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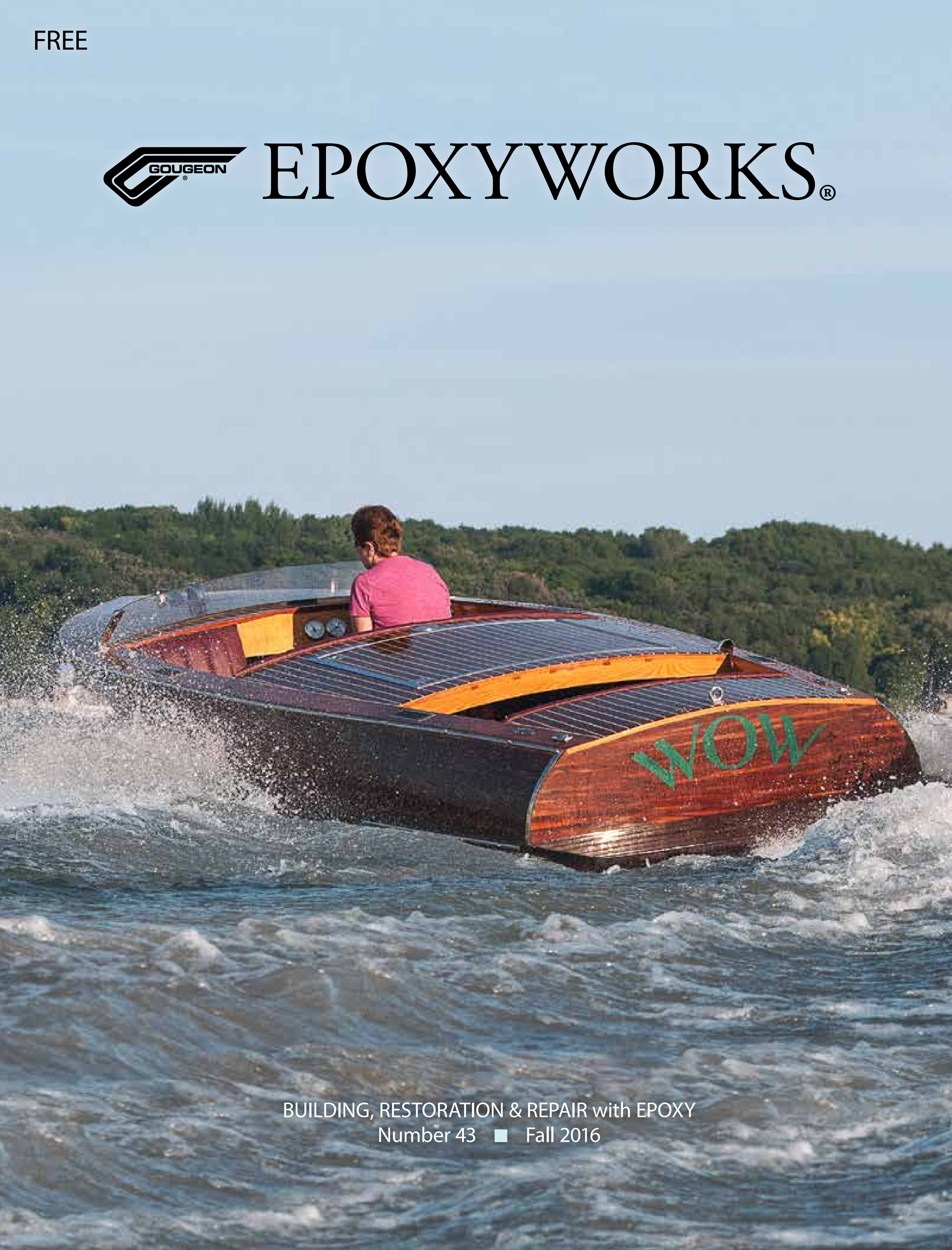

BUILDING, RESTORATION & REPAIR with EPOXY

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EPOXYWORKS

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WOW

By Mike Barnard

In June of 2000, Mark Bronkalla launched his nearly complete but unnamed boat. The boat turned heads wherever Mark took it and the reaction from bystanders was a universal "WOW." This is how the beautiful home built 20 foot Glen-L Riviera got its name.

Mark had never built a boat before, and found lackluster information from first time boat builders like himself. Websites or blogs with good information tended to end once the structure was built. Mark used his background in woodworking, marketing and computer science to share his first time boat building experience to encourage and help other first time boat builders. In this article, I'll give a brief overview of this build where WEST SYSTEM® Epoxy was used. Anyone considering a build similar to this should consult Mark's website, bronkalla.com, for more detailed descriptions of each step.

Mark began by building sawn frames using white ash on a sturdy table covered with plastic sheeting. To bond the frames and transom together, Mark used WEST SYSTEM 105 Epoxy Resin with 206 Slow Hardener and wax-coated padded clamps to reduce slippage. The construction of the hull was done in his basement and when completed had to be carried out a double door at a 45° angle. Friends offered to lend him chainsaws to extend the doorway, but that wasn't needed thanks to his attention to detail.

Mark pre-coated the frames and stringers in epoxy before the assemblies were glued. This prevents water that might be sitting in the bilge from penetrating into the wood.

The battens were then fitted and installed into notches in the frames. Some battens were too short and needed to be glued together. Edge-glued battens would not be flexible enough for

Mark's completed home built 20' Glen-L Riviera, WOW.

Cover Photo: WOW built by Mark Bronkalla

the installation, so a scarf joint was required. For cutting these scarfs, Mark set up a jig to match the ideal 8:1 bevel. Once the battens and sheers were glued on, the boat took its general shape and the "real fun" could start: fairing.

When we mention fairing, or the process of making a surface smooth, we're generally referring to the final step of sanding before coating with epoxy or paint. However, when cold molding a boat, waiting until the last possible moment to sand would make for a lot more sanding. Mark decided to deprive himself of the extra "fun" of sanding at the end and fair the hull before the first laminate was applied and between each successive layer. Sanding between layers helps the next layer to lie down nicely and will prevent distortions caused by uneven thicknesses of wood or epoxy drips that have cured. Since a majority

The transom assembly coated with epoxy to prevent water intrusion.

Attaching the ribs to the bottom of the boat.

Mark's kids show off the incandescent Christmas lights they strung inside the hull to help make it easier to see the epoxy squeeze out.

of the hull was empty space at this point, the only way to get a fair surface was to sand multiple planks at a time using a long board.

Mark dry fit 6"-wide (4 mm and 6 mm) Okuome plywood strips at a 45° angle by loosely stapling them, then removed them and glued them into place. With two helpers during this process, he was able to finish it in good time. One helper followed him to catch any squeeze-out or drips, while the other was inside the hull doing the same thing. Since this was a family build, his helpers were his kids. His son David was the most involved and put in about half as many hours as Mark. As the process neared completion, they learned that a string of incandescent white Christmas lights under the hull allowed them to see excess epoxy that they could wipe away or use to create fillets.

Mark's daughter removing staples from the hull after its second layer of planking.

Final layer with mahogany planking

After the first layer of planks were glued down, it was time to fair once again. An air file was invaluable, but filing was still difficult. Mark recommends taking multiple short breaks not only because of the difficulty, but also to refresh the eyes, making it easier to see the contours of the hull.

Being efficient with his wood usage, Mark was able to save about 1.5 sheets of plywood by scarfing sheets together. His website describes a moderately dangerous but overall good technique to use for scarfing. Alternatively, if there is a lot of scarfing to be done, a WEST SYSTEM 875 Scarffer® can come in handy.

Mark glued on the second layer of planks, then circled the low spots with a pencil. He was smart about not wasting excess epoxy from the gluing process. He added 407 Low-Density filler to the collected squeeze-out to fill the low areas he'd marked.

Once the second layer was fair and sanded, it was time for the final layer of planking. On the bottom, these were 6" wide strips of mahogany plywood that ran longitudinally. The hull sides and small portion of the hull bottom were made from 2" wide mahogany planks. Since this was the final layer, Mark chose to staple through strips of sacrificial wood to hold the mahogany planks in place while the epoxy cured. This kept him from digging into the final wood surface when removing the staples. The sacrifical strip came off once the staples were removed.

The hull was sanded and then stained using Minwax oil based stain. This stain was tested by Gougeon Brothers in 2003 (three years after WOW was completed) and failed after both 24 hours, and four days, of drying. Using our recommendations at the time on how to test adhesion to the surface of stained wood, Mark tested several methods and was satisfied with a drying time of one week followed by a 220-grit sand.

6 oz. fiberglass was then applied to the hull using the dry method. That is where the fabric is laid directly on the dry hull and epoxy is applied on top of it. For optimal clarity, Mark chose to use the 105 Epoxy Resin with the 207 Special Clear Hardener. Laminating was a three person job—one person to mix, the second to spread, and the third was a "go-fer."

The fiberglass was applied to the entire hull and overlapped 1" at the stem. The fiberglass on the transom was tabbed onto the hull side and applied over the already cured fiberglass on the hull. Because this overlap created too much fiberglass thickness to cure clear, it was instead hidden behind a stainless steel trim piece. When the time came to install the trim, Mark noticed the fiberglass started to lift slightly which indicates the epoxy did not bond well enough to the stained wood to resist a peel force. The lifted fiberglass was trimmed back to where there was a good bond and ended up being covered by the stainless steel trim piece.

The rudder, struts, water pick-up, motor mounts, prop shaft and stuffing box were installed and the engine was hoisted in place and hooked up. Once that was done, the electrical, exhaust, steering, and fuel systems were installed. If you'd like to learn more, visit bronkalla.com where Mark has gone into great detail on each of these topics.

With the majority of the systems installed, it was time to focus on the deck frames and ski tow blocking. Using the plans from Glen-L, this process was pretty straightforward.

Since one of the purposes of the boat was to pull wakeboarders and water skiers, a ski pylon and ski tow were added. To prevent the deck from deforming too much from the force of pulling up a wakeboarder, two pieces of wood were added to make it into a very stiff and strong box beam. The ski tow was mounted at the transom and bolted down through the horizontal brace there.

Eager to complete the engine hatch but still without a transmission shaft flange, Mark eyeballed the fit and decided it looked close enough to continue. He jumped the gun and installed the engine before all of the parts were in, and ended up having to uninstall and reinstall it because it didn't fit right. He cautions would be boat builders not to make this mistake.

6 oz. fiberglass applied to the hull using the dry method

Once the engine was mounted correctly, plastic was draped over it and the plywood decking layer was glued on. Gluing most of a 4' x 8' plywood sheet down at a time, Mark used dry wall screws to temporarily fasten the plywood down while the epoxy cured. As soon as it was fastened he crawled under the deck and formed fillets with the squeeze-out. After an overnight cure in cool temperatures, the epoxy had not cured solid by the next morning. This made the squeeze out on the top side easy to remove with a rabbet plane. Once the epoxy had fully cured, the screws were removed.

After the walnut finishing board was glued on and trimmed, the mahogany planks were glued onto the deck. To get the spacing between each plank, 4 mm plywood scraps were cut into ²/₃" wide strips about 1.5" long.

The screws temporarily holding the planks in place were spaced 12" to 16" apart, but once a section was fastened, more screws were added so the final distance between each was 6" to 8". After epoxy cures, it is difficult to remove the screws, so Mark removed them while the epoxy

As Mark says on his website, painting of the hull is where "Ventilation becomes important! I had put on a respirator shortly after this was taken. The fumes are strong. Using epoxy makes you spoiled."

The hull finished, waxed and ready to be flipped and moved to the trailer for the rest of the build.

was still rubbery. Another option would have been to coat the screws in wax before driving them through the uncured epoxy. The wax prevents the epoxy from bonding to the screws and they can be removed even when the epoxy is cured.

The top of the deck was sealed with WEST SYSTEM 105 Epoxy Resin and 207 Special Clear Hardener. Mark squeegeed a mixture of 105 Epoxy Resin, 206 Slow Hardener, 403 Microfibers, 406 Colloidal Silica and 501 White Pigment between the mahogany planks and allowed it to cure. Then the deck was sanded flat so 4-oz. fiberglass could be used with the 105/207. He filled the fiberglass weave with four coats of epoxy and allowed it to cure, sanded it, then applied several layers of Z-Spar Flagship varnish. After perfecting each of the three decks, it was time to cut a hole for the engine hatch.

The final touches of adding trim, hardware and modifying the seats were technically not completed by the time the boat hit the water, but it still looked good enough to turn heads and earn its name from admirers.

In addition to allowing me to summarize the building of WOW, Mark has been kind enough to provide an update on the boat after 16 years of use. In our next issue, his retrospective article will cover how the boat was used, how well it has stood the test of time, and the modifications he's made to the boat over the years.

Mark applying fiberglass to the deck. It was 90°F when this picture was taken, but when using epoxy, gloves and a T-shirt are still strongly recommended.

Fake it Until You Can Make it

By Don Gutzmer

Wood inlay marquetry has been around for a very long time, and I am always looking for different ways to use epoxy. I have learned that it is possible to use a laser jet printer with a clear transparency film to print an image, then transfer that image onto a substrate coated with West System Epoxy, resulting in the look of marquetry without all the cutting, fitting and craftsmanship. (Ink jet printers do not work with this process because the ink does not transfer to the transparency film.) The image could be a picture of a wood inlay or whatever you can imagine. Here is the process I have found that works the best.

1. Wear gloves to avoid leaving oils on the surface of the transparency film which can jeopardize the transfer of the ink to the film. Keep in mind the image will be reversed when transferred to the epoxy coating.

2. The substrate needs to be sealed, especially if you are using bare wood. West System 105 Resin with 207 Special Clear Hardener is recommended for clear wood finishes. The epoxy can be applied with an 800 Roller Cover and tipped off by dragging a section of foam roller cover over it.

3. After the epoxy coating cures, sand the surface dull with 120–220 grit.

4. Apply tape around the perimeter of the location where the transparency film will be placed. This will keep the surface clean. On one edge of the transparency film apply a strip of cellophane tape to make it easier to start peeling off the transparency film after the epoxy cures.

5. Coat the surface with 105/207. This could be done with an 809 Notched Spreader to create a good buildup of epoxy. To ensure that there are no air bubbles in the coating, run a propane torch over the coating moving at 12-18 inches per second to break any bubbles.

6. Lay the transparency film carefully into the wet epoxy coating, making sure the printed side is down. The image will be reversed when transferred to the epoxy coating. This is especially important if writing is involved. The third photo on the left shows the transparency being applied center first so that so any entrapped air can be worked to the edges of the film. The film also could be rolled onto a PVC or cardboard tube for application.

The finished fake inlay.

7. Use a plastic spreader with light pressure to remove air bubbles trapped under the transparency film. Force the air to the edge, taking care not to push all of the epoxy out from under the film—you need a sufficient amount of epoxy under the film. Pull the tape away around the outside of the film and remove any excess epoxy that was squeezed to the edges.

8. Let the epoxy cure for about 8 hours at room temperature before removing the transparency film. The image will be embedded in the epoxy. The surface may be wavy because the transparency floats on the liquid epoxy.

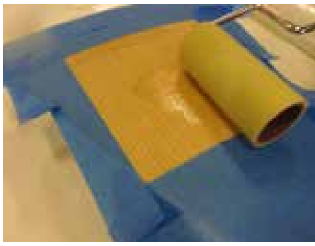
9. Avoid sanding the image away when preparing the surface for more epoxy or another coating. Even an abrasive pad can remove the image. Apply more epoxy without any surface preparation within 18 hours (at 72°F) of the previous coat to achieve primary bonds with 105/207.

10. Sanding is now possible because the surface has a thicker coating applied over it and the image will remain unblemished in the epoxy coating. UV stable top coats, such as polyurethane or spar varnish, should be applied for long term protection.

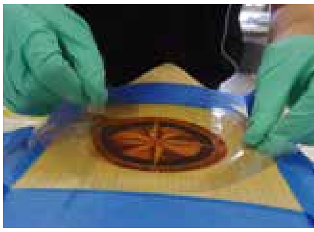
Enjoy the new look you achieved. I recommend you experiment to get the technique down before attempting this process on your project.

Applying a Fake Inlay to a Canoe Bow

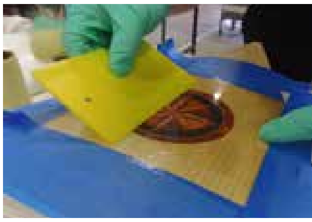
Wood surface sealed with epoxy and sanded before transparency application



Second coating of epoxy with the area masked



Apply the transparency from the center out to avoid trapped air bubbles



Smooth out the transparency to get rid of entrapped air bubbles

G/flex Does it

By Hugh Horton

The project was creating a shower pan for an American Disability Act (ADA) bathroom in the home I've been building in Cedar Key. How does one satisfy shower pan requirements of Levy County Florida and meet ADA suggestions, too, when the floor is concrete, twelve feet above ground?

A conventionally built two-story "stick" structure, 24' by 32', is bolted and steel strapped to the 40' by 48' concrete platform on six columns. It's engineered to withstand winds of up to 130 mph. For ADA access, the stair tower can fit a commercial elevator.

To me, the 12" thick concrete is like a ground floor conventional slab, so, the slab should be the floor of the shower. A shower dish had been cast into the concrete in 2010, but it didn't meet my current plans.

An ADA shower must have space for a wheelchair to turn around, and a sill low enough to roll over. The whole floor can be the shower pan, and the whole room, walls and all, can be hosed down. This bath's walls are steel sheathed like the outside of the house.

Choosing dust instead of a wet slurry—too much material to remove while working with diamond-edged electric tools—I cut and ground a new dish an inch deep, four feet in diameter. Then I ground a ½" radius around the drain. With a 1.5" high bathroom door sill, I'd meet the 2.5" depth requirement for shower pans.

ADA compliant house Hugh has been building in Cedar Key, Florida.

The first inspector went by the book and said I must have a conventional 40 mil vinyl membrane as is used under tiled shower floors. Water must not get to the 2x6 pressure treated pine floor plate. I felt as if the weight was on me of every failed shower wall in Florida since the advent of pressure water systems.

The beveled slope to the shower drain.

Vastly experienced Sarasota home builder and third generation native Floridian, Pat Ball, suggested a Corian baseboard, stuck down and joined at the corners with 3M® 5200. My thought was a fiberglass-epoxy border, two inches onto the concrete and four inches up the oriented strand board under the steel sheathing.

The new boss and chief inspector of the Levy County building department visited since he was near Cedar Key one day, and wanted to take a look at the eight-year project he'd inherited. He was inofficious, friendly, and strolled around asking about this or that feature.

We came to the ADA bath floor. I offered the two ideas: 3M 5200 or G/flex epoxy. "Yeah, sure," he said, smiling. "Anything you want."

G/flex 650 seemed right because of its permanence, wide bond onto the concrete, and its flexibility to cope with movement from temperature and humidity changes.

The oriented-strand board (OSB) on the walls comes down to a half inch from the floor. I filled the half inch with pressure treated pine strips, and screwed on a 45 degree beveled piece ripped from "two by" PT lumber.

Next came 6" wide "peel and stick" flashing membrane on the beveled wood and up the

G/flex is available in 8 oz., 32 oz. and 2 gallon sizes.

OSB. This allows movement between the wall and the epoxy-glass, to protect and not stress the water tight bond at the concrete.

When epoxy mixing time finally came, it was June 19th, 2015 and 88°F. My helper Ryan, a thoughtful, 24-year-old Army veteran, had done a bit of heavy glassing on work boats, but hadn't used epoxy.

The glass to be wet out was two layers of 6"-wide, 17-ounce biaxial with 3/4 oz. mat.

My earlier experiences with G/flex 650 had been in cooler weather. Because epoxy is exothermic, I considered the ambient temperature, but other than using fans and knowing we'd need to work quickly, I did nothing else to counteract the heat.

I'd masked the margins to be glassed, and prepared the surface by coarsely gouging it with the diamond blade on a hand grinder, then scrubbing and rinsing it with alcohol.

Ryan measured and mixed half cup batches as fast as I could unroll the tape I'd pre-cut and had re-rolled. As we worked around the wall-floor joint, it was obvious that shorter, convenient-to-handle lengths with overlapping joints were better to cover long sections. But, at corners, precise cutting or individual patches made a neater job. It also was evident the G/flex was curing faster than I'd expected. I couldn't go back and slightly shape and manipulate the first glass fabric applied. It was cooked, and we'd used more epoxy than anticipated.

After removing blush with water and a 3M Scotch Brite™ General Purpose Hand Pad and lightly whisking the surface with a grinder, I rolled on a couple fill-flow coats of WEST SYSTEM 105 Epoxy Resin and 207 Special Clear Hardener. The results pleased me.

Two layers of 6" wide , 17 oz. biaxial with ¾ oz. mat.

The wood strip on the left is a 45° beveled piece ripped from "two by" PT lumber. The right is six inch wide "peel and stick" flashing membrane.

The drain pipe shimmed and centered in place.

The G/flex 650 collar poured and curing.

How to secure the shower drain in the hole in the concrete slab? G/flex 650 would form a collar locking the drain into it. Because the drain pipe and the shower drain are PVC, cutting it out is easy if replacement is ever necessary.

To hold the 3" drain and pipe at the right height, I wedged a vertical 2x4 under the pipe from the ground below. Working from a ten foot stepladder under the concrete, I shoved in wedges around the pipe to center it in the hole, and checked my centering job from above. Also from above, using a 4"-diameter diamond saw on a grinder, I cut a horizontal, quarter inch wide and deep groove a half inch below the hole's rounded edge.

When the drain was where I wanted it, I needed to prevent the G/flex 650 I'd pour in from oozing out. From beneath I stuffed ⁵⁄₈"-diameter flexible foam "backer rod." If the foam rod came up too far when seen from above, I jammed it back down. Working from above and below, I was convinced it was closed off. Because it was well above 80°F, the temperature helped to make the G/flex 650 runny enough to pour easily into the gap around the drain. After pouring I ran below to check for drips or runs. None!

Were I to do it again in Florida's summer heat, I'd ask the Gougeon tech people how to slow down the G/flex 650 for glassing. Maybe by adding a small proportion of mixed 105 Epoxy Resin and 209 Hardener? [Editor's note: this would work, although it would slightly reduce flexibility. For more information see "Mixing G/flex Epoxy with other WEST SYSTEM Epoxies," *Epoxyworks 26*, Spring 2008]

In November, the Levy County chief and electrical inspectors came out. They looked under the slab. They looked in the bathroom. Besides a signed electrical inspection, they left with approving grins and holiday well wishes.

Postscript: June 16th, 2016 the house passed the Certificate of Occupancy inspection. As of August 2016, kitchen trim and shelving are coming along. The top floor epoxy deck-roof has performed impeccably.

The finished drain installed.

Big Red Gets His Smile Back

By Tom Pawlak

My neighbor Rollie is always coming up with these unbelievable deals along the highway between his home in Bay City, Michigan, and his cabin a couple hours north. The latest super deal was a big red garden tractor that was mechanically in near perfect working order—except the previous owner ran it into something and busted up the grille. He brought it over and asked if it could be fixed. Here's how we repaired "Big Red."

Some of these injection molded plastics are difficult to get a reliable bond to, so I told Rollie there were no guarantees on the repair. I was reasonably confident the repair could be done though because I have had some success repairing injection-molded hoods on different brands of riding tractors in the past. We could have approached this repair by riveting metal straps to the back side of the grille as reinforcement, but with all of the molded details and the multiple broken pieces that needed to be connected, I felt that the fiberglass buildup/overlay made more sense and would likely end up being a stronger repair.

My plan was to reassemble the broken pieces by stretching plastic tape across the deformed pieces and hold stubborn spots with spring clamps and temporary supports. The tightly pulled tape acted like rubber bands that helped draw everything together.

The "mug shot" of Big Red's completed grille. The large rivets give his grin a "don't mess with me" look, kind of like Scarface.

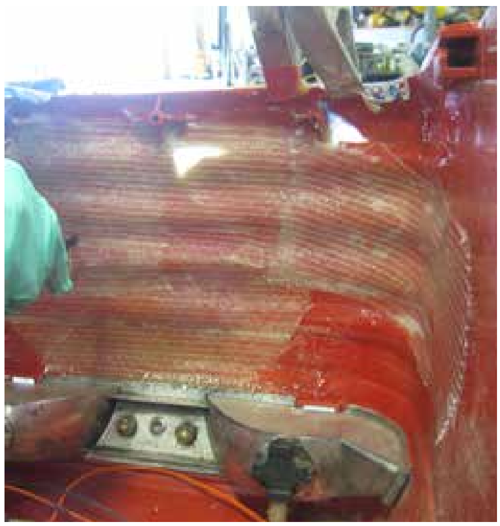
The structural part of the repair was done from the backside by cleaning the plastic, sanding aggressively with 40 to 60-grit sandpaper, and flame treating the plastic (blue part of the flame from a propane torch touches the plastic with it moving at about 12" per second across the surface to enhance the bond) just before applying a coat of WEST SYSTEM® G/flex 650 Epoxy. While this coat of epoxy was still wet, I laid in a single layer of 6-ounce fiberglass cloth. G/flex Epoxy is best for bonding to plastics; however it is not optimized for wetting out heavier fiberglass fabrics. I opted to switch to 105 Resin and 206 Slow Hardener (while the G/flex Epoxy was still uncured) to more quickly wet-out the layers of 17-ounce biaxial fiberglass cloth used for the rest of the reinforcement.

For this repair, I did not grind bevels like we would recommend on a fiberglass laminate repair because I wanted to keep the repair simple. For additional strength, Rollie installed large pop rivets along each side of the major breaks after the fiberglass reinforcement on the back had cured solid. I think the large rivets give Big Red a "don't mess with me" look—sort of like Scarface in the mobster movies of old… All that mattered in the end though was that Rollie was very happy.

For more on gluing plastics and instruction on flame treating plastics for best adhesion see the article "Gluing Plastic with G/flex" in *Epoxyworks 26.*

Above: The tightly stretched tape helped draw everything together.

Right: three brushes are taped together to expedite the wetting out process.



The repair was done from the back side by cleaning, sanding and flame treating the plastic prior to applying a coat of G/flex 650 Epoxy. While this layer of epoxy was still wet, I laid in a single layer of 6 oz. plain weave fiberglass cloth.

The fan with support crane installed and awning extended.

An Outdoor Ceiling Fan Support Crane

By Douglas Heckrotte

I first saw outdoor ceiling fans while vacationing on Isla Mujeres, Mexico, just north of Cancun. These fans are ubiquitous and evidently inexpensive. Used both indoors and outdoors, they're mounted on 3"x 3" concrete beams. Some of those beams also support sun shades, but usually the fans are completely open to the weather.

We purchased a waterproof outdoor-rated ceiling fan and for many years used it under the shed roof over our patio. In the course of renovating a summer kitchen and open porch into an all-season summer room, we recently replaced the shed roof with a retractable awning. The outdoor fan makes the open or awning-covered patio very pleasant on beastly hot, airless days.

Here is how I mounted the fan, using West System Epoxy for laminating and coating.

The design constraints were: stay stylistically in keeping with the Gothic trim on our 1857 house; be easily removed for the offseason; conceal wiring; mount the fan adequately; safeguard the awning fabric from chafe; and be long lasting.

I had on hand a quantity of air-dried, rough-sawn American white ash, and several years' worth of half-used West System 105 Resin, Hardeners, and Fillers. I used fresh 207 Special Clear Hardener for transparent finishes, limiting the older, darkened hardeners for uses that weren't appearance-critical.

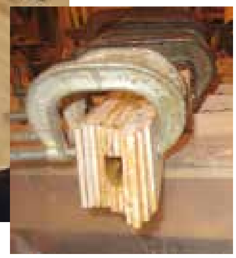
I designed the fan crane on AutoCAD and printed full-size patterns for curves, end angles, and intersections at the hub. I lofted the crane's legs onto a plywood workbench and included a small amount of camber to account for sagging under the weight of the fan. I didn't add to the designed curvature to account for springback since the fan would tend to bend the legs in the intended direction. I covered the workbench with poly sheeting and screwed brackets against it for bending and clamping the laminate layups.

I milled the ash lumber into laminae using the least attractive of my stock, usually from the slabs cut near the outside of the log. I didn't worry about the random lengths available knot-free, and I collected enough full-length stock for the "face" hub. The milled laminae ended up approximately 3/16" thick and were made ¼" over width. This meant that I ended up with 12 ash laminae and one 1/16" thick mahogany veneer. I arranged the random lengths so that the curved portion didn't have joints, and the joints were

The cranes's legs lofted onto a plywood workbench with poly sheeting and brackets for clamping the laminates.

The laminates clamped onto the brackets while curing.

The laminates for the legs trimmed and sanded.



The end of the laminate where the power cord will run.

staggered throughout the planned layup. I numbered the pieces with chalk.

The 3/16" ash was too stiff to make the curve, so I had to pre-bend the laminae at the curve. Rather than steam bending, I leaned the wood stock against a short electric baseboard heater and experimented to determine how much time each face of the stock needed to be heated to reach the desired bend. I heated each piece, using a darkroom timer to keep me honest, and popped it into a form to cool. I maintained the stacks of bent laminae in order, and somewhat beyond the required curve until they were laminated.

The crane legs are hollow to accommodate the fan's power cord. I determined that it would be necessary to laminate the inner four laminae, the middle four laminae and the outer five laminae separately. I used the same clamping setup for these six preliminary layups. I cut the middle layups and removed a portion to make way for the wires. Next, I laminated the two narrower layups to the inner layup, then added the outer layup. To set the dimensions and end lengths, I used the lofted drawing that the finished laminations had been done on.

These finished legs were difficult to handle. To be sure of the fit of the fan hub, I made the pintles and hinges and a mockup in my shop.

I laminated scrap ash for the fan hub components and its little "rooflet." Two of these hub components were fitted and bonded with epoxy onto the top ends of the legs and the remaining three components, with the fan and rooflet, were arranged to be mounted onto the legs/hubs. One bolt suffices for the leg hub connection and a second holds the fan, fan hub, and rooflet assembly in place.

Once all fits were complete, I coated the assemblies with epoxy, allowed it to cure, then sanded and painted them.

The fan hub clamped to the legs.

The fan hub assembled with the rooflet ready for epoxy coating and painting.

Boats as Art

"Undulating Passion," a contemporary table built out of scrap boats and WEST SYSTEM Epoxy.

As a career architect-sculptor, Larry Brown created a vocabulary of freeform shapes that bring a sense of naturally flowing, organic dimensionality to his art. Recently, he applied his methods to a municipal scale art project using recycled fiberglass boats. His goal was to make large fine art pieces and park scale sculptures.

The idea of using boats came to mind after a different source of materials fell through. Brown had attempted to salvage materials for the project from a local industrial plant undergoing demolition. When that didn't work out, he found promise in the expanse of boat hulls and deck surfaces. A drive around a coastal community revealed scores of unused fiberglass boats stashed in backyards and at marinas. The possibility of using old boats as his source material captivated his imagination. The question became how to extract useful components from those existing hulls and decks.

The constructed 12' 6" tall abstract art sculpture is assembled from a Rhodes 19 sailboat.

To prove the idea that boats could become art, he sketched several organic shapes over a drawing of a sailboat hull. He drew these same artistic shapes in perspective, and then combined them to visualize a whole, standing sculpture.

Each sketch was reproduced to ½" scale on 64# cover stock. He made sure all the parts would fit on the surface of the Rhodes 19 class centerboard sailboat that was available. Next, he assembled a paper model by cutting the cardboard and gluing the parts together with hot melt glue. This 3D model proved that freeform shapes cut from boats could, in fact, make fine art. This model helped him demonstrate his core idea to others, as well as mark the boat for the cutting stage.

The Rhodes 19 sailboat became Brown's first "proof of concept" sculpture. At 12'-6" tall, the finished piece can be seen from a great distance in the landscape. The juxtaposed curved fiberglass panels and multiples holes in the design enrich its dimensionality with light and shadows. The openness invites people to walk in and around this abstract outdoor sculpture.

Marking organic shapes on the hull of a MC Scow before cutting to make "Undulating Passion."

A second boat sculpture was a byproduct of the cuttings made from an unwanted 17' centerboard sailboat with a cutty cabin. During the slicing of the cockpit and deck, two 9' long fiberglass coaming pieces stood on end, immediately framing the view of the landscape beyond these tusk-shaped pieces. This discovery led Brown to fabricate a base to fix the same relationship of the tusks to one another. He welded a Z-shaped base from scrap jungle gym bars. This twin tusks sculpture now graces a historic New England garden.

While exploring the assembly of a variety of styles of marine craft, Brown combined four sailboards vertically along with one elevated surfboard at a horizontal angle, making a 12' tall art presentation.

A national competition to submit designs to recycle old canoes as park sculptures along the Huron River in Ann Arbor, Michigan inspired him to use aluminum canoes for public art. This competition allotted a dozen canoes per sculpture. Brown arranged these in a splayed, upright, flower-like configuration. This sculpture's 12'-wide interior provides a cathedral view to the sky and speckled views out to the surrounding river and parkland. People can walk through the 17'-tall outdoor structure year-round. This sculpture received an honorable mention award in the Ann Arbor competition.

A single-person Laser sailboat provided the material to make a dozen art panels for a 3'- long tabletop sculpture. Brown used WEST SYSTEM Epoxy to connect all the panels together.

At nearly six-foot tall a red flame shape sculpture called "Flicker" is assembled from parts created out of fiberglass dinghies. Epoxy coated fiberglass mat and cloth strips connect its six curvy panels, with the same tabbing process mounting the entire art piece to its base.

"Undulating Passion" is a 7'- long fine art console table assembled from parts cut out of an MC Scow sailboat. Fiberglass tabs connect the boat panels to make a modern functional table. There are no obvious signs that this piece of contemporary art is made from recycled materials.

The hulls from a G-Cat catamaran and a Hobie 18 catamaran promise to become a spiky, 14'- tall sun tanning bench in Florida. Brown has built a scale model, and the four hulls are ready to be marked, sliced, and assembled into their new art form. Upon completion of this abstract and gossamer sculpture, Brown is seeking to find it a home where others can enjoy it.

At 6' tall, Flicker is painted red and ready to be installed.

The collection of artful furniture and abstract sculpture fabricated from fiberglass panels shaped out of boats of all sizes seen in this article confirms that high-quality art can be created from repurposed boat material. Boats as Art promises to become a unique contribution to American Art.

In order to evolve his burgeoning idea to repurpose boats as art, the artist is actively pursuing a few large-scale sculpture assignments. Perhaps your community has unloved fiberglass boats that could be turned into contemporary dimensional art and modern public sculpture. The artist, Larry Brown, enjoys transforming architectural and environmental elements into culturally advanced art.

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Sarasota FL and Beverly MA

A paper model of a 17' tall sculpture to be made from four catamaran hulls.

Azek® PVC Decking – is it an option in boat construction or repair?

By Bruce Niederer

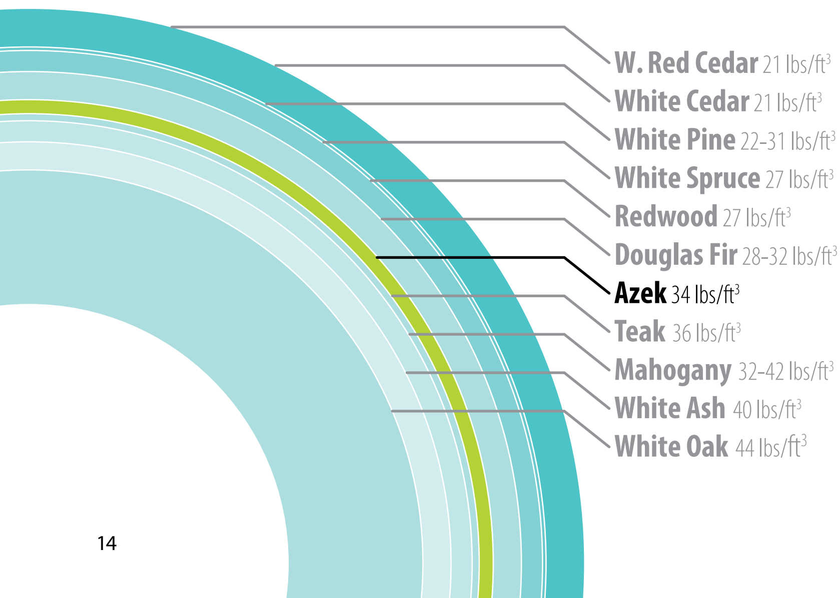
Wood has always been used in fiberglass boat construction, in stringers and oftentimes as core in high compression areas such as under cleats, stanchions and winches. Wood works great in these applications but we all know that the big problem with wood is the fact that it rots if it gets wet. Here at Gougeon Brothers, Inc. (GBI) we have spent long hours writing manuals and training people to use proper techniques using epoxy to keep wood dry and strong.

But wouldn't it be nice if it simply didn't rot?

This is the idea behind some testing I conducted to learn whether or not Azek PVC decking would be a viable substitute for wood in select situations.

First, I considered density because it seemed a bit heavy—but with a quick bit of online research, I learned that wasn't the case. The density of Azek PVC is definitely in the ballpark. (See density chart below.)

Now it was time to look at adhesion. I used two surface preparations; 1. Sanding with 60 grit using a random orbital sander and 2. A flame treatment (reference "Gluing Plastic with G/flex" in *Epoxyworks 26*) and two epoxy systems; 1. WEST SYSTEM 105 Resin/206 Slow Hardener, and 2. G/flex 650.



In the tensile adhesion data to the right, there's nothing unusual in the results for the sanded surface—I expected G/flex to perform somewhat better than the 105/206 system. Although the average tensile adhesion values are very similar (within about 100 psi) the failure mode reveals quite a bit more substrate failure using G/flex.

The flame treated surface tells a different story. All 20 test sites—regardless of what epoxy was used—failed 100 percent of the Azek, creating large voids in the surface. The epoxy did not fail, and the average adhesive strength was identical.

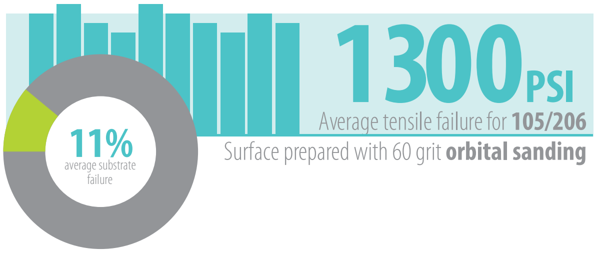
The hardware removal—pull out test, is again very revealing. The average pull out strength of the fastener threaded into a proper pilot hole is 761 lbs of direct load (the upside-down numbers on the bottom of the samples). The numbers are very closely grouped indicating the value represents the shear strength of the Azek PVC with that particular thread. Adding a little 105/206 into the pilot hole and painting some on the fastener threads changed the failure mode from a shear failure to a destructive failure, breaking the PVC out in chunks. This raised the pull out strength by 389 lbs.

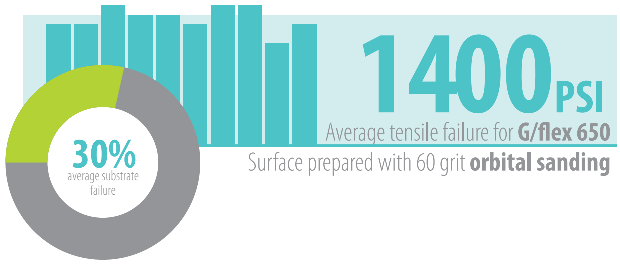
All of these data sets—density, adhesion and hardware bonding support the notion that the Azek PVC copolymer PVC decking may well be an option in certain boat building and repair applications. Clearly it can be substituted for wood backers and crush resistant core applications i.e.: under stantions and loaded hardware. One final consideration is the cost—one ¾" x 6" x 12' Azek board purchased locally cost $46. That's probably not a deal breaker but it's something to keep in mind.

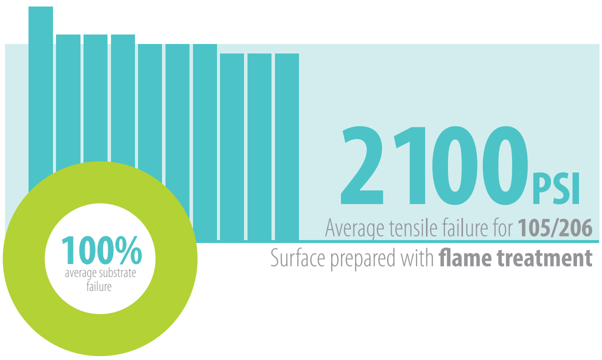
Sanded surface. The left panel was G/flex; the right was 105/206.

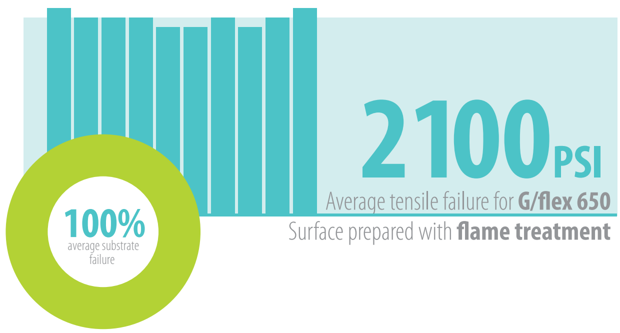
Flame treated surface. The left panel is G/flex; the right is 105/206.

Tensile Adhesion

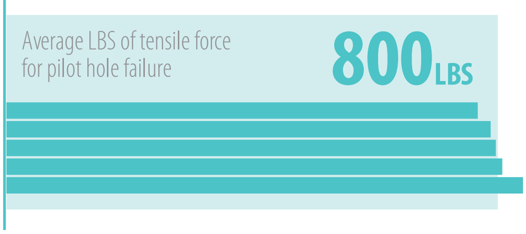








Hardware Removal



Hog Tide Deck Repair

By Greg Bull

J22 Hog Tide at the Gougeon Brothers shop.

Last summer Gougeon Brothers, Inc. partnered with Sail Magazine to produce a series of short videos showing how to repair a 1983 J22 sailboat that was brought into the Tech shop. The boat, named *Hog Tide*, needed the types of repairs we wanted to cover. The videos can be found at both westsystem.com and sailmagazine.com.

Hog Tide's deck was spongy around the chain plates, so I decided to fix the coring in the deck. Because the main bulkhead was being replaced, it made it easier to do the deck repair from the underside. I started by removing the inner laminate to get to the bad core. I determined the extent of the bad core by tapping on the laminate; a duller sound suggests deteriorated coring. Another way of determining if the core is bad is to drill small holes to see where the bad core is by noticing if the balsa core is a dark color. Water may even drip from the drilled holes. To cut the inner laminate I used a high speed oscillating cutter with a diamond grit blade (multitool). When cutting out the inner laminate, keep the area that is being opened up as small as possible. You can always make more cuts to make the area larger.

Above and below: the rotted core exposed beneath the fiberglass skin.

Removing the inner laminate allowed me to see where the core had turned black because it was rotten. I started out with a small area and slowly made the cutout larger as needed. The inner laminate was hard to pull away, so I used a pry bar and pliers to pull the inner laminate from the core. I ended up opening the inner laminate up to almost twice the size that I had started with. That is how it usually works out.

A second approach would be to cut out a larger area that you think is into good core and then remove the inner laminate in one piece. For this approach, you would do your repair, bond the cutout piece of the original inner laminate back onto the new and old core, and tab around the outside edge of the cutout.

Although the core looked good, (not black) it was wet. The still yellow core had not had the time to start rotting. I decided to just replace all the wet coring because drying the core is time consuming and would slow down the progress of the project. Alternatively, I could have just dried it so that the new inner laminate could bond to the old core. The wet core will still be good after it has completely dried.

The rotted and wet core removed.

The rotted core removed between the two skins at the hull/deck joint.

The core was deteriorated all the way around the chain plate. Damaged core may not be just a square or circular area: it may have "legs" that will go all over. While I only had to remove the core that was bad, usually it is black, I also removed the core that was just wet instead of drying it.

The coring needed to be removed at the hull/deck joint even where the laminate was not cut away, so I scraped it out from between the two laminates. By doing it this way, I did not have to rebuild this area. The core tapers down to just glass at the hull/deck joint, and the core only went back about an inch. I pushed thickened epoxy (WEST SYSTEM® 105 Resin / 205 Fast Hardener with 403 Microfiber filler) back into the tapered area then pushed the new coring into this. The hollowed out opening between the two skins provides space to push the new coring into the hull deck joint. You will have some thickened epoxy come out around the coring, and this is how you know you've put enough epoxy into the void before pushing in the core.

I cut new 3/8 inch balsa core to shape. I pushed the new core into place using 105 Resin/205 Fast Hardener thickened with 403 Microfiber filler to a non-sag consistency. If this repair was being done in temperatures over 80°F, I would use 206 Slow Hardener so I would have more working time. An alternative would be to use our Six10 Adhesive to put the coring back in place. A repair of this size would require a couple tubes of Six10. I applied thickened epoxy to both the underside of the deck skin and the top of the new core then pushed the core into place. Some thickened epoxy came out around the edges, which I used to fill any gaps around the new to old coring.

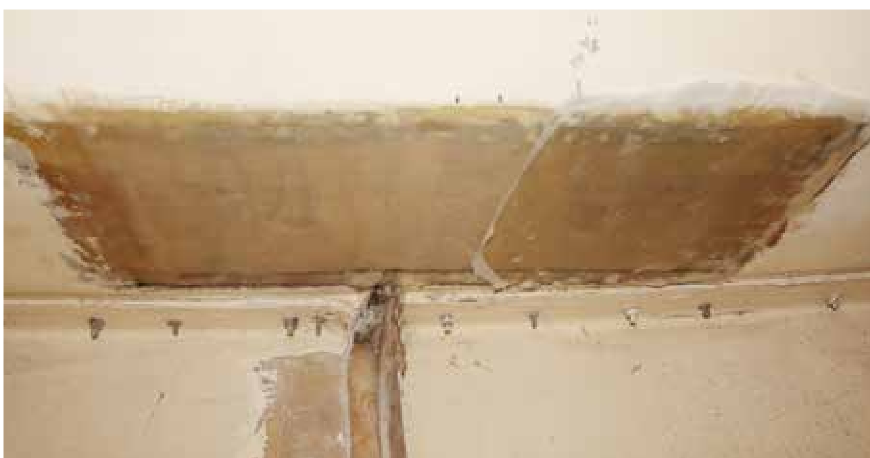
This was followed with two layers of WEST SYSTEM 737 biaxial fabric laminated over the repair. There was a ½" step taper between the two layers of fabric.

New balsa core epoxied into place where the rotted material had been removed.

WEST SYSTEM 879 release fabric was applied over the area and smoothed down. This smoothed the edges of the glass, so very little fairing needed to be done. 879 Release Fabric left a slightly textured surface on the finished repair. A light sanding of the surface is still required before the top coat goes on, but it will need far less sanding thanks to the release fabric.

The deck core repair had to be completed to this stage before a new bulkhead could be installed. Once the bulkhead gets installed, we will cut the chainplate hole using the original hole in the top skin as a template.

Just a few weeks after returning Hog Tide to her owner she took first place out of eight J22s racing on Lake Huron's Tawas Bay.



The repair area after the area had been fiberglassed and cured. The right side still has 879 Release Fabric attached.

The finished product: fully cured hiking staves ready to hit the trail.

Merit Badge

By Tom Dragone, PhD

In Epoxyworks #38, we published an article featuring two projects that met the requirements for the Boy Scout's Composite Merit Badge. Here, Tom Dragone tells us about two more projects completed by scouts in Troop 7369 from Chantilly, Virginia.

In 2006, the Boy Scouts of America created the Composite Materials merit badge for scouts to earn, to help them learn about the importance of composite materials and encourage them to consider careers in this field. Being an aerospace composites engineer as well as an active scouting advisor, I saw this as a natural opportunity to share my interest and experience in composite materials with the scouts in my troop. I developed a set of projects to help the scouts learn about composite materials and share them in the hope of getting more young men interested in this exciting field.

As part of the requirements for earning this merit badge, the scouts learn about the constituent fibers and matrices that make up composite materials including graphite, fiberglass, Kevlar®, epoxy, and polyester. They

(Left): Scout slides Kevlar/graphite braided sleeve over PVC pipe mandrel.

(Right): Scout measures out and mixes epoxy resin and hardener. Braid donated by A&P Technology.

Hiking staves were hung vertically while scouts used brushes to coat the fibers. Hanging the staves prevented epoxy from pooling on one side of the staff.

also learn about processing and fabrication techniques such as hand lamination, filament winding, and oven—versus autoclave—curing. Most importantly, they learn how to use these materials safely.

The most challenging (and fun!) requirement to earn this badge is making two separate items with composite materials under the merit badge counselor's guidance and direction.

The inspiration for this project came directly from Robert Baden-Powell, the founder of The Boy Scouts Association, who consider the "Scout staff" to be an indispensable part of a Scout's equipment. The basic staff should be about 5' long, strong, stiff, and easy to hold and carry (therefore lightweight). It can be customized in a variety of ways to provide a scout with useful tools while adventuring in the outdoors. While Baden-Powell conceived this staff out of wood, I thought it would be helpful to upgrade the Scout staff with 21st-century materials, since many of the requirements for the staff are the same ones I use for optimizing aerospace structures.

A&P Technology offers braided fibers in a variety of sizes and material choices. The ideal staff should be stout, but easy to wrap your hand around, so I chose a braid that was 1" in diameter. While graphite would provide a classic composite material look, Kevlar was much more appealing to the scouts because of the idea that they would have a "bullet-proof" hiking staff. In the end, I chose a hybrid braid of graphite and Kevlar that provided decorative interest to the staff as well as stiffness and strength.

The cure reaction was accelerated by heating in an oven (home-built using insulation board and halogen lights) to allow the scouts to apply three coats of epoxy within the 8 hour day.

Choosing an appropriate mandrel for the staff was a challenge. A removable mandrel for a 5' staff would be difficult at best, so I quickly turned to core materials that would stay with the staff. Previous groups had used foam core which would result in a very light and sturdy staff, but I could not find an off-the-shelf core, and a custom-made core would be cost-prohibitive. I also considered cardboard tubes, but again, 1" diameter by 5' long tubes were not available and too costly to custom-make. Ultimately I chose 1" PVC pipe as the mandrel. While not as light as the other options, it was readily available, low-cost, and easy for the scouts to use.

I did not have access to an autoclave, so the choices for resin materials were limited, compared to what I typically use to create aerospace parts. WEST SYSTEM Epoxy offered ease of use, room-temperature curing, and a strong durable finish. Experts at the WEST SYSTEM technical support center recommended their 105 Resin with 207 Hardener for this application so that the finished product would have a clear surface that would not yellow over time. They also recommended at least three coats of epoxy to provide a smooth surface. The

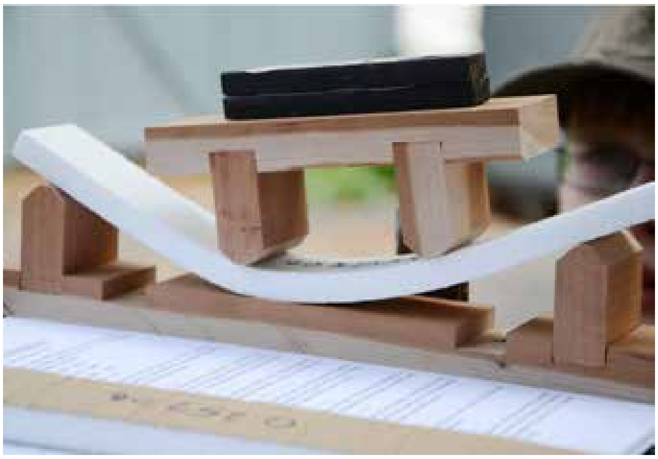
The scouts made sandwich panels from fiberglass cloth and Styrofoam.

scouts measured out the epoxy and hardener in plastic cups, and they used brushes to apply the epoxy while the staves were hung vertically. This prevented the epoxy from pooling on one side of the staff.

The only disadvantage of using this resin-hardener system is that it is slower to cure. Since I offered this Composite Materials merit badge to scouts as part of a one-day Merit Badge University that our troop runs for the local scouting District, the project had to be completed within a single 8-hour period. To accelerate the cure reaction, I created a simple oven from ½" insulation board and duct tape, and heated it by four 100-watt halogen lights. The oven was efficient enough to reach about 120°F, which reduced the typical 8-hour cure time to 2 hours. This enabled a well-paced day, allowing the scouts to complete three cure cycles on the hiking staff while giving us time to discuss fibers, resins, processing methods and applications while the staves were curing. The finished hiking staves were strong, light-weight and ready to hit the trail.

As a second project, the scouts created sandwich panels from fiberglass cloth and the same epoxy over a ¼" Styrofoam board. In this case, they used plastic spreaders to distribute the epoxy into the cloth. This project required only one cure cycle to create a good structural bond between the fiberglass and the foam core. When the panels were cured, we tested them in a simple four-point bend apparatus. The foam core alone weighed 0.08 oz and held 12 oz before breaking while the fiberglass panel of the same size weighed 0.8 oz and supported over 30 pounds. This demonstration made a lasting impression on the scouts as to the strength and structural efficiency of composite material construction.

Dr. Tom Dragone is a Senior Scientist at Orbital Sciences Corporation, specializing in the application of composite materials in advanced spacecraft and launch vehicle structures. He is also Advancement Chair for Troop 7369 in Chantilly, Virginia.



The foam alone only supported 12 ounces.

The composite panel supported over 30 pounds.

Adagio
Still Formidable after 46 Years

By Ben Gougeon

Adagio, our beloved trimaran, was designed and built by Meade and Jan Gougeon in 1969 and launched in the summer of 1970. After undergoing a minor refit this past winter, she still has what it takes to win. We're extremely proud that *Adagio* placed first in the multihull division of 2016 Bell's Beer Bayview Mackinac Race, which spans almost 300 miles of often treacherous Great Lakes.

This year's race was fast, with *Adagio* finishing in just over 29 hours. The fleet had a beautiful, mostly downwind run to the Cove Island buoy and then a thrilling reach most of the way to Mackinac Island. Of course, Lake Huron had to throw 35 knot winds, rapidly shifting direction, at us about 40 miles from the finish line, but *Adagio* continued strong. This was the fifth time *Adagio* took first place in this venerable race, having won the open class in 1999, 2000, 2002 and 2006.

During the winter we prepared for the race by modifying the spinnaker pole, replacing most of her hardware, improving the deck layout for speed and simplicity, optimizing sheeting locations and putting on a gorgeous set of North Sails. We performed some minor repairs and maintenance to the hulls, but did almost no structural work other than extending the cabin top 12" to gain sheeting angle.

In many ways *Adagio* is a testament to wood/epoxy boat building. To our knowledge, she was the first large wooden boat bonded together entirely with epoxy and using no permanent mechanical fasteners. She was also the first wooden boat completely sealed with epoxy both inside and out for moisture exclusion.

This winter, we plan to replace the original centerboard which has provided 47 years of service. Considering what she's been asked to do over the last half-century, I'd say *Adagio's* longevity has been quite amazing. With proper care, maintenance and a little luck, hopefully she'll be leading future generations of Gougeon's across the finish line.

Adagio tuning up before the start of the race.

Adagio leading the pack at the start of the race. Strings, another Gougeon built boat, shown in third would finish second in the multihull division.

Heavy winds and rain as Adagio passes Round Island Lighthouse to finish the race first in the multihull division.

(L to R) Alan Gurski, Matt Scharl and Ben Gougeon crewed Adagio to victory in the Division III, Cove Island Multihull fleet of the 2016 Bell's Beer Bayview Mackinac Race.

Cold Weather Bonding

By Don Gutzmer

"What's the lowest temperature WEST SYSTEM Epoxy can be applied?" During the winter months, this is a common question our Technical Advisors are asked. Fortunately, it's one we're well equipped to answer. Gougeon Brothers, Inc. got its start in the world of DN Iceboat racing. Both Meade and Jan Gougeon have won multiple DN cup races worldwide. It's not unusual for an iceboat to need repairs mid-regatta, so part of the discipline of iceboat racing is getting epoxy to cure despite cold working environments. The trick is using strategies that bring epoxy temperatures up to adequate cure levels in cold working environments.

Cold weather techniques

1. Use WEST SYSTEM 105 Resin and 205 Fast Hardener. 205 Fast Hardener is formulated to cure well at temperatures as low as 40°F (4°C), but this does require an extended cure time before removing clamps or sanding. 206 Slow Hardener and 207 Special Clear Hardener should not be used below 60°F (16°C) unless you elevate the working temperature to allow the system to cure properly. For best results when clear coating with 207 Hardener, postpone coating until the temperature in your working environment is around 70°F (21°C). 209 Extra Slow Hardener should not be used below 70°F (21°C).

WEST SYSTEM 105 Resin and 205 Fast Hardener will cure at temperatures as low as 40°F (4°C)

2. Warm resin and hardener before using. Cold temperatures increase the viscosity of the epoxy, making it more difficult to dispense, mix and apply. Warming the resin and hardener lowers their viscosity, allowing the product to flow through the dispensing pumps better, cling less to the containers and mixing equipment, and blend more easily for thorough mixing. The warmer, lower-viscosity mixture will flow more smoothly during application and penetrate porous surfaces more efficiently.

Methods for warming resin and hardener before use:

a. Leave the containers in a warm area

b. Place a heat lamp near the containers

c. Put containers in a cooler with a light bulb or heating pad

d. Build a custom warming box out of rigid sheets of foil-backed insulation and keep it warm with a lightbulb or heating pad

In any case, you will want the resin and hardener at a temperature between 70°F and 90°F (21°C to 32°C). These methods keep the warmed resin and hardener close to your work and allow less time to cool off between dispensing and

Buddy Melges rigging his DN Ice Boat on the Saginaw Bay.

application. Warming the epoxy helps the initial chemical reaction get off to a better start, and results in more cross-linking even if the mixture cools when it is applied to a cold substrate.

3. Dispense resin and hardener at the proper mixing ratio only. Altering the amount of hardener will seriously compromise the epoxy's ultimate strength. WEST SYSTEM 300 Mini Pumps are designed and calibrated to dispense the correct ratio—one full pump stroke of resin for every one full pump stroke of hardener. If you are not able to warm the resin and hardener, do not use excessive force when dispensing. Keep steady pressure on each pump and allow each pump head to make a full stroke down and a full stroke up. Remember, the resin and hardener become thicker and more difficult to pump when they are cold and require significantly more time to return to the top of the stroke.

4. Stir the resin and hardener thoroughly in a small pot, and allow more time before applying. Mix the resin and hardener for at least two minutes, scraping the sides and bottom of the mixing container. Use a mixing stick shaped to reach the corners of the pot. A smaller diameter mixing pot increases the chemical reaction between resin and hardener because its limited surface area prevents heat from dissipating too quickly.

If you are unable to pre-warm the resin and hardener, allow some induction time. This simply means letting the mixed resin and hardener stand in the pot for several minutes, then stirring it again before using. This helps get the chemical reaction started, and the exothermic heat the epoxy generates will reduce viscosity making the material easier to apply.

5. Warm the substrate as much as possible. The epoxy will thin out as it is applied to a warm substrate. It will flow out much more smoothly and penetrate better, resulting in a stronger bond. You can warm a repair area with heat lamps, hair dryers or hot air guns. Small components or materials such as fiberglass cloth can be warmed in a hot box (as described in section 2). Larger areas can be warmed by tenting the area and adding a portable heat source.

Avoid unvented open-flame heaters that burn kerosene or fuel oil. Unburned hydrocarbons may contaminate bonding surfaces, and elevated moisture and CO_2 levels can contribute to the formation of amine blush. Catalytic heaters do not appear to pose a problem unless they are used in a confined space such as an unventilated curing tent or box.

To prevent temperature-related moisture contamination, be sure you're working in ambient temperatures above the dew point. Your local weather resources will provide the dew point temperature based on relative humidity.

6. Prepare cured surfaces carefully

between applications. When coating at cold temperatures, the slower cure can result in the formation of an amine blush on the surface. The blush feels like a waxy/greasy film on the surface of the cured epoxy. Wash the surface with warm water using a 3-M Scotchbrite™ pad before applying subsequent coatings to a cured surface. Don't let the water evaporate. Dry the surface with plain white paper towels. Sand any remaining glossy areas with medium grit sandpaper.

7. Allow additional cure time before removing clamps or stressing joints. As a general rule, double the cure time for every 18°F (10°C) drop in temperature. Allow additional cure more than the 18°F (10°C) rule for pre-stressed joints, such as bent laminations and joints that will be subject to high loads.

8. Elevate the temperature of partially cured epoxy. Elevating the temperature of the epoxy after initial cure can help to complete the epoxy mixture's cross-linking and boost the epoxy's physical properties even after a week at cold temperatures. Elevate the temperature of the epoxy and substrate gradually to avoid thermal shock. Although any temperature elevation will improve cross-linking, try to boost the temperature to 72°F (22°C) or warmer. The time required for final cure depends on the hardener used and the temperature the epoxy is exposed to. Generally, higher temperatures require shorter cure times. Do not exceed 140°F (60°C) and do not remove clamps or load the joint until the epoxy has cooled.

CAUTION!—Heating a porous material may cause air within the material to expand and "out-gas." Allow the epoxy to reach a partial cure before elevating the temperature. If an epoxy coating applied over the material has not gelled, bubbles from the out-gassing material may show up in the cured coating or glued joint as it warms. In some cases your shop will naturally warm itself enough to complete the cure during the day, following a cold night. Outdoors, building a plastic tent to trap heat can easily boost the temperature enough for the epoxy to cure. Turning up the thermostat, using radiant heaters, electric heaters or electric blankets are the most common way to control the cure temperature in a shop. It is not necessary to heat the entire structure if you are working on only a small area. Tents of plastic or insulated board are very helpful for confining heat to specific areas and provide greater mobility with a limited heat source, both indoors and outdoors.

Cold weather storage

It is best to store WEST SYSTEM materials above 35°F (2°C) with the container caps screwed down tightly to avoid moisture contamination. The containers can be stored with the 300 Mini Pumps left on them. After a long storage, verify the metering accuracy of the pumps.

Repeated freeze/thaw cycles of the 105 Resin may cause crystallization. However, the formation of crystals does not permanently harm the epoxy, and they can be dissolved easily. Place the open containers in water warmed to 125°-140°F (52°-60°C) and let the resin come up in temperature. Stir the resin with a clean stick until all the crystals have melted and the liquid becomes clear. Remove from the water, replace the lids tightly and invert the container to melt any crystals which may be clinging to the top of the container. If the resin has crystallized inside the mini pump, pumping warm resin through it should dissolve them. Leaving the pump in the can while heating should clear the pump, too.

With a little advanced planning, and observing the precautions listed above, you can get WEST SYSTEM Epoxy to cure reliably in cold working conditions. Since the 1970s we've been using these techniques to assure dependable epoxy bonds throughout our frigid Michigan winters.

Vintage cars trailering DN Ice Boats onto the Saginaw Bay for a regatta.

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

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

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

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

How-to publications

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

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

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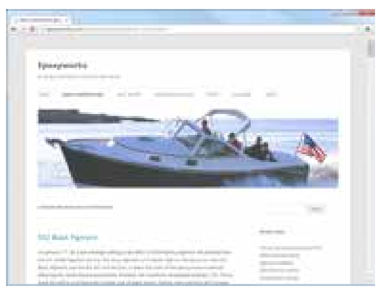

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Readers' projects

Jennifer is raising bees. The boxes called for nails to assemble, but she used West System Epoxy and made them fastener free.

The family that epoxies together, sticks together...

Chris built new mast supports for trailering the family's J22. The epoxy coating will make them last for years to come.

Jenna, in the middle of restoring her newly purchased Wayfarer, has used West System to repair some of the cracks from years of use.