal Journeyman Cabinetmaker with many hobbies, including restoring old vehicles. I combined both the love of my craft and my hobbies to build a running/driving, cherry strip, 1928 Ford® Roadster Pickup.

To begin my wood truck project, I purchased a 1928 Ford Roadster pickup truck. My first task was to disassemble it, so I could reuse the chassis, motor, and transmission as the base for the wood truck. With the help of my friends, we rebuilt the motor, and rewired the truck, so that it runs and drives just as well as when it came off the assembly line.

The rest of the truck body became templates to recreate the fenders, box, and cab in cherry wood strips. With the help of my CNC programmer friend, we created forms for the fenders. This process involved taking many photos and measurements due to the complex curves. Once satisfied, I cut out the forms on my CNC router. I also used my CNC to cut the form for the hood.

ABOVE:

Multiple angles of the finished 1928 Ford Roadster pickup truck.

Watch the video

See Neil build the 1928 Ford Roadster out of cherry strip wood.

The Ford logo on the tailgate was programmed by the same friend that helped with the fenders. It was cut out of solid walnut using ⅛" round over bit and took over two hours to cut on the CNC.

The process of steaming, bending, clamping and gluing the strips was time consuming. I would put a piece of wood in to steam, build some cabinets or make a countertop, then take the strip out to bend and glue on the form. Then I would add another piece in to steam and repeat.

Building with these forms gave me final fenders and a hood that are identical to the metal originals. I only ended up making

LEFT:

The cherry wood strips have been glued together on the form for the rear fenders. Now it is time to apply the fiberglass.

BELOW:

The runner boards were also made from cherry wood strips and were fiberglassed.

one extra fender, as I was not happy with my first attempt. The hood fits the chromed radiator and fan shroud just as good as the original metal one.

The straight part, like the box and the tailgate, were easier and faster to do. I built the cab as one piece then cut the doors out after so the grain match stayed intact. I also used the same process to match the grain on the hood. The dash is a solid piece of cherry that has been sanded and formed for the windshield supports and the instrument cluster.

After all the pieces were removed from the forms, I sanded the cherry with my random orbital sander to prepare for the fiberglassing process. I knew, in order to have the structural integrity I needed to be able to drive this truck around, that fiberglass and epoxy were the answer. Before beginning my build, I had visited a kayak store in Edmonton that used WEST SYSTEM® Epoxy, and I was impressed with their final product. I chose WEST SYSTEM for my project because of the quality they were able to achieve with their kayaks, and because it was straightforward to use.

I cut the fiberglass to the size and shape needed, then laid it out in place. I saturated the fiberglass with the WEST SYSTEM 105 Epoxy Resin® mixed with WEST SYSTEM 207 Special Clear Hardener®. After it cured, I gave it a light sand to scuff the surface, then I applied another layer of fiberglass and epoxy. Both sides of the Roadster panels were fiberglassed, sanded, and sprayed with a protective coat of satin sheen polyurethane, to an ultra-smooth finish.

The pieces not made of cherry were sent away for chroming or purchased through a store that specializes in Model A Ford parts. I upholstered the interior, the door panels, and wrap around the cab myself. Plus, I sewed the seat cover after making the seat out of plywood and glued foam to it.

It took three and a half years, but I finally got it done. It's been one of the most challenging things I've ever done, but it's very satisfying seeing the finished project.

Neil Musgrave is the owner of Musgrave Millwork & Cabinetry Ltd. located in Two Hills, Alberta, CA.

Build Stats

- Over 4 gallons (15 m) of WEST SYSTEM 105 Epoxy Resin
- 16 yards (15 m) of fiberglass
- 2 gallons (8 L) of polyurethane
- .8 gallons (3 L) of wood glue
- 3,960 linear feet of cherry
- Approximately 2,500 hours (over the course of three and a half years)

Scan to see more of Neil's work or visit **musgravemillwork.ca**

Choosing Glue!

By Russell Brown

I was recently asked for help in choosing adhesives for a large spar-building project. This led to much thought and discussion with the wonderful WEST SYSTEM® Technical Advisors.

The choices we made won't surprise anyone, but the reasons we made those choices are worth explanation.

The Materials

We chose WEST SYSTEM 105 Epoxy Resin® with 205 Fast Hardener® (and 206 Slow Hardener® when we needed a little extra working time). We chose this route over pre-thickened adhesives for two important reasons:

- The first was the ability to "prime", or saturate the gluing surfaces with unthickened epoxy before applying the thickened epoxy. (It was the same epoxy combination, but fillers were added to create a thickened version.)
- The second was the ability to make the thickened epoxy relatively thin (lightly thickened). With our limited clamping pressure, it was important to be sure the parts weren't held too far apart by the thickness of the epoxy.

The spars (a 53' mast, 30' top mast, 34" boom, and a 26" gaff) are all built from Sitka spruce and are all built from eight staves (eight sided) before being shaped round. The individual staves for the mast needed scarf joints to make them long enough.

The scarf joints are critical to the strength of the mast. Doing them right can be somewhat challenging because the end grain of a scarf joint can draw epoxy into the wood after the joint has been clamped. This leaves a dry, or starved joint, with a high filler to epoxy ratio. While fillers are essential for bonding wood, Gougeon Brothers' lab testing shows that a casting of epoxy with fillers is not as strong as a casting of neat epoxy.

Before selecting our fillers, we determined our approach to make the scarf joints as strong as possible:

1. We used WEST SYSTEM 205 Fast Hardener. The epoxying was done in winter so the shop stayed around 60°F. With proper preparation, we had ample time to epoxy the individual joints. Our schedule required the joined parts to be moved the next day, which puts considerable stress on the joints. 205 Fast Hardener cured quickly enough to allow us to do so without any complications. The other benefit of using the 205 Fast Hardener is that the shorter cure time reduced the possibility of epoxy being drawn into the end grain, leaving a dry joint.

The staves, once scarfed to length, were epoxied together in very clever jigs. (These guys have done this before!) They started with just two staves, then added two more the following day to make one half of the mast.

A test scarf joint. We encouraged it to soak up as much unthickened epoxy as possible before applying thickened epoxy.

The thickened epoxy was poured onto the staves and then metered to an even quantity using an 809 Notched Spreader.

2. We pre-warmed the joints before priming them with unthickened epoxy. In the same way that warming wood will blow bubbles, cooling wood draws epoxy into the grain. We were encouraging penetration of unthickened, priming epoxy to fill up the grain before applying the thickened epoxy.

The fillers we chose were the 406 Colloidal Silica and 403 Microfibers. The 406 Colloidal Silica is an excellent thixotrope, meaning that it takes less filler to reach your desired consistency than using one of the other WEST SYSTEM Fillers. The wood was primed with unthickened epoxy immediately before applying the thickened epoxy. This allowed the epoxy to penetrate further into the end grain, without drawing it out of the thickened epoxy. The Microfibers were used because the thickness of the fibers helps keep all of the epoxy from being squeezed out of the joint when clamping, also helping to prevent a dry joint.

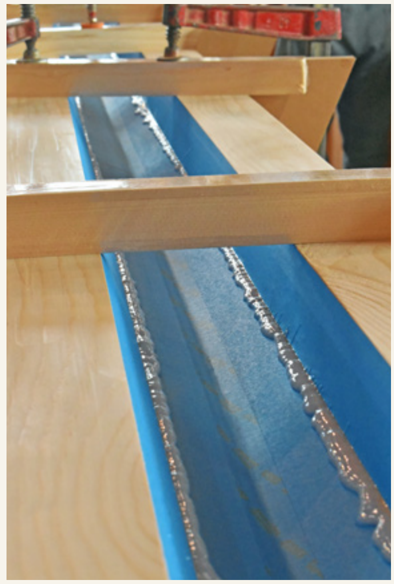
The Build Process

Speed was essential while epoxying the staves together. We had multiple joints that were very long, and clamping was quite complicated, making the process time-consuming.

We started by liberally priming the staves with unthickened epoxy. Once the epoxy was fully mixed, we worked quickly to get the epoxy out of the roller pan and onto the staves with a 3" long foam roller. Once it was spread out, we returned to even out the coating. Epoxy left in mass cures much more quickly than when it's in a thin film. By spreading out the epoxy, it gave us more time to work.

For the thickened epoxy, we mixed less than a quart at a time. The mixed epoxy was poured onto a stave in a long bead before being spread with a 809 Notched Spreader. This type of spreader allowed us to meter the epoxy so we had a consistent thickness coverage over the whole bonding surface. Because of the limited clamping pressure, we were generous with our thickened epoxy. Our ample squeeze-out told us that we had sufficient epoxy in our bond lines.

These spars are for a century-old cutter named *Tally Ho*, which won the Fastnet Race in 1927. The rebuilding of *Tally Ho* is being documented with a fantastic series of videos, which you can find at the Sampson Boat Co. channel on YouTube. Future videos will surely show these spars in action!



Squeeze-out everywhere means enough epoxy was used.

The mast had solid blocking at both ends. Conduits for wires were installed before the two halves were glued together.

Ample epoxy was used to ensure a secure bond, when bringing the two halves of the spar together.

Photo by Leo Goolding

Watch the video

See Russell build the *Tally Ho* mast.

Safety Factor (S_f)

By Jeff Wright – GBI VP of Technical Services

At Gougeon Brothers, Inc. we are always measuring the ultimate strength of our epoxy products, their adhesive strength, and the strength of the resulting composite laminates (The values measured are often impressive, and the numbers for real-world applications may seem unbelievable). For example, the tensile strength on our Technical Datasheet (TDS) for 105 Epoxy Resin® and 205 Fast Hardener® is 7,900 psi. This means I could easily hang my Chevrolet® Silverado with a full payload using a 1" x 1" casting of epoxy! This is true in a perfect application, but our common sense tells us that it is risky. That common sense may be because we understand the need for a safety factor (S_f) in our calculations.

A safety factor is the ratio of the strength of the material to the actual load it will be subjected to in use. An example of a safety factor is comparing the tensile strength of rope to what is often stated as the working load. The rope manufacturer states that when the rope is used in different environments and has aged, it is only safe to use at 20% of the tested breaking strength. In most cases, the rope user values the margin of safety, but it comes at a cost. For example, in sailboat rigging, it is added weight and of course, dollar cost.

Continuing with the rope example, the safety factor for lines used on a racing sailboat in coastal waters with support boats nearby may be much lower than a cruising sailboat used to explore Antarctica. The consequences of failure are part of determining a safety factor. In my experience, the calculations used for a recreational planing powerboat hull bottom may have a safety factor of 4 to accommodate the loss of stiffness from fatigue. The deck may only be 2.5 because a cracked bottom is obviously a bigger problem than a cracked deck.

When using strength data available on WEST SYSTEM® products, keep in mind that the properties listed are the ultimate strength as measured in a testing environment. Although the testing process may not reflect the conditions the epoxy will be exposed to in service, it is important to remember that materials need to be tested in a controlled environment so the results are comparable to tests performed elsewhere. A test lab on the other side of the world can load the sample at the same temperature, load rate, and sample size to compare the results. The data on a TDS is valuable and accurate, just remember it is more than likely the highest strength value achievable.

If your project involves making calculations that may use the strength properties listed on the TDS, or from other test data, the safety factor used should take into consideration some of the potential variables that can affect when an assembly fails:

- **How accurately can the epoxy be metered and mixed?** WEST SYSTEM can tolerate common variances when the resin and hardener are measured at the correct ratio, but remember that the TDS lists properties of test samples that were mixed at the exact target ratio.
- **Will a full cure be achieved before the part is put into service?** Partially cured epoxy will have much lower properties than those achieved after two weeks at 72°F (22°C).
- **For applications dependent on adhesion, how well can you prepare the surface? Is it difficult to clean or abrade?** The adhesion values that we publish are always on properly prepared surfaces.

- **Are you depending on a specific fiber orientation?** With fabrics such as a unidirectional fabric, it is important to appreciate the effect of an alignment error. Even a 5° error can have a measurable effect on the strength and stiffness of a unidirectional laminate.
- **Could there be an unanticipated off-axis load in an assembly?** In some cases, assuming the load is only placing a load that is 100% in tension on a bonding bracket may cause a failure when the load is slightly off-axis. The difference in the direction of the load could result in a peel load which may cause an unexpected failure.
- **What deflection is there in the assembled parts?** Deflection of the assembled parts can generate the peel loads. An example of this would be on a powerboat with very thin hull sides (many of us have tested this by using a closed fist to thump on the hull side to see how much it deflects). When this boat is underway, and the sides deflect outward when the bottom deflects upward, the tabbing on the stiff bulkhead may peel away.
- **What kind of fatigue is expected?** If a structure will be subjected to high stresses repeatedly, the effect of fatigue on the strength should be accommodated. This is why older boats often feel "soft". Excessive deflection has created microcracking resulting in loss of stiffness and strength.

Experienced boat builders have developed strong intuition that enables them to anticipate these types of issues that may result in an unexpected failure. Much of this intuition is based on evaluating the stiffness of a laminate or assembly. In many cases with composite boats, the excessive deflection will provide a warning sign of insufficient strength. If a swim platform is intended to support a Personal Watercraft, it should not have noticeable deflection when a person stands on it, or when standing on a sterndrive the transom should not deflect. If the stiffness is not sufficient, more than likely the structure is not strong enough to withstand the long-term effects of fatigue.

The consequence of failure and variables that are not clearly known should influence the safety factor. For example, if new chainplates are being bonded to a bulkhead, and the loads cannot be accurately determined, the safety factor used to calculate the bonding area should be conservative because the failure consequence is a broken mast. Be sure to use a sufficient safety factor, or work with an expert, to review your plan. A small increase in weight and cost can provide a nice safety factor, which will give you peace of mind when you find yourself in an unplanned situation during use or construction.

Teardrop Camper Trailer

This 5'x10' teardrop camper was designed and built by Bill Lawson. He wanted a camper that could transport his ILCA dinghy to regattas and would be comfortable to stay in for the duration of the event. This year alone, he's taken it to regattas all the way from Florida to Nova Scotia. The trailer was built with Okume plywood, WEST SYSTEM® 6 oz. fiberglass cloth, and 105/207. The interior cabinetry is cherry and birch. The roof racks are Ipe. He has enough battery to go off grid for four days and takes four hours to recharge while towing.

The teardrop camper transporting Bill's ILCA dinghy.

Close-up of the interior cabinetry.

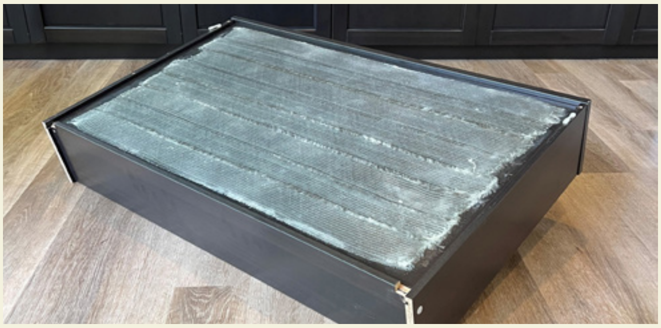
Hatch for the kitchen and extra storage.

Tips for More Successful Epoxy Projects

that have nothing to do with epoxy mixing or application techniques

By Jenessa Hilger – GBI Marketing

As a beginner to intermediate epoxy user, we focus a lot of effort on learning techniques for mixing and applying epoxy. While these skills are important, there are other aspects to epoxy success that most of us only learn through experience. Luckily, or unluckily, depending on how you want to look at it, I've learned a lot about what not to do from working on my own projects. Through my experiences, and hours hanging around our GBI Technical Advisors and their projects, I've learned a few approaches to help make things go smoother. Hopefully, some of the knowledge I've gained can help you on your next project.



Have a Well Developed Plan

It's easy to think to yourself, "This will be easy. I'll just slap a little fiberglass on here, a little epoxy on there, and bam! Good to go." It's important to walk through each individual step. How much epoxy am I going to mix? Am I going to mix it in one batch, or in stages to prolong pot life? Are all my materials cut to size and dry fit? Should I wet out my fabric in place or on a flat table? Will it cause problems if the fiberglass stiffness changes once wet out? How am I going to clamp? Etc. Basically, you want to do a dry run of the whole repair before mixing a drop of epoxy.

A few years ago, I was reinforcing the bottom of the drawers in my Ikea® wardrobe with some fiberglass, so they could support our heavy winter boots. The external temperature was around 80°F degrees, but the inside temperature of my garage where I was working felt much cooler. I grabbed my WEST SYSTEM® 105 Epoxy Resin®/206 Slow Hardener®, and mixed my epoxy. I trimmed my fiberglass as I went, since it was such a simple shape. First drawer, no problem. Second drawer, no problem. Halfway through the third drawer (of seven) the batch kicked off in the pot before it even touched the fiberglass.

Lesson Learned: Develop a thorough plan. Be honest with yourself about how long each step will take… unless your project is to make a pot of smoking epoxy like I did.

Prepare, Prepare, Prepare

This is one I consistently struggle with. I've got my glass cut, my mixing cup and stick, and I'm ready to dive into epoxying. It's only when I'm elbow deep in epoxy (while wearing our 838 Protective Sleeves of course), that I realize I need a knife, or I ran out of epoxy, or there was something else I missed.

For my rudder support article ("Bond Girl's New Custom Rudder Support" in *Epoxyworks 56*), I didn't even consider how much packing tape I would need for clamping to secure the laminate to the rudder. I'm pretty sure that by end of our layup, there were three or four different kinds of tape on it. We just kept grabbing the first thing we could find every time we ran out.

Lesson Learned: Collect all the materials and tools you think you might need ahead of time. Have them at your fingertips so you don't run around like a chicken with its head cut off trying to find more tape.

Work Cleanly

Cured epoxy is vastly more difficult to remove than preventing the epoxy from getting where it shouldn't be in the first place. We've all been lazy—unintentionally spreading epoxy from dirty gloves, or sloppily applying excess epoxy because we're in a hurry. It happens. However, we end up spending so much more time and effort removing the cured epoxy slop than if we had taken a little more time to start with.

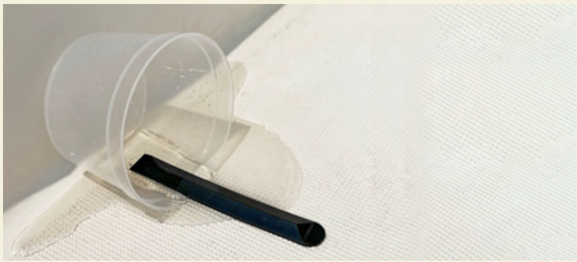
The first step to working cleanly is to prevent unintended epoxy slop. Mask off more area than you need to—epoxy gets everywhere. I've even found it in my hair on occasion. Change your gloves often. Once your hands get hot and sweaty it's a real pain to put a new pair on, but trust me. It is much easier to change your gloves than deal with the mess.

The second step is to clean off excess material from the project, and the surrounding surfaces, before the epoxy cures. It's easy to wipe off when wet, but it's time to break out the grinder when the epoxy is cured.

Early in my career here, I heard a story about the windmill blade building days of GBI. The workers were applying too much epoxy, which meant they were spending a lot of time every day sanding or grinding it off. To remedy this, a "policy" was instituted. "You epoxied it. You sand it." True or not, my husband and I have implemented this "policy" within our family. I must say, it makes working on projects together much more enjoyable.

The third step is to have the proper clean up materials at hand—a full roll of paper towels, acetone for your project, and a bottle of waterless hand cleaner, like GoJo®, for your skin. Even for small projects, proper cleanup is important.

Lesson Learned: A little extra care in applying the epoxy is actually a short cut, and, in my experience, makes for a happier marriage.



Know Accidents *Will* Happen

Yes, that's right. It's not a matter of if, but when. The experienced epoxy user approaches a job with this in mind, so they are prepared to handle most issues on the fly.

One spring, my husband learned this the hard way. He was spending the afternoon working on our boat at the yacht club rebuilding winches and relocating some hardware. While he was below digging out a syringe to fill the hardware holes, a gust of wind caught the drop cloth he was working on and dumped a pot of mixed epoxy all over the aggressive nonskid in the cockpit. He hadn't planned on doing a major project, just filling a few hardware holes, so he had only packed some paper towels. He wiped up as much as he could but still needed to quickly remove any remaining residue before it cured. Luckily, he kept his cool, contacted a friend who lived about a mile down the road, and borrowed acetone from him (which was faster than running to the store). Now, whenever we plan on epoxying, we make sure we have sufficient products for a proper clean up.

When an accident does happen, keep your cool and try to pinpoint the issue. Then ask yourself these questions: Is this fixable before the epoxy cures? Should I finish part of the application and allow it to cure, then regroup? Is it better to remove everything before it cures and start over? The most disheartening thing is to keep trying to fix it, only to realize once it's cured that you made things worse than when you started.

Lesson Learned: Don't panic. Think it through. Always pack your solvent just in case.

Take your Time

As with all things, good work takes time. Build in time to get your project exactly how you want it before the epoxy cures. Be realistic with your abilities and time estimates. Whenever possible, plan in extra time before the epoxy cures or have an additional person available to assist if you run into problems. I am often volunteering to do this in our tech shop. It gives me great insight into their thought processes, and they get an additional set of hands to mix batches of epoxy, grab materials, or act as a temporary clamp. Win-win.

Lesson Learned: Make friends with other people who love epoxy too.

It takes time to make these tips second nature in your epoxy project routine. I'm definitely guilty of ignoring my own advice from time to time. However, incorporating these tips into your next epoxy project will help minimize surprises and maximize results.

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

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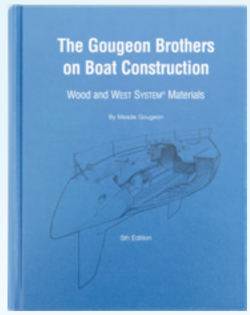
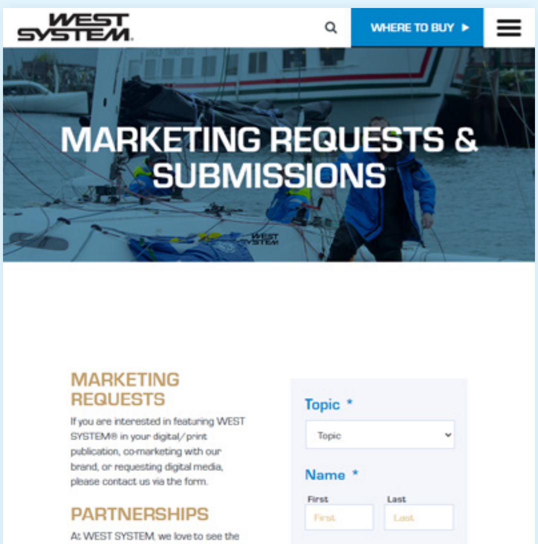
Illustrated guide to structural restoration, reducing maintenance, and prolonging the life of wooden boats with WEST SYSTEM Epoxy. Includes dry rot repair, structural framework repair, hull and deck planking repair, and hardware installation with epoxy.



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.



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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.

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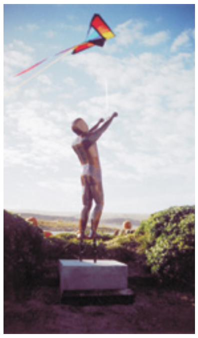
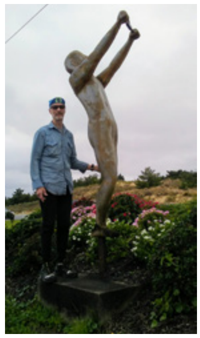
One of Bob Garrison's past build projects was a trebuchet. An integral part of the design was that the trebuchet could be moved by three people, a pickup truck, and a tractor. This way it could be assembled for the main entertainment at his big annual cookout in September.

The trebuchet was built using mostly 2x6 lumber and WEST SYSTEM® 105 Epoxy Resin® with 206 Slow Hardener®. The round counter weight and the four anchor blocks were made of poured concrete. Machinery was needed to move these. It took about a day to get it assembled or disassembled for storage.





15 years ago, Robert Crowell built a cedar kite-flying man sculpture for Kitty Hawk Kites, on the Outer Banks of North Carolina. Twelve boards were laminated together with WEST SYSTEM® Epoxy to form the sculpture. It was finished with epoxy and topped with coats of Captain's Varnish.

After visiting recently, he was pleased to see what good shape it was in, since the weather there can be very harsh. "As expected, after 15 years, the finish is practically gone but the laminated boards are holding well. A true test of your product!"

This sculpture was initially featured as a reader project in Epoxyworks 25 back in the summer of 2007.

Diana & Hound is an interpretation of Diana the Huntress from Greek Mythology. The sculpture was coated with WEST SYSTEM® Epoxy for short-term outdoor exhibiting. The sculpture has been exhibited in many locations throughout Michigan—Art Prize in Grand Rapids, Art Rapids in Elk Rapids, and currently in Traverse City. To view more of Chuck Mack's work, visit chuckmackdesign.com.

Jon Bauer built two boats with WEST SYSTEM® Epoxy. He says, "I found this product very easy to use and it resulted in a professional finish."

First up is his stunning lapstrake craft 12' canoe, which was completed back in 2016. In 2022 he completed his last boat, a 13' kayak.

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