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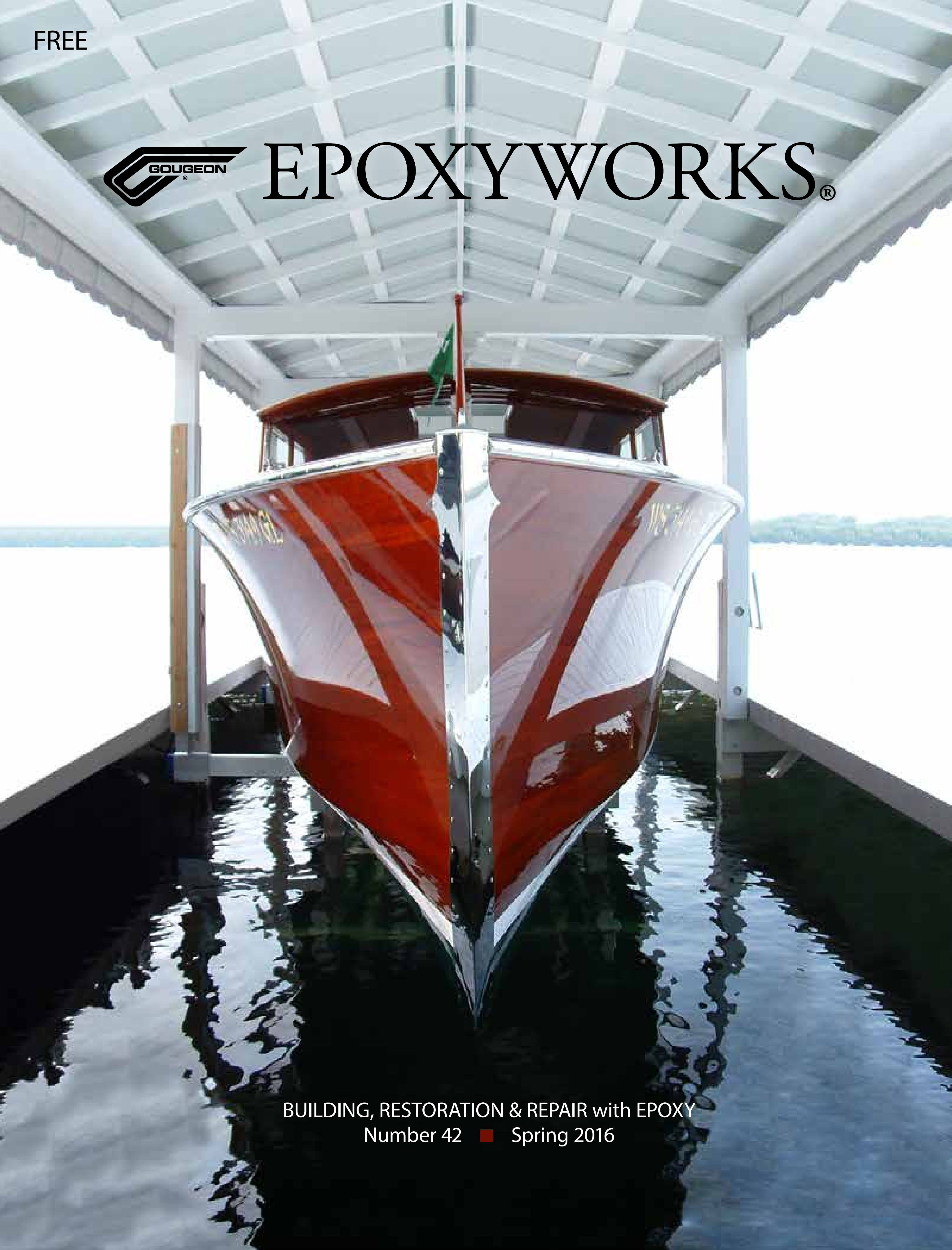

BUILDING, RESTORATION & REPAIR with EPOXY

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EPOXYWORKS®

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Browse back issues or look for specific topics.

Part Two

The finished boat was delivered to its new owners the summer of 2015. Here are the proud new owners of a Van Dam Custom original, doing what it was meant to do-having fun and LUV N IT!

VAN DAM
CUSTOM BOATS

Cover Photo: Nokomis, the sister ship to LUV N IT. Photo taken by Michel Berryer

By Bruce Niederer

In the previous issue of *Epoxyworks*, we looked at the start up process employed by the craftsmen at Van Dam Custom Boats as they built *LUV N IT*, affectionately referred to as the *Limousine* in Part One. We ended our "tour" of this build with the hull stained and pre-coated with WEST SYSTEM® 105 Resin/207 Special Clear Hardener, and the custom-built stainless steel cutwater being fitted for installation.

Let's pick up the build with the cabin top being installed…

LUV N IT Build

1

The Team at Van Dam often pre-stains and then coats components with WEST SYSTEM 105 Resin/207 Special Clear Hardener before installation. Here the pre-coated and sanded cabin sides are being fit.

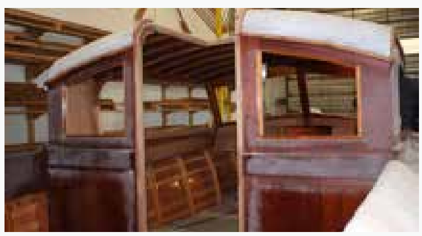
2

The cockpit coamings in place. The multiple pre-laminated curved pieces that make up the aft corner of the cabin have been installed.

3

Seating and storage are built and finished before they're installed in the boat.

4



The cabin trim, door jambs and window trim installed, and the cabin top primed.

5

Dave Snyder fitting the ceiling boards on the interior.

6

The engine room is wired before the engines are set. Van Dam does all wiring to ABYC standards with team members who are ABYC certified.

7

With the shaft logs installed and the bilge area painted white, the first engine is lowered into place and set on custom aluminum mounts.

8

Now the focus becomes hours and hours of finish work. On the left Trevor Brazell and Justin Halteman work on finishing the interior of the cabin. On the right, the dash, steering wheel seats and sliding windows are installed.

9

The neat installation of the engines and the shop-made exhaust pipes. The area under the engines is isolated, covered with 6 oz. cloth and WEST SYSTEM Epoxy, then painted white.

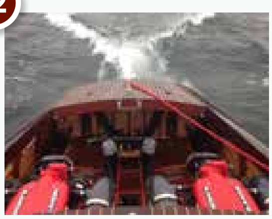
10

Van Dam is comfortable with multiple finish approaches and finish products. In this case, as on many of its new boats, Trevor Brazell sprays an automotive clear coat over the top of the WEST SYSTEM 105/207 on the exterior.

11

Trevor Brazell pulls the tape on a freshly painted waterline. The boat's name gleams under the new clear coat.

12



Van Dam does its first of multiple sea trials with engine hatches off and all mechanical and electrical systems accessible. This allows for ready monitoring of all components, assuring a trouble free experience for the customer.

13

This piece of mahogany was carved to fit custom engraved crystal glasses and decanters—a good example of the level of detail Van Dam provides for their clients.

14

LUV N IT is a great example of Van Dam Custom Boats' dedication to fine boatbuilding and complete customer satisfaction. Every Van Dam boat is a result of sound engineering, high-quality materials, excellent craftsmanship and long experience in boat building. To learn more, visit their website: vandamboats.com

A Tall Ship for Drummond Island

By Captain Hugh Covert

The current boat I have is in good shape, sails well and has been a lot fun for 17 years. It had grown in the planning stage from 18 to 20, 22 and finally to 36 feet long on deck. But, while it grew much longer and somewhat wider, it didn't gain much in headroom. The need for a bigger boat with more room, fused with a desire to sail a tall ship with passengers, resulted in a plan for a new boat. I have been captain of several big sailing vessels around the U.S. and the Bahamas, and have built several boats, so the idea of building one to sail close to home seemed natural.

Various limitations of water depth and haul out facilities produced a plan for a boat 60 feet on deck, 14 feet wide, schooner rigged with two masts, a centerboard and shallow draft. The inspiration for the design is an early 19th-century Baltimore Clipper-type Virginia pilot schooner whose measurements were taken by a French naval engineer in 1820. The lines were later re-published by Howard Chapelle, the American naval architect and historian. Reuel Parker, a leading light of the wooden boat fraternity, adapted the plans to modern building techniques and built a successful boat 20 years ago that cruises the East Coast and Bahamas, proving the validity of the concept. My boat will be named *Huron Jewel* and be licensed to carry six passengers on day sails in Potagannissing Bay and voyages to the North Channel.

In working out my ideas about a new boat, I drew heavily upon Mr. Parker's experiences and developed a plan further adapted to current wood/epoxy construction and U.S. Coast Guard rules.

We have built a 32' x 72' boat shop and are now lofting: drawing lines on the concrete floor based on a full-size model temporarily pinned together to get the dimensions just right. We've already acquired two Yanmar diesels for power and a tiny wood stove made in Benton Harbor, Michigan for heat and the proper aroma of wood smoke that belongs on a traditional schooner. We are sourcing as much material as possible through suppliers and manufacturers in Michigan, and have pledges of volunteer help from the local community.

The sail plan is that of a typical 19th-century schooner, gaff rig with four lower sails: jib, staysail, a boomed foresail and mainsail. A main topsail will be part of the working canvas, making for about 1,700 square feet, with an additional fisherman staysail for lighter winds.

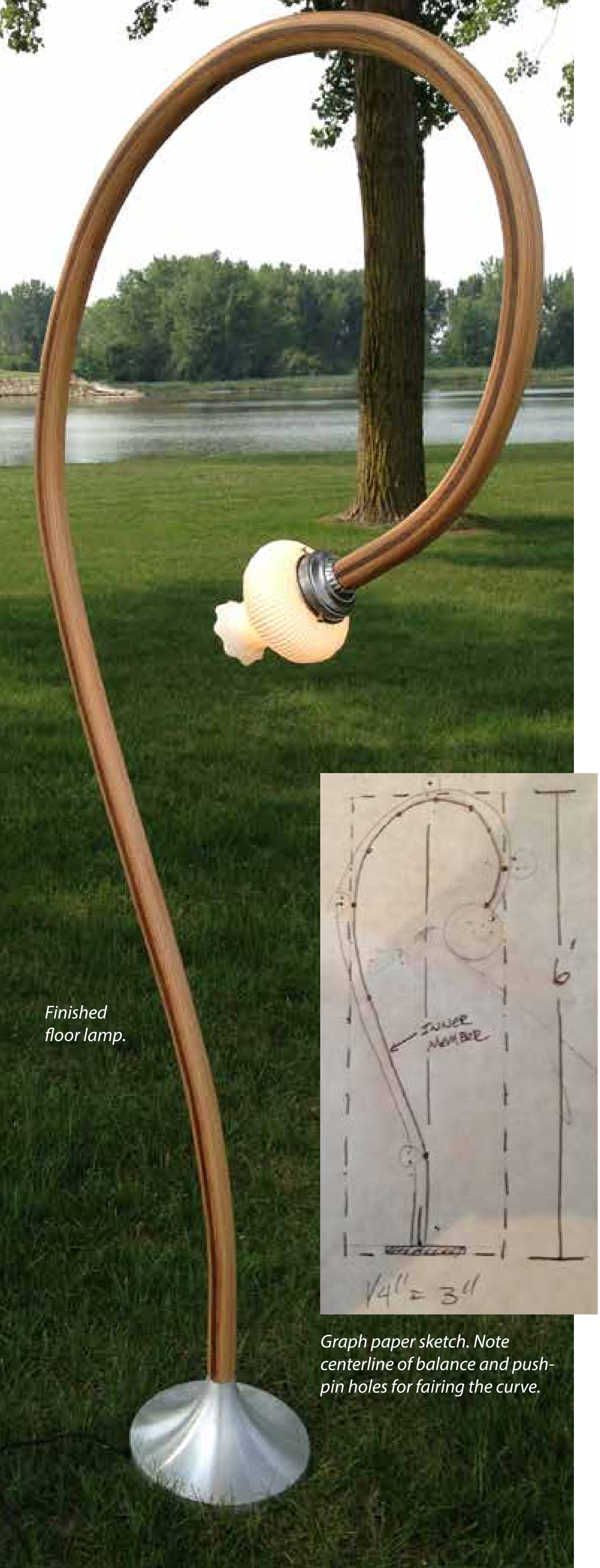
The hull will be planked in Douglas fir (milled in Michigan) and sheathed in WEST SYSTEM Epoxy (made in Bay City, Michigan) and fiberglass cloth. The interior will have eastern white cedar, as well as birch and other hardwoods. The masts will be of wood as well. We'll be carrying almost 14,000 pounds of ballast, mostly lead, but also counting the weight of engines and gear such as anchor chain.

We plan to launch in Big Shoal Bay in the summer of 2017, after building the hull and turning it over the summer of 2016 to finish the interior.

She will be a very fast and stable boat, suited to cruising around the rocky shores of Drummond Island, the Les Cheneaux Islands and the North Channel, and capable of extended voyages to the Caribbean.

Captain Hugh Covert owns and manages Shelter Island Transit Company on Michigan's Drummond Island. We'll be keeping in touch with him as the project progresses, and hope to provide updates in future issues of Epoxyworks.

Below are two views of the model built to the plan dimensions.



Finished floor lamp.

Balance

By Alan Gurski

I have always been fascinated with balanced objects. Buildings, stones, sculpture—the more impossible a balanced item looks, the more intriguing. I have been thinking for a long time about how to bring almost unbelievable centers of gravity into objects that are practical.

A good floor lamp is hard to find, so after our children destroyed our paper-lantern shaded floor lamp while playing hide-n-seek, we went shopping and found nothing. I decided I wanted to build a balanced and beautiful floor lamp. Lamp construction is very approachable. Lamp-specific hardware elements are readily available for next-to-nothing on a few well run internet stores. Aside from these standard fittings and castings, any material can be incorporated and the design possibilities are endless.

Design

The inspiration for this lamp would be a Fiddlehead Fern. Aside from being a tasty forage food, they have a very interesting balanced structure that I have always admired. The materials would be maple wood and aluminum as I like mixing organic and industrial materials in the mid-century tradition.

Graph paper sketch. Note centerline of balance and push-pin holes for fairing the curve.

I sat down with my trusty ¼" grid graph paper over coarkboard and set a workable scale of ¼"=3". I determined the space available for the lamp would require it to fit into an imaginary rectangle 2' wide and 6' high. I knew the general shape of a Fiddlehead so I used a piece of plastic cut away from an egg carton lid as a fairing batten. As the shape I wanted began to form, I fixed the curves with push pins plunged into the underlying corkboard. I picked easily scalable points on the graph paper grid where I could. Once I got the shape refined and the pins in place, it was time to study the balance element.

Finding balance is a matter of placing material or mass at distances off a neutral axis or centerline so the forces cancel each other out (like a seesaw). I knew my centerline and then calculated the mass of my materials on each side of the centerline. As the wood structure element was a relatively fixed mass per foot, some simple math was all that was required. I set out to keep the top curve material about equal on each side of the

Fiddlehead Fern

The clamping jig made from laminated MDF. Note the subtle red grid lines scaled up from the design sketch.

centerline. I used the glass lamp shade and bulb components on the right side to balance the more vertical material on the left side of the centerline.

Construction

I needed to get the very distinct recurve and spiral elements so I set out to steam bend the wooden element. To keep this brief, it was a terrible failure. First the maple snapped and then the substituted ash snapped. Suffice it to say steam bending is best accomplished with green/air dried very straight grained stock of a species with excellent cross-grain strength. At the 10' lengths required for this project there was no such stock to be found locally.

Laminating veneers was my fallback plan. I needed to get the lamp cord inside the 1 ½" x 1 ½" lamination so I decided on a three step process. I would laminate a ⅝" inside member, a ¼" center member with a hollow for the lamp cord and a ⅝" outside member (totaling 1 ½" thickness). Thus I could run the lamp cord inside the lamination and then bond the three members. I found some (+-) 0.1" spruce veneer at the required 10' length in our Technical Center. I ripped these down to 1 ½" wide and determined that 7 veneers each would give me the roughly the ⅝" thickness I was looking for in the inside and outside members. I further determined the ¼" center member would be walnut as a dark contrast to the much lighter spruce.

With stock prepared I set out to build the bending jig. Two layers of ¾" MDF were laminated with WEST SYSTEM® G/5 Five-Minute epoxy and an 809 Notched Spreader using the ⅛" tooth to keep the jig lamination thickness constant at just a little greater than 1 ½". I transferred the grid from my design sketch to this jig blank. From the grid I laid out the series of known points from the design sketch and lofted the curve with a stiff batten. I then cut carefully with a reciprocating saw and fine-tuned for fairness with a sanding block. I used a large hole saw in the drill press to make the clamping holes.

With the jig ready it was time for the inside member lamination. I mixed a small amount of 406 Colloidal Silica filler into WEST SYSTEM 105 Epoxy Resin/207 Special Clear Hardener to maintain some glue joint thickness, and rolled it onto the veneers with an 800 Roller Cover. Once all the veneers were wet, I stacked them, wrapped them in polyethylene plastic sheeting and taped it snugly. The polyethylene wrap simplified transportation to the jig and protected the jig and clamps from epoxy squeeze-out. Starting at one end, bar clamps were applied at logical intervals and tightened sequentially until epoxy squeezed out from between the veneers. This inside member was left to cure in the plastic sheeting.

The next day I removed the sheeting and put the lamination back on the jig. The ¼" walnut accent strip was laminated to the inside member. The accent strip is comprised of two pieces of wood each ¼" thick but only ½" wide. When placed at the top and bottom of the lamination they would leave a ½" recess slot in the middle of the lamination for the future installation of the lamp cord. It is important to point out that each member or layer of the finished lamination has a different shape. The radius of the inside member is the smallest with the center member radius slightly larger and finally the

Cut-offs of the laminations showing the inside and middle member lamination ready for lamp cord and then outside lamination.

The finished lamination

outside member is the largest radius. Each successive member was laminated on the former rather than the jig itself.

Next I prepared the outside member in the same fashion as the inside member including the polyethylene wrap. This was important because, in order to run the lamp cord, I needed to laminate against the now combined inner member and center member without actually gluing to it. Once this was cured I had two “halves” of my finished, laminated 1 ½" x 1 ½" blank.

I prepared the blank for lamp hardware by square cutting the two ends and installing the hollow threaded lamp nipples. I ran the cord along the slot in the walnut accent strip and then took the pieces back to the jig to glue the two halves together again with my 105/207/406 laminating mix.

Once the epoxy had cured I began sanding. I scribed some reference marks on the blank with a compass and began the process of turning a square blank into a round piece. I started with a course grit on a belt sander and changed to increasingly finer grits on an orbital sander. Finally I faired with a hand-held sanding block.

During the course of my sanding marathon I got just a bit overzealous and experienced some grain tear-out where the inner most veneer was getting thin from being worked down toward something round in shape. This has happened on other projects so I have learned to save the fine sanding dust from the orbital sander’s dust bag. With some G/5 Five Minute Epoxy and the sanding dust, I made my own custom filler putty. I knifed in this mix, let it cure, and continued sanding. When mixed very rich with sanding dust, and barely wet, a better filler putty cannot be found. I challenge you to find the grain tear.

After many sweaty hours of hand sanding and fairing I coated the nearly round piece in Sanding Sealer, let it dry and sanded down to 320 grit. Next I applied three coats of satin polyurethane and the woodwork was complete.

A Weighted Base

The lampshade holder and base were installed and fine fitted to the wood piece. I checked for balance and could not have been more pleased. The light gauge and hollow aluminum base, at only 11" at its widest, provided for a very stable floor lamp. That being said, the fact that this floor lamp was destined for a carpeted room with three young children inspired me to fill the aluminum base with a combination of 105 Epoxy Resin/209 Extra Slow hardener loaded with beach sand. The sand-filled base lowered the lamp’s center of gravity, ensuring it would not topple over if jarred during some intense game of hide-n-seek. I was able to cast such a large volume of epoxy without fear of excessive exotherm as the shop temperature was mild and the 209 Extra Slow Hardener produces very little heat as it cures. This allowed the thermal mass of the sand to absorb much of the heat generated by the slow curing mass of epoxy.

With the base filled, the lamp was wired and the bulb installed. I found the unique frosted flower bulb shaped glass shade at our local antique shop to complete the lamp.

Glass lamp shade found at an antique store on stock lamp hardware

Warm Temperature Bonding

By Don Gutzmer

During warm summer months, handling characteristics of WEST SYSTEM Epoxy will be different than at other times of the year. Our cure times are based on an ambient temperature of 72°F, but in warmer temperatures the epoxy will cure faster. There are some steps you can take to ensure good results when using WEST SYSTEM Epoxy in warm environments.

Epoxy cures by a chemical reaction between the resin and hardener that releases heat, called an exothermic reaction. The larger the volume of epoxy the more heat that is generated. Many epoxy users have seen pots of epoxy uncontrollably exotherm. The good news is there are some things you can do to prevent this. A good rule of thumb for gauging cure speed is that for every 18°F increase above 72°F, the working time and pot life will be cut in half. To maximize the working time of the epoxy, consider how much time you need and what temperature you'll be working at, then select the hardener accordingly.

The pot life on the WEST SYSTEM technical data sheets refers to a confined mass of 100 grams of epoxy at 72°F. Pot life is always shorter than working time because epoxy contained in a pot kicks off faster than epoxy spread into a roller pan (thin film). Spreading out the epoxy extends working time.

Select either the 206 Slow or 209 Extra Slow Hardener for best results in warm temperatures.

To maximize working time (and minimize waste), mix a batch size that you can use within half of the pot life. With 206 Slow Hardener that would be 10-12 minutes and for 209 Extra Slow Hardener it would be 20-30 minutes at 72°F. This approach lets you continue using the same mixing pot, mixing stick and roller cover or glue brush. The 300 Mini Pumps meter approximately 1 fluid ounce per pump stroke so you can mix small batches quickly and accurately.

After thoroughly mixing resin and hardener, pour the epoxy into roller pans or onto the substrate. This increases surface area so heat buildup (exotherm) can dissipate, slowing the epoxy's reaction.

To slow epoxy's reaction in very warm temperatures, create a foam box that is glued together and sealed to hold your roller pan as shown in the picture. Fill the inside of the foam box with tap water that will act as a heat sink and increase epoxy's working time. An ice cube or two can be added as long as you do not chill the epoxy too much. Chilling the epoxy too much can cause moisture in the air to condense on the epoxy. The moisture can cause the epoxy to cure at a faster rate, become cloudy and reduce its cured physical properties.

The thicker the mass of epoxy, the quicker it will cure. For large bonding applications we recommend using a two-step bonding technique:

1. Wet out the surface with neat (unthickened) epoxy.

2. Apply epoxy thickened with high-density filler like 403 Microfibers, 404 High-Density, or 406 Colloidal Silica.

Foam box holding water and a roller pan to help cool epoxy and increase working time.

Wetting out the surface with a thin coat of neat epoxy will help ensure that it has contact with all the nooks and crannies before the epoxy starts to cure. The thin coat of epoxy will cure more slowly and have time to effectively wet out the surface. The thickened epoxy is applied to bridge gaps, and should be applied last to the places with the largest gaps (requiring more epoxy volume) to maximize assembly time.

To monitor the cure process from each batch, pour a small sample into a container to see how fast the system is curing in thin film. "Controlling Exotherm" by Mike Barnard in *Epoxyworks 39* covers managing exothermic reaction when working with large quantities of epoxy.

1994 Four Winns 190 Horizon

Cockpit Sole Repair

By Don Gutzmer

Rotted and damaged wooden cockpit sole

As a technical advisor, part of my job is to guide our customers to the correct product selection and discuss proper repair procedures. Sometimes it's a fun challenge to take on my own projects to stay busy, and it helps me learn what my customers are up against when they do similar projects. This project was repairing the cockpit sole (floor) of a 1994 Four Winns 190 Horizon. The pictures will help tell the story.

The fasteners that held the seats in place likely provided the main entry point for the water which eventually rotted the plywood in many different areas. Removing the rotted wood was a dirty, time consuming task and the hardest part of the repair. To remove the damaged wood I used a powered multi-tool, circular saw, pry bar, and hammer. The pry bar and hammer were what worked best for me.

Rotted stringer and damage done to the flotation during wood removal

Because a majority of the wood had not fully rotted away, a lot of plywood came off the flotation foam in small sections, taking pieces of foam with it. When I had all the rotted wood removed, I could see that the remaining flotation foam was dry and in good condition.

Cardboard templates made for the new plywood sole and stringers

The boat was built with 4 longitudinal stringers. The two inboard stringers next to the fuel tank and the bulkhead between them had mostly rotted away and needed to be removed. The outboard stringers were surrounded by flotation foam and in good shape, so there was no reason to remove them.

Using pieces of cardboard, I created templates for the two stringers I had to replace, and the bulkhead. The templates were my guide as I cut the replacement stringers and bulkhead out of ½" marine-grade plywood. I paid special attention to ensure the end grain of the plywood was well sealed with WEST SYSTEM 105 Resin and 205 Fast Hardener. Using an angle grinder with a carbide wheel, I prepared the fiberglass hull for good adhesion.

I mixed 105/205, then thickened it with 403 Microfibers to a mayonnaise-like consistency and used this to glue the stringers to the hull. Thickening the epoxy ensured there would be enough material to prevent a glue-starved joint.

With the replacement stringers in place, I then installed the bulkhead. I applied a layer of WEST SYSTEM 727 (17 oz.) biaxial fiberglass tape to the stringer/bulkhead hull joint, like the existing tabbing, for added reinforcement.

After the bulkhead was installed, I placed pieces of cardboard over the exposed flotation foam to create the template for cutting out the new plywood sole. I pieced the plywood in three

The plywood stingers and bulkhead have been dry fit. The backer panels for the butted plywood seams are set into the foam.

The plywood sole was covered with one layer of 6 oz. fiberglass and a coat of epoxy tinted with 503 Gray pigment. The composite panel is being dry fit in place.

sections with the same veneer orientation. To create a backer panel for the butted plywood seam, I set a small section of plywood into the foam. I then used a little two-part, pourable flotation foam to level the surface of the original flotation foam (which I'd inadvertently removed with the rotted plywood). I mixed 105/205/403 to a mayonnaise consistency again and applied it to the bottom side of the plywood sole and the surface of the flotation foam to ensure a good bond when installing the sole.

Once the epoxy had cured, I applied a layer of WEST SYSTEM 742 (6 oz.) fiberglass cloth to the bare wood to provide additional wear resistance and prevent the wood from checking or splitting over time. I tabbed all of the edges that met the hull by applying a layer of 727 (17 oz.) biaxial fiberglass tape for added reinforcement.

I coated the plywood sole with 105/205 tinted with 503 Gray Pigment and sprinkled it with paint color flakes for a nice cosmetic finish. UV degradation doesn't concern me because I'll only be using this boat a handful of times throughout the year.

To replace the old wooden center sole panel, which provides access to the fuel tank, I repurposed a composite panel made from 1"-thick high-density foam and thin fiberglass skins. This was a leftover test panel from Gougeon Brothers.

Checking the placement of the access hole to the storage compartment, using the wood hatch, before cutting the opening.

If that hadn't been available, I would have made the replacement panel from wood like the original sole panel. The composite panel is very strong and stiff and does not deflect when walked on. Recycling it this way was actually an upgrade to the original construction. After reinstalling the fuel tank, I finished this panel to match the rest of the cockpit sole, then fastened it in place.

I coated the original removable wood hatch for the storage compartment with 105 Resin/207 Special Clear Hardener to prevent water damage. I installed this hatch into the composite panel to provide additional access to the storage just forward of the bulkhead and fuel tank.

The project overall was a fun challenge and turned out well.

For detailed information on how to repair a cockpit sole, see our *Fiberglass Boat Repair & Maintenance* manual, pages 40–42. To download a free PDF of this manual, go to westsystem.com/ss/assets/HowTo-Publications, and click on Download Fiberglass Boat Repair & Maintenance.

Completed cockpit sole ready for use

Sea Ray 400 Seat Repairs

By Sam Magruder

I have a 1996 Sea Ray 400 Express Cruiser that I purchased in April 2014. The vinyl is in excellent condition in the cockpit. However, when someone sat in the front passenger seat (45" wide) the back looked like it wasn't attached. I went to the Sea Ray Owners Club website to explore the repairs and a fix for the seat. I learned that if I waited until the seat back broke, the vinyl would be damaged, and it would be costly to replace.

It took me several hours to remove the seat, the vinyl seat cover and the foam. The roto-molded seat shell was severely cracked on each edge. I contacted the manufacturer and learned that a new one could be purchased from Sea Ray for $523 delivered to Atlanta, Georgia. Ultimately I decided to repair the old seat instead and reuse the original vinyl.

On Ship Shape TV I saw an ad about using G/flex Epoxy to glue together a kayak that was cut in half. I thought, maybe they could tell me how to repair my old seat shell! I downloaded the WEST SYSTEM manuals and read as much as I could before calling Gougeon Brothers, Inc., Technical Support office. Gougeon Technical Advisor Don Gutzmer said my seats could be repaired if I followed all the steps and used the G/flex Thickened Epoxy Adhesive (G/flex 655) and some fiberglass tape. I beefed up a few of those steps to make sure my project would be a success.

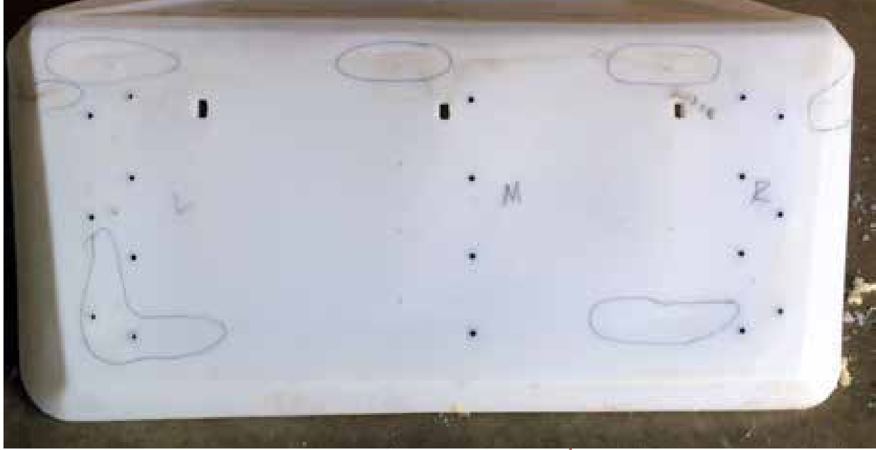
The seat shell was dirty from 18 years of use, and was also covered in foam glue. I used a flat razor blade scraper to remove the bulk of the foam glue where the repairs were to be done. I wanted the shell to appear like new where I would be doing the repairs. After cleaning the repair areas, I noticed the bottom of the seat had five additional cracks that needed repairing.

Alcohol would not remove the stubborn glue residue, so I cleaned the seat shell with MEKP (methyl ethyl keytone peroxide). This is a highly flammable solvent which I had to use outdoors, but it cleaned all of the old foam glue off the seat. I poured some on a white towel and rubbed it on the shell until the shell was spotless. In some cases I repeated the application multiple times. I used a white towel because MEKP can make the dye in a colored towel bleed onto the seat shell.

Don Gutzmer advised that I should feather back 1" from the cracks for the 655 G/flex Thickened Epoxy Adhesive to adhere correctly. Some of these cracks were 12" long. Because I was prepping a large area, I used a rotary tool (rather than a scraper) to feather the cracks. A faster, rougher tool resulted in the correct shape, and then a finer tool made the shape smooth. I did this for every crack I was repairing. I then drilled a ⅛" hole at the end of each crack to prevent further cracking.

Severe cracking had compromised the structural integrity of the seat.

The seat has 18 years of accumulated dirt and residual foam and glue that needed to be removed.



The cleaned bottom of the seat shell. The circles highlight the areas where cracks need to be repaired.

I ordered the quart size (655-2QT) of the thickened G/flex along with WEST SYSTEM 732-10 fiberglass tape (4" x 10').

I sanded each joint with 80-grit sandpaper and wiped the entire area surrounding the repair with alcohol to remove dust from sanding.

To flex the seat back into shape I used two ratchet straps. These worked perfectly to get the shell back to the correct angle. After getting the seat to the correct angle, I used the rotary tool to prepare the cracks.

Don had advised that in addition to the epoxy I should use the fiberglass tape to strengthen the repair. On each crack on the bottom of the seat, I used a 1", 3", and 4" wide strips all with the G/flex 655 Thickened Epoxy Adhesive. I used the 4" wide tape and cut 1" off the edge to produce a 1" wide and a 3" wide piece. This raised the thickness of the repairs to about $\frac{1}{8}$"-$\frac{3}{16}$". For the side repairs (heavy stress areas) I used strips of 2" wide tape, staggered 2", and two each of staggered 4" wide pieces.

Once the Epoxy arrived I prepped my work area with:

- G/flex 655 Epoxy (1 quart cans of Part A and Part B)
- 3 paint stir sticks about 1" wide (one for getting part A out of the can, one for Part B, and one for mixing)
- Newspaper spread across a large area of floor to protect it from epoxy
- Cut up cardboard (about 12" x 12") to use as pallets for mixing each batch of epoxy
- Disposable latex gloves
- A flat-bladed screwdriver for opening the cans
- Pre-cut fiberglass tape for each repair area
- Propane torch
- Alcohol for the final wiping
- 2 ratchet straps for keeping the seat in shape while it was being epoxied
- An old box to hold the seat bottom in the up position
- Disposable 1" paint brushes for brushing the epoxy
- 10 large rags for cleanup

Now I was ready to get started. I wiped the seat repair areas, plus an extra 4" all around with isopropyl alcohol and let that dry for 10 minutes. I then used the blue flame of the propane torch moving at 12" a second over all the areas that were to be repaired, plus 4" wider than each side of the crack. The flame treating helps to oxidize the surface to improve adhesion.

I used separate paint stirrers to glop equal amounts of 655 G/flex Epoxy Resin and Hardener onto a cardboard pallet and worked these together for 3-4 minutes to make sure it was thoroughly mixed and uniform in color. I scraped the separate resin and hardener stirrers with a third stirrer and wiped them clean for reuse.

I applied the mixed G/flex to each repair area way too thick over a 4"-5" wide area. I then applied the fiberglass tape going from smallest to largest, applying the mixed epoxy between each layer. I used the stirrer to smooth out the epoxy and to apply more to the top of the tape. When I needed more epoxy I added it from the mixed batch on the cardboard pallet. I did this until all 3 or 4 layers were covered with epoxy. I used the paintbrush to smooth any lumps. Once I was done I scraped the

All the cracks were beveled with the use of a rotary tool with a tapered bit.

The bottom of the seat shell with cracks filled and reinforced with fiberglass.

repaired area with the paint stirrer until all the tape was covered and fairly smooth.

I made the repairs in two sessions: the bottom and the sides. To the side I applied only the G/flex, not the fiberglass tape. The bottom was flat and easy, but the side stress areas required moving the shell around.

To prepare for the second repair session, I smoothed the cured epoxy using a palm sander with 80-grit sandpaper, alcohol wipe, and blue flame on the raw roto-molded parts.

For the sides of the seat, high stress areas, I spread epoxy away from the crack 12" on each side. I also used 4 layers of fiberglass tape. When completed these repair areas had a 3/16" buildup. I let the epoxy fully cure for 48 hours. With the palm sander I feathered each edge and the top of the repairs to smooth out any rough spots.

When it was done it felt sturdy and solid. My cost to repair this was about $170 including the epoxy, tape, propane torch, and supplies.

I have done some other fiberglass repairs so I thought this would be similar. However, there are a few things I wished I had known beforehand:

- G/flex 655 Thickened Epoxy Adhesive is thick—almost like sheetrock mud.

The corners of the seat shell were reinforced with fiberglass tape.

- G/flex 655 Epoxy is messy, so change your disposable gloves often.
- G/flex 655 Epoxy could be worked easily for about 30 minutes. Multiple batches may be needed.
- I ordered the quart sized containers of the G/flex 655 Epoxy and I only have about ⅓ of each can left.
- G/flex 655 Epoxy takes several hours to cure and 24 hours to fully cure.

The 655 Epoxy fixed the cracked seat and it is very sturdy. If you follow the directions, the repair is simple.

I want to thank Don Gutzmer of Gougeon Technical Support for all of his help with the repairs. He made it simple and easy.

The completed seat installed and ready for use.

Applying Polyester Gelcoat Over Epoxy

By Mike Barnard

Andy Miller has a great understanding of WEST SYSTEM Epoxy, having used it for years as owner and chief repairman of Miller Boatworks in Herbster, Wisconsin. Andy also maintains BoatworksToday.com, a website featuring instructional boat repair videos. Having watched, verified and referred people to the videos on Andy's website over the last few years, I know that Andy knows his stuff. What's even better is that, when he's unsure about a detail, he contacts us for the right answers. This gives me a lot of confidence in the methods featured in the videos at the Boatworks Today website.

Andy wanted to conduct some experiments to either validate or debunk what most people in the marine industry are taught; that gelcoat cannot be used over epoxy. I relayed the information that we've gathered over 30 years of in-house testing. While he found that interesting, he didn't want to mimic our experiments. He chose to take a different approach, replicating the variables the average service technician faces while doing a repair in the real world.

We know polyester gelcoat can be used over WEST SYSTEM Epoxy. As Jeff Wright wrote in "Polyester Over Epoxy" in *Epoxyworks 22*:

> "As with many products, the surface must be prepared properly: if it is not, then poor curing and adhesion may result. Polyester materials can be affected by amines in the epoxy hardener. If the hardener has not fully reacted with the epoxy resin or the amine blush is not removed from the cured surface, problems can occur. Proper surface preparation will prevent these problems. (See our *Fiberglass Boat Repair & Maintenance* manual, Section 16.4.1 for details.)"

To ensure the amines won't compromise the cure of the polyester gelcoat, standard mixing and curing instructions apply. Before coating a fully cured layer of epoxy with polyester gelcoat, prepare the surface properly to remove any amine blush.

Surface Preparation Steps

1. Allow the epoxy to cure to the point where sanding produces a fine powder.

2. Wash away amine blush with water and an abrasive pad such as a 3M #7447 Hand Pad.

3. Dry the surface with paper towels, or rinse well and allow it to air dry.

4. Sand the epoxy with the sandpaper grit level recommended by the gelcoat manufacturer.

I asked Andy to follow these steps and do some testing to prove to himself that it is possible to gelcoat over epoxy. He videotaped the steps as well as the testing he did.

A screen capture of the accompanying video to this article explaining the tests. boatworkstoday.com/archives/1668

To ensure thorough mixing and that the epoxy would completely cure, he took the additional steps of pouring the mixed epoxy into a new container and stirring it again before applying it. He then allowed the application to cure for 3-4 days. This wasn't required but would help ensure consistent results, especially if there are multiple people doing this in a repair or manufacturing environment.

Real World Testing

Andy focused on three common factors in repair work: fine edge bonding, flexing stress, and cleavage strength. All of these tests were done comparing the three WEST SYSTEM hardeners he commonly uses with 105 Resin: 205 Fast Hardener, 206 Slow Hardener and 207 Special Clear Hardener. The fiberglass used for all the tests was 738 Biaxial Fiberglass Fabric with Mat.

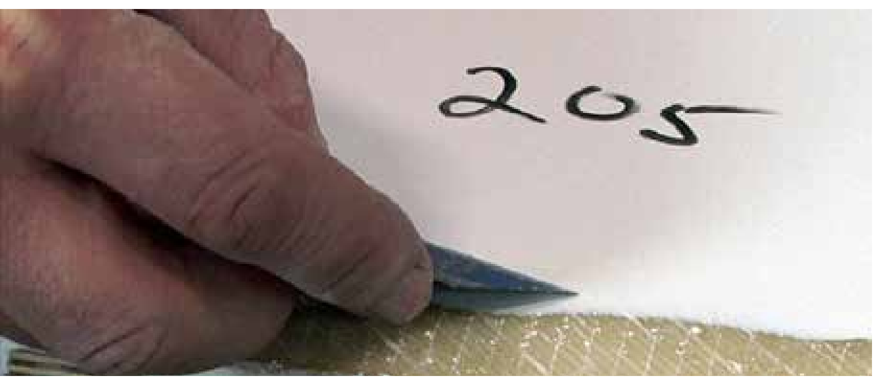
Fine Edge Bonding

Fine edge bonding is important when finishing off a gelcoat repair. As the gelcoat is sanded down and feathered into the surrounding area, the perimeter of the patch becomes very thin, almost translucent depending on the color you're working with. What Andy is looking for here is to see how well this fine edge stays intact. When gelcoat gets this thin it tends to lift or chip if not bonded solidly to the substrate.

All three epoxy samples performed as well as the polyester sample. When sanded to a fine edge and picked at with a razor blade, no lifting or separation of the gelcoat was noticed.

Flexing Stress

Boats flex while in use. In order to prevent stress cracks in the gelcoat, this material needs to be able to move with the boat without delaminating or peeling apart from the substrate. Andy made three samples of single layer 738 Biaxial Fabric wet out



Fine edge bonding test. Scraping the edge of the gelcoat with a razor tests how well the fine edge of the gelcoat stays attached to the epoxy layer below.

Flex stress test. The panel was intentionally broken in half looking for bond failure along the fracture point.

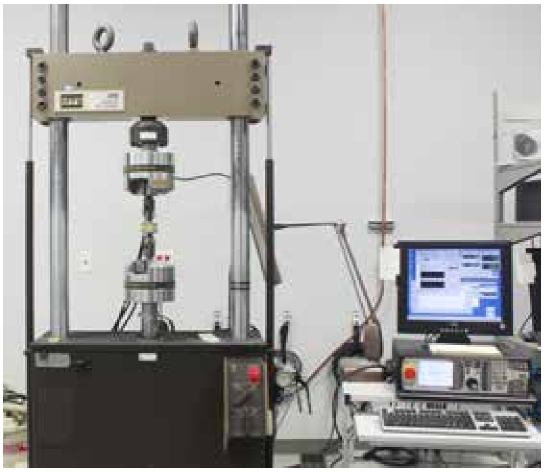
with 105 Epoxy Resin and either 205, 206 or 207 hardener. He finished each with a polyester gelcoat to test how well it would bond. The gelcoat was sealed with PVA and allowed to fully cure.

Here again, all of the epoxy samples performed as well as the polyester sample. Each of the samples were bent and twisted to varying degrees far beyond what would normally happen on a boat underway. Stress cracks were noticed as he intentionally broke the fiberglass sample in half looking for bonding failure along the fracture point, but there was no lifting or separation of the gelcoat from the cured epoxy.

Cleavage Strengths

While it's good to have cleavage strength data, it can be helpful to simplify that into something more concrete and easily understood. Andy made sample pieces with each of the three hardeners, then made identical polyester samples. When the epoxy samples were cured, water washed and sanded, he bonded the epoxy and polyester samples together with polyester gelcoat. When the samples were fully cured, he ripped them apart to determine a clear pass/fail on the bonding strength. Whichever side broke free from the gelcoat, comparatively, did not have as strong of a bond.

The results surprised Andy. The samples showed that the polyester gelcoat bonded to the epoxy laminate but the amount of force to break the samples and failure mode varied between the different systems. Our experience from many years of testing has taught us that WEST SYSTEM hardeners all achieve similar cured properties so there should not be a difference. Andy's work illustrates the strength and weakness of shop floor testing. He was able quickly determine if the adhesion of polyester gelcoat to an epoxy laminate was acceptable, but he was unable to



The MTS machine pulled apart samples to determine the amount of force needed to cause failure.

The samples after failure. The results of the maximum loads are listed in the table below.

measure it quantitatively. Experienced epoxy users like Andy also know that they have to evaluate the results achievable in their shop but may need testing results from a lab to reach a final conclusion. We always encourage our customers to test materials in their shop to gain confidence, and we remind them we are willing to support them with additional testing in our Technical Center.

Tensile Adhesion Strengths

While this wasn't "shop floor testing" like Andy did, a couple of us analytical types at WEST SYSTEM wanted to put some hard numbers to this data. When Andy made up the cleavage strength samples, he made several more for us so we could do some of this testing ourselves.

Using an ASTM standard that is typically used for cored composites, and our MTS load frame, a force was exerted perpendicular to the bond line in order to cause failure. To determine the strength of the various bonds, we compared the amount of force required to cause each sample to fail.

Because we expected the plywood glue to fail before the polyester and epoxy, I reinforced the plywood edges without reinforcing the polyester or epoxy glue joint. I prepared the pieces for testing by applying fiberglass and epoxy on each of the four sides that had exposed end grain. When they cured, I cut this laminate with a razor blade directly on the gelcoat line. This fiberglass and epoxy reinforced the plywood, and cutting through the fabric on the gelcoat line forced the failure to occur in the bond line between the pieces of plywood. The results are recorded on the Tensile Strength table, and as you can see the strength is nearly identical for all four samples. Each of these samples (including the polyester-to-polyester sample) failed in the polyester/glass laminate. This more quantitative tensile adhesion testing confirms that polyester gelcoat will properly cure and adhere to epoxy.

Andy Miller's Conclusion

Based on Andy's and our own testing and experience, I am confident saying WEST SYSTEM Epoxy is a suitable substrate for polyester-based material such as gelcoat. Gelcoat-to-epoxy adhesion will be as reliable, if not better than, a polyester-to-polyester adhesion, providing proper steps are followed throughout the repair process.

For further details of Andy's tests, see the video documentation of his testing process at boatworkstoday.com/archives/1668.

Tensile Strength

Sample	**Area** (sq. in.)	**Max. Load** (lbs)	**Peak Stress** (psi)
Polyester / Polyester	4.03	1382	343
Polyester / 105/205	3.78	1572	416
Polyester / 105/206	3.58	1309	366
Polyester / 105/207	3.85	1586	412

Hog Tide Project

By Bruce Neiderer

J22 Hog Tide at the Gougeon Brothers shop, getting a new bulkhead.

Last summer we partnered with Sail Magazine to produce a series of short videos showing how to repair an older J22 I had arranged to be 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.

If you're wondering about the name, all the J22s that race in East Tawas, Michigan out of the Tawas Bay Yacht Club have 'pig' names—*Pork Bellies*, *Pigs in Space*, *Pygmalion*, *Evil Dr. Porkchop*, *The Other White Meat*, and my favorite, *Notorious P.I.G,* are notables.

This article features still pictures taken while the videos were being shot. I'll comment as we walk through the process.

The bulkhead we were replacing, looking from the companionway towards the bow.

The bulkhead we were replacing had a lot of checked and rotten areas around each chain plate. There was rot just about everywhere except for the trim piece, which we removed and saved to re-install on the new bulkhead.

To remove the bulkhead intact, I used a vibrating side cutter with a diamond grit blade. This allowed the bulkhead to be removed full size so we could trace the shape for the new bulkhead.

The bulkhead has been removed and the tabbing that was on the back side was left in place. Inset, the intact bulkhead that was removed.

The back side tabbing was left in place to make the alignment process a no-brainer when we installed the new bulkhead.

Had the bulkhead not come out so cleanly, we would have needed to make a template from scratch for the bulkhead. Tom demonstrates how to make an accurate template by fitting some cardboard loosely then stapling small wooden strips extending to meet the hull of the boat to define the exact shape needed. Tom laid out

Tom double checking the fit of his template. The inset shows the wooden strips measuring the hull.

Tom transfers the template points to the plywood.

the template and made tick marks at the end of the wooden sticks on the sheet of marine grade plywood. Then, using a flexible batten, it was simply a game of connect the dots to define the shape of the bulkhead.

Once our new bulkhead was cut out, it was ready for 6 oz. fiberglass to be laminated to both sides. After curing overnight, all surfaces that would receive epoxy were prepped using an abrasive pad so as to not damage the fibers of the fiberglass, but still scuff up between the weave of the fabric.

New bulkhead with a layer of 6 oz. fiberglass cut to size

To install the new bulkhead, I precut enough 727-4 Biaxial 4" Tape for the tabbing then shanghaied Tom to be my "ground crew" while I worked inside the boat.

Tom supplied me with 105 Resin/206 Slow Hardener filled to a non-sag consistency with 403 Microfiber filler. We chose to use the 403 because it thickens fast without much airborne dust while mixing. The resulting graininess of the fillet would be glassed over anyway, so cosmetics were not an issue.

We applied thickened epoxy to the flange (original tabbing) we'd left intact, then clamped the bulkhead to the flange drawing it into perfect position. This allowed me to apply a fillet to the perimeter of the part—with the exception of the limber hole along the centerline—water still needs to flow into the bilge from the bow area.

The new bulkhead clamped to the tabbing from the old bulkhead to hold it in place, and the new fillet applied.

Once the fillets got a bit tacky, the 727 glass tape tabbing was installed—again using 105/206. Note that we used several shorter lengths of glass tape to make the curve and overlapped them a bit. This kept the glass from buckling around the curve and eliminated the need to cut pleats in the glass.

Shortly after we'd completed the transom replacement (along with some other repairs) *Hog Tide* was returned to her owner and took first place out of eight J/22s racing on Lake Huron's Tawas Bay just a few weeks later.

To watch the complete series of videos covering all the repairs we accomplished, visit westsystem.com/ss/how-to-use-demos or sailmagazine.com/videos.

The new fiberglass tabbing applied.

The cabin of the J22 fully reassembled.

Strings' Float

By Greg Bull

When Jan Gougeon built *Strings* in 2010 one of the most interesting features he included, at least from my point of view, was the float that goes on top of the mast. Due to its zeppelin-like shape, this is also called a blimp or a dirigible. The purpose of the float is to make the boat self-rescuing: if the boat tips, the float prevents it from going any farther than lying on its side. The mast and float are then used to right the boat. Jan developed this system when designing the Gougeon-32 back in the late '80s, so he thought it would work for Strings.

Jan built the float by making a half mold to build the two halves from, then gluing the sections together. He simply used pink insulating foam board (Owens-Corning Foamular® InsulPink®) 2" thick that he picked up at our local home improvement store. To create the desired thickness he glued the pieces of foam together with WEST SYSTEM 105 Resin/206 Slow Hardener with 410 Microlight filler mixed to a catsup consistency.

He roughed out the shape with a rasp followed by a coarse file and 36-grit sandpaper on a wooden sanding block. When it reached the shape Jan was looking for, he added a thin coat of thickened epoxy over the entire surface and let it cure. He smoothed this down first with 36-grit sandpaper on a sanding block, then moved up to 80-grit and finally 220-grit. This completed the mold.

He waxed the mold surface then laid a layer of carbon fiber fabric over the mold with 105/205 and allowed it to cure until tacky. Next the surface was coated with epoxy filled with 410 Microlight. The next day the sanding started again—this time to smooth the outside of the dirigible. It was easier to sand the outside with the part still stuck to the male mold surface and get it really close to the final smoothness.

When the fairing was done, Jan made a stuffing jig. The stuffing jig served a couple of purposes: 1. To hold the half-round part so work could be done on the inside and 2. to create a flat plane to trim the half dirigible to. The stuffing jig would also help in the final assembly.

When the jig was completed, the first half of the dirigible was pulled from the mold and put into the stuffing jig. It had been left on the mold during the jig building process to maintain the correct shape. Jan laid up the second half the same as the first, again fairing the outside.

The completed dirigible atop Strings' mast as it's being stepped for the season.

Installing carbon fiber tows inside the dirigible

Wooden sticks serve as stringers inside the dirigible.

With the first half of the dirigible held in place in the jig, the structure could be installed on the inside. This is where Jan came up with the great idea of using just tows of carbon to create a grid work on the inside of the dirigible half, like small frames or ribs on 2" centers. The tows were laid length wise first (the long way) then across (the short way). This added a lot of structural reinforcement with minimal weight.

Where the pivot tube goes through to attach the dirigible to the mast, more reinforcement was added. Strips of 1/8" x 1/2" thick clear spruce function as stringers positioned on or next to the carbon tows bracing the area around the tube to help carry the load.

Putting an internal flange on the inside perimeter of the dirigible halves allowed the assembled dirigible to be smooth on the outside. The temporary backer for the flange was made of plywood covered with plastic, then screwed down to the jig with the plywood protruding into the inside of the dirigible half by about 1". Jan applied 105/205 mixed with 407 Low-Density filler to a peanut butter consistency. He used the rounded end of mixing stick to fillet the corner formed by the plywood and the edge of the dirigible. After the fillet cured, the temporary plywood backer was removed. This made a smooth bonding area on both halves and provided a larger surface area for joining the two halves. Having more bonding surface area allowed him to apply a thinner coat of thickened epoxy to create minimal squeeze-out when he joined the two halves. The squeezed out thickened epoxy was smoothed over the surface of the seam. Carbon fiber tape, 2" wide, was then applied along the seam, adding strength.

For fairing, 105/205 thickened with 410 Microlight was again spread across all surfaces. Most of this fairing compound was sanded off so that you could see black carbon through the fairing, but he didn't sand into the carbon. This took a couple of applications to reach the desired smoothness. Once this was achieved, paint was applied to match the rest of *Strings*.

The dirigible surface during the fairing process

Left, the temporary plywood backer for the flange screwed onto the jig.

Far left, thickened epoxy was applied to the underside of the wooden backer to create the flange.

Shiloh, an Argie 15

By Craig Bousquet

I didn't know what I was getting myself into when I decided to build my own boat. While not exactly a novice—I have owned a 21' sailboat and am a tall-ship model builder—I'm not experienced in building sailing vessels.

I looked through various plans and decided on the Argie 15 from Dix Designs. This is a stitch and glue boat which looked easy to build, but also gave me a variety of options. I ordered the plans and started to acquire the materials needed to construct and assemble this boat.

The Argie 15 is designed to be rowed, sailed, or used with a small outboard motor. I lofted the lines from the plans and cut out the panels from marine grade plywood. The Dix Design plans called for the joints to be butt fitted and covered with 2"-wide fiberglass tape and epoxy. I opted to scarf the joints to provide better strength in the panels (two side panels per side and one for the floor).

The first step was to align the floor panel and the two lower side panels, and to drill the holes for the wire ties, or stitches, that would hold the panels in place. The next step was to do the same with the upper panels on each side. At this point, it actually looked like a boat.

Now the fun really started. The tasks turned to tightening all the stitches to close any gaps between the panels, and to check for proper alignment and symmetry. As a novice in fiberglass techniques I knew I was in for an experience, and boy was that correct. I began by laying the dry fiberglass on the inside seams using WEST SYSTEM 105 Resin and 205 Fast Hardener. The first batch worked correctly. But when I did the same seam on the opposite side I must have taken just a tad too long as the epoxy uncontrollably exothermed in the mixing cup. In both cases it was about 70°F in my workspace. I'd used pumps to correctly meter the resin and hardener and it had cured within the time frame listed in the WEST SYSTEM *User Manual & Product Guide*.

I realized I needed to use the 206 Slow Hardener instead to give myself more working time. This required me to make another trip to my local West Marine, where they now greet me by name—shades of Norm in Cheers.

The most important lesson learned on the first go around: Don't think you have more working time than what the WEST SYSTEM *User Manual & Product Guide* states; you really don't. Now that I woke up and smelled the epoxy uncontrollably exotherming in the mixing cup, I knew that I had to move quicker and have the strips of glass laid out and taped into position.

I finished epoxying the seams on the inside, then turned the hull over and removed the stitches so they wouldn't interfere with glassing the outside seams. I had great luck pulling the stitches all the way out from the outside without having to cut the fiberglass tape on the inside.

I mixed more 105/206 and blended in 403 Microfiber filler to fill in gaps between the seams, and to flair off the edges of the side panels and floorboard. I epoxied a narrow layer

I was eager to get out on the water and start enjoying my work. The barrier coat is holding up very well.

of fiberglass on each outside seam and allowed it to fully cure. I then sanded the fiberglass and epoxied a second, wider fiberglass strip to each outside seam. The increased bonding area of the wider fiberglass improved the strength of the seam reinforcement. I turned the boat over and repeated this process on the inside.

The Dix Designs plan required me to stitch and glue the seat supports to the hull side panels. I didn't agree with this and decided to fasten stiffeners to the seat supports, and then screw them into place. After all interior panels were in place and attached to the hull, I mixed a batch of epoxy with 405 Filleting Blend and used that to seal any small gaps and fillet the corners. I applied several coats of epoxy to all of the enclosed interior seat areas to seal the wood against moisture.

At this point the chill of winter had set in, and my garage is not heated so I stopped working on the project from November until the following April.

Upon the return of warmer temperatures, I sanded my previous epoxy coats to make them fair. I applied two layers of epoxy over the outside and inside of the hull to seal the wood. The epoxy was rolled on with a foam roller. The hull will be painted in the near future, but I was eager to get it into the water to start enjoying my work.

The panels have been stitched and some seams fiberglassed

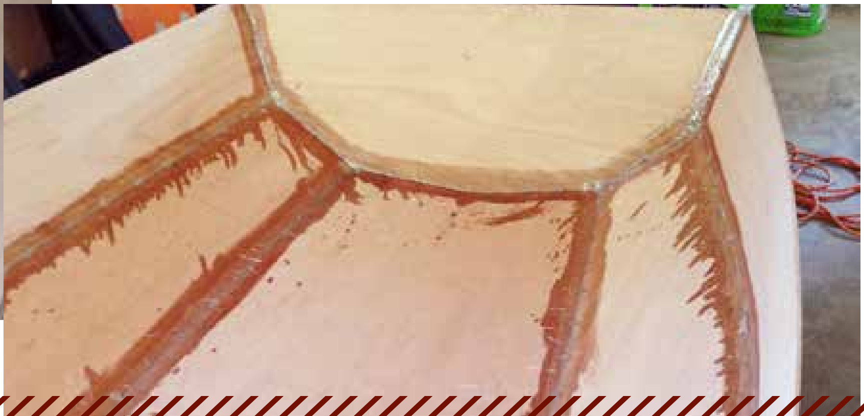
The boat after the epoxy coating was rolled on.

I recently started on the dagger board and rudder and anticipate using G/flex Epoxy, as it is designed for constant shifting loads. Currently, I am rowing about four hours a week. The epoxy coat has held up very well, with boat launching and recovery every trip.

The instructions in the WEST SYSTEM *User Manual & Product Guide* were a great help. I called WEST SYSTEM Technical Support several times with technical questions and they were very accommodating. One of my mixing pumps came apart while dispensing the epoxy and the company sent me a set of new ones.

I named my boat *Shiloh* which means "peace." When on the river it's mostly silent and you can hear the birds and other delightful sounds of nature. Within the next year, the hull will be painted and the mast and sails will be in place, but for now, I have had great fun rowing up and down the Mohawk River in the Albany area of New York.

Glassing of the inside seams



Testing out GADABOUT 's performance at 70% throttle

GADABOUT

By Susanne Altenburger

The US Navy asked Phil Bolger & Friends Inc. (PB&F) to develop a container-transportable power cruiser. This was a rather irresistible opportunity. We had been developing a modest sequence of design concepts to match a variety of unusual requirements for the Navy. This time they wanted us to design this craft, and manage the prototyping of the project from the earliest stages of construction to final testing. While our design office had never built anything bigger than perhaps 16 feet, we understood the basics of how any design would be built.

In pursuit of a collaborative model, the US Navy would put up a modest budget which would then be matched by the City of Gloucester. The Navy would stretch its limited research funds, and the City would get to explore working with this most potent marine industrial partner — a rare opportunity for marine-industrial development. If successful, this first modest step might result in increasingly more ambitious collaborations in the future.

Starting with the many smaller pieces, learning how to measure three times and cut once, then onto epoxy coating and fiberglassing sessions.

This was the brief:

- Can this patrol craft design be built as a prototype for the US Navy by Gloucester low-income non-boatbuilders to adequate quality and performance?

- If so, the US Navy would take these plans and the well-illustrated construction manual overseas to help poorer nations build their own riverine and inshore patrol craft.

- Later these crews could repeat the effort on larger or smaller scales to match their particular needs.

The US Navy has an extensive network of friendly overseas partners, including those who cannot necessarily afford to buy boats built in highly industrialized, high-wage nations. By selecting plywood, epoxy, fiberglass and closed-cell foam core as construction materials, an untrained building crew can complete the project under rudimentary conditions with little industrial infrastructure.

To support the project development, the Navy would first build the #2 hull on a US naval base as a test of the construction manual, and an opportunity for Navy staff to learn the process so they could eventually serve as instructors overseas. For the hulls built far away, the Navy would fill containers with all the materials, hardware and consumables necessary, slide the #2 hull into its own 40' ISO container, and these steel boxes would be shipped to the partners' locations. Once these containers had arrived, the instructors would fly in, pull the materials out and demonstrate the remaining construction process.

Learning how to join full-length pieces, here are her near 40' topsides laminated to match the design's plan view curve and panel twist. Instead of attempting to learn scarfing with Douglas fir plywood we used modified "Payson joints" for all long or wide panels, with the joint stronger than the wood.

This was the first dry assembly of the kit, with the pieces coming together to look like a boat.

This would build motivation among the local Navy/Coast Guard boatbuilding apprentices, and they'd get going on the first local copies.

Apart from the convenience of shipping the #2 hull as a model for overseas partners, the Navy wanted the general tactical utility to ship fully assembled boats anywhere. This way they could open innocuous looking containers and quickly launch a military craft. Therefore, the design had to match the internal dimension of the standard 40' box, starting with the door-opening. Getting the most boat into the box would be one of the leading design goals, leaving just enough room for low-key insertion and extraction. To match a standard ISO 40' shipping-container, the boat would measure:

- 39' 1" length (vs. 39' 6" available)
- 7' 5" width (vs. 7' 8")
- 7' 3" height (vs. 7' 6")
- 6500 lbs empty and dry
- 225 hp outboard and 200 gal of fuel for 20-25+ kts depending upon load

As an inshore and coastal craft, patrolling for days on end with a crew of two to four, this boat called for two bunks, a modest galley and a private head. On shorter runs, eight additional troops would be carried, deployable to the beach via the bow gate. Her bow cockpit was designed to carry a swivel-mounted .50-cal MG or Mk.19 40 mm grenade launcher system and gunner. Additional weapons would be carried by military crew members.

What had started as a promising collaboration between the US Navy and the City of Gloucester began to suffer under the increasingly severe fiscal consequences of the Great Recession. There would never be more than 55% of the original budget for the project. Soon, instead of four, only one person remained on the job. Then, without any more funds for even a boat shop, the partially finished project had to be moved outdoors in the New England winter. Without a matching budget our bills for materials, hardware and labor would really add up.

The project eventually became the property of PB&F. Before she was even completed, private interests snapped her up as a well-subsidized good deal that was already demonstrating success:

- She had indeed been built by non-boatbuilders from Gloucester in full public view.
- She has been constructed using 90% sustainably sourced hull materials using US farm-grown Douglas fir marine-grade plywood.

Why does the latter matter? Beyond the US Navy interests, PB&F wanted to demonstrate that this low-carbon design and construction technology was also a reasonably "green" approach. 21st Century, low-carbon, "green" commercial boat building could help reestablish Gloucester's fishing fleet and port sustainability. Fishermen would be eager to obtain an advanced boat while saving a lot of money.

Turning over the largest piece: – her completed bottom, with her V nose applied and everything fiberglassed and painted.

Testing the fit of the completed shipping container boat for low-key insertion and extraction into a standard ISO 40' shipping-container

slow and tedious to have to heat each fastener with an electric soldering iron to overcome the epoxy's tenacity before removing fasteners using a power screwdriver. An easier option would have been to wax the screw before fastening the laminates to prevent the epoxy from adhering to the screw when cured.

We mimicked the non-industrial construction approach that would be the norm overseas. We used an unseasoned crew and worked ourselves into the construction process. We learned skills building the smaller pieces, which we applied building dozens of increasingly larger parts.

We used West System 105 Resin, 205 Hardener and the very portable 306 Metering Pump. The larger 305 Positive Displacement Pump was indispensable for large-area bonding operations such as rapidly adding plywood layers in one shot along the full length of her topsides and hull bottom panels, and for wet layup of several layers of fiberglass cloth at once. The pumps allowed us to work quickly enough to get through the laminating process before the epoxy could cure. There were times when three crew members would rush to spread epoxy and handle the fiberglass while the fourth produced a steady flow of mixed resin and hardener. Any slow-down or interruption would have resulted in a waste of expensive materials and additional man-hours to clean up the mess and repair any damage.

Because we needed to maintain a low-tech approach, instead of vacuum-bagging our laminates we installed lots of dry-wall screws to temporarily secure pieces and apply clamping pressure. This required us to make frequent late night runs to the project in order to unscrew the fasteners before the epoxy fully cured, grabbing them for good. We found it

Even the largest individual piece, the bottom and V-nose assembly, would be fully glassed and painted before we turned the boat right-side up to receive the prepared frames, bulkheads, transom, topsides, etc. Unfortunately, by that time the project crew was down to just me and one other person, and then to me alone. With such a small crew, assembly took longer than planned.

Nevertheless, by the time she was done all of the outside surfaces had at least one layer of 10 oz. fiberglass cloth, and the topsides and hull bottom had several layers. Even with all her plywood and a fair number of foam panels laminated into her structure, she would have over 2000 lbs of positive buoyancy offsetting the heavier-than-water weight of fiberglass, epoxy, outboard, batteries, ground-tackle, weapons, etc.—making her harder to sink after taking bullets under her waterline.

It was gratifying to finally see her come alive. We enjoyed feeling her out at increasing speeds, then taking her out into the bay, the assault-landing simulations with some local veterans, family-outings and just plain showing her off to pleasure boaters and the working waterfront alike.

Starting with a CAD-based design, built by non-boatbuilders using US-sourced plywood and epoxy, she was completed and is expected to serve her owners for as long as they will care about boating.

Susanne Altenburger, Phil Bolger & Friends Inc. (PB&F), Boat-Design since 1952

Local veterans performing assault-landing simulations

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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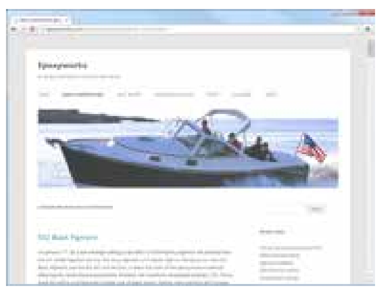

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Readers' projects

Epoxyworks reader Ted sent us these photos of the floor he installed with 105/207 at a restaurant in Ann Arbor, Michigan.

Facebook Feature

January 29, 2016

This in-progress cedar strip canoe was made with WEST SYSTEM 105 Resin and 207 Special Clear Hardener purchased from KC Sailing in Lawrence, KS.

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IIT Architecture students designed and built a building facade panel system. This project was meant to simulate a real-world challenge and give hands-on experience working with carbon fiber.

Their instructor also led the group of students who created the FIBERwave pavilion in Epoxyworks 40.

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