

FREE



EPOXYWORKS®



BUILDING, RESTORATION & REPAIR with EPOXY
Number 44 ■ Spring 2017

In This Issue

A Wooden Bicycle Frame

Epoxyworks reader Aaron Holmes makes a beautiful black walnut wooden bike frame.

Stayin' Awake at Daryl's House

A standard coffee thermos is not enough for Daryl or Bruce. They each build a custom insulated box which can hold up to 2½ pots of coffee.

Sunfish Wood Restoration

Years of weathering have taken their toll on the mahogany dagger board and rudder from a Sunfish. Don restores them to like new condition.

Epoxy Bowl

Burls and rotting wood typically aren't good for wood turning, but with a little epoxy, they can create one-of-a-kind pieces.

WOW 17 Years Later

Builder/owner Mike Bronkalla shares what he'd do a little differently if he were to build his 20' runabout again.

One Small Trailer and a Teardrop

An experienced boat builder tries his hand at building a home away from home. The trouble is he does such a good job that his daughter wants one too.

Self Defense Canes

A Cane-fu class inspires the pursuit for the perfect self-defense weapon/medical device.

Tunnel Hull

Among other things, G/flex epoxy can be used to permanently mount documentation numbers on a hull.

My First Cadillac

Purchased for a dollar, a 1954 Cadillac 14' Runabout is being restored by technical adviser Bruce and his brother Nelson.

You Can Build It With Fiberglass

Epoxyworks reader Clayton gets creative building cosplay helmets, props and armor out of epoxy and fiberglass.

Bonding with Fillets

Fillets are an important structural component in many projects. Here are some tips for creating the right size fillet and make it look nice.

GLBBS 2016

Congratulations to the Great Lakes Boat Building School's graduating class of 2016.

1

4

6

7

8

12

14

15

16

20

22

24

Editor/Designer Jenessa Hilger

Managing Editor/Copy Editor Grace Ombry

Contact/Subscriptions Mari Verhalen

Contributors Aaron Holmes, Bruce Niederer, Clayton Woods, Don Gutzmer, Ed Stubbs, Joe Llewellyn, Mark Bronkalla, Mark Copeland, Mike Lance and Tom Pawlak

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

Product Number 000-605

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

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

Subscriptions, US and Canada

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

Contribute to *Epoxyworks*

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

Mailing address *Epoxyworks*

P.O. Box 908

Bay City, MI 48707-0908

Email epoxyworks@gougeon.com

***Epoxyworks* Online** epoxyworks.com

Browse back issues or look for specific topics.

A Wooden Bicycle Frame

By Aaron Holmes

For the past ten years I have enjoyed an increasing passion for cycling. It's the perfect combination of effort and motion for me. I'm fascinated with the details and getting "hands on" with bicycles, both designing and building them. All types of bikes have interested me: road bikes, cross bikes, gravel bikes, mountain bikes, and more. I ride these bikes several thousand miles each year on all types of terrain.

As my interest and passion for bikes and cycling grew, I discovered the world of custom, hand-built bicycles. Expert craftsman work through every detail of design and fabrication to deliver custom frames and completed bikes to their discerning customers. The imagination and touch that goes into these bikes is impressive and stirring.

Inspired by custom-built bicycle frames, I wanted in on the action. I decided I would build my own frame. For several years I considered a frame building class or even going at it myself, but I realized I'm not set up to do metalworking. Interested, yes, but it was not a match for my experience or workshop tool arsenal. In the spirit of "run what you brung," I began to consider another possibility: building a bicycle frame of wood.

I grew up in my father's woodshop and had a front row seat for the design and building of many impressive furniture projects. These experiences set me up for the possibility of building a wooden bicycle frame. Having seen some wooden frames in pictures, the question in my mind was always just how functional are these wooden bicycles? Meeting Jay Kinsinger of Sojourner Cyclery clearly answered this question for me.

Jay has built a dozen or more wooden frames and graciously shared his methods with me. Furthermore, he has tested his frames in a laboratory setting, and in real world testing, on some really epic rides. Wooden frames have proven functional, dependable, and durable, and I was going to build one.

Design

One of the first steps of my project was to decide what type of bike to build. I settled on a touring style road bike intended for comfortable road riding, designed around efficient, large volume road tires. I began filling in the details of the design, choosing wheels, crankset, handlebars and more. With these components identified, I started designing the frame.

Using free CAD software, I began defining the geometry of the bike. The topic of bicycle geometry is thick with details. I chose a conservative geometry for this bike for comfort and stability. I drew the shape of the main triangle and then defined the rear triangle with the head angle, seat angle, chainstay length, wheelbase, stack, and reach.

Of particular challenge was fitting the rear tire into the frame with adequate clearance for the chain ring, crankarms, and heel clearance when pedaling. My friend Rody Walters, the mastermind of Groovy Cycleworks, is particularly adept at manipulating his custom designs to accommodate larger tires. Rody passed along some good frame design ideas and helped with metal fabrication support later in the project.

The main triangle of the frame would be made from custom laminated right and left halves. These blanks would have pockets hollowed on the inside and then be cut and formed to shape on the outside. Full-size drawings were used to create external and internal plywood templates.

The rear members of the frame would be made from solid, bent laminations. Again, full size drawings were printed and these were used to create plywood bending forms.

Construction

Excitement high, I made a predawn visit to an Amish lumberyard to purchase several black walnut boards. It was time to turn a couple months



Cover Photo:
Wooden bicycle
designed and built
by Aaron Holmes.



Each half of the main triangle bicycle frame is made up of four layers of 5mm black walnut.

of design and planning into flying sawdust and the building of a bicycle frame.

The rough sawn boards were resawn, planed, and sanded to 5mm thickness. I made a lamination layup drawing to show each of the four layers that would comprise each right/left half of the main triangle. The grain orientation of the pieces in each layer was varied for strength at the high stress areas of the frame.

After an informative technical support call with WEST SYSTEM, I began laminating both main triangle halves. The plies were layered on backer boards which allowed brad nailing in waste areas to secure the individual pieces. I used a second backer board, cauls, and a lot of clamps to compress the laminations while the 105 Resin and 206 Slow Hardener worked their magic. I added one layer at a time and allowed the epoxy to cure until I had four layers per frame half.

Once the blank was fully cured, I routed internal pockets. The top tube and downtube were hollowed to reduce weight. I expected this to contribute to the feel of the bicycle when riding. The head tube and seat tube were hollowed to receive steel inserts that receive headset bearing cups, seat post, and bottom bracket bearings. The next step was to roughly cut out the main

triangle and then follow a pattern to route its external shape.

In a similar process, the seat stay and chainstay components were made from laminations. The grain on these pieces all went in the same direction and thin plies were clamped in a form to achieve their shape. I made a mistake of not leaving one of the chainstays in the form long enough to fully cure. It may have also had a dry joint from excessive clamp pressure. In hindsight, I would make the plies thinner for these pieces so they would require less clamping force to achieve their shape, and, of course, not rush the cure time.

During this phase of the project, further design was needed for the rear dropouts. I guess this was my time to learn some metalworking and I did it in a very manual way. The dropouts are the pieces that join the frame members at the rear wheel axle. For my design, they also accept mounting of the rear disc brake caliper on the left side as well as the rear derailleur on the right side. I worked through five design iterations, testing each one with plywood mockups before committing to a whole lot of effort with a piece of 4140 pre hardened chro-mo steel. Using an angle grinder, drill press, files, rotary tool and ambition, I handcrafted my one-of-a-kind custom dropouts.

Assembly

A frame jig was made for assembly with proper placement and alignment of each component. By design, the dropouts were not symmetrical per side. I observed some difference in the chainstays from side to side. Fitting the rear triangle onto the main triangle with the jig would keep everything aligned on the centerline of the frame.

I called WEST SYSTEM technical support again to get some expert advice on the best epoxy choice for bonding the wooden stays to the metal dropouts. They recommended G/flex. Again, I appreciated the detailed discussion and advice. I also used G/flex to bond the stays to the main triangle, thinking its flexible properties and ability



Excess wood trimmed away. Pockets routed for the steel inserts.



The two halves of the frame becoming one.

to absorb the stresses of shock and vibration would be advantageous at these critical junctions, particularly while bouncing down a chip and seal road at 45mph on my bicycle.

After doing some cleanup and initial shape refinement on the left and right halves, I placed the steel tubes and epoxied the two halves together with 105 Resin and 206 Slow Hardener. Another clamp collection was on display to compress the halves for curing.

Shaping & Finishing

The construction and assembly was exciting every step of the way. To my surprise, the shaping and finishing was an enjoyable process too. I employed a multitude of tools and techniques to take away all the wood that I didn't think should be part of my bike frame: chisels, planes, rasps, a rotary burr in a hand held drill, an oscillating spindle sander, and lots and lots of sandpaper. It was pleasing to see the chunky, blocky shapes become more refined until finally, I was satisfied with my frame and ready to apply the finish.

This frame was not built just to look at; it was built to be ridden and that means a scratch or dent is inevitable. I considered several types of finishes but settled on an oil based finish, thinking it would be easier to touch-up and maintain over time compared to other finishes.

Visions of finely finished walnut gun stocks led me to Birchwood Casey Tru-Oil® finish. Here's another company with excellent technical support. After a phone call, I was confident in this finish choice for my application. As advised, I applied the finish by hand one finger dip of oil at a time. Five coats resulted in a beautiful gloss finish. It's a wooden bicycle frame!

Final Thoughts

As my cycling friends know, there's nothing like the excitement of building up a frame then taking it out for the first ride. Let me say, that excitement

was tenfold for me this time. I spent extra time on the build, partially to ensure it was well done with all the details correct, but also to savor the experience of building up my first hand-built frame.

Rolling out on the first ride I was a little nervous, but I smiled for 30 miles and enjoyed every pedal stroke. The back roads around my house are familiar, and strangely enough, this brand new bike felt familiar too. While it was the first ride, I had imagined this first ride many, many times throughout the project. I thought, "Wow, this bike feels like it was designed just for me."

The ride was smooth and efficient, the fit was perfect, and the entire experience, in addition to the final product, was extremely rewarding. Every time I see my wooden bike, I want to take it out for a ride and I often do.



The dropouts bonded to stays. Bolts will be used to secure the dropouts in addition to the epoxy.

The completed bike with a beautiful grain pattern.



Stayin' Awake at Daryl's House

By Bruce Niederer



Right: Daryl's finished carbon fiber insulated coffee box.

Below: Bruce's assembled box built out of insulation foam.

Bottom: Layering 881 Breather Fabric, the mylar bag and the top foam piece.

To stay awake at Daryl's house requires a lot of caffeine—it must if the Box o' Coffee idea he came up with is any indication. *Epoxyworks* readers may recall his riveting article in issue 40 "Dirt Bike Loading Ramp." Daryl is talented, imaginative and loves to build stuff with carbon fiber.

Inspiration hit him one day after buying a Box o' Coffee from Tim Horton's® on his way to teach a motorcycle safety class to aspiring scootertrash. Disappointed that the Tim Horton's coffee didn't stay warm very long, he salvaged the Mylar® bag with its built-in cap and built his own insulated box.

You may be asking yourself "Why not just buy a decent thermos?" That's a valid question. I have a Stanley® thermos my father bought me as a 14 year old kid to take in the woods for deer hunting. In those days I drank warm Vernors® Ginger Ale or hot chocolate and later I started drinking coffee and discovered caffeine, my favorite addiction. The problem with the Stanley is that it only holds 7 cups of liquid: enough for a short day excursion. Daryl's box o' coffee holds 2½ pots of the delicious hot brew—enough for a long overnight excursion.

Let's take a look at what Daryl did with his prototype, then at what I did to make one for myself.

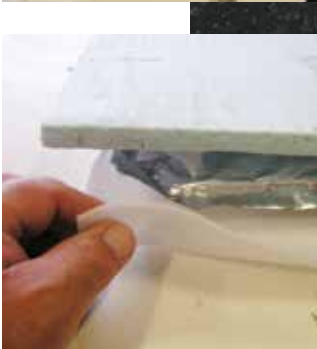
Daryl started with an empty cardboard box which he first lined with ¼" blue Dow® foam insulation board, inserted the mylar bag and secured the spout and cap through a hole he created, and bonded it in place. He simply duct taped the box closed.

After taping the cap and spout with duct tape, he wrapped the box in carbon fiber cloth wet out with 105 Resin/207 Special Clear Hardener.

At this point the entire box was prepped for another coat of 105/207 using an abrasive pad and sandpaper on the end panels and a final coat of 105/207 was applied. He then added the finishing touches—Detroit Tiger decals.

Daryl's new box thermos worked great. He filled it with hot water from our "tea spigot" that delivers water at 192°F, and recording the rate of temperature loss using a circular chart recorder, Daryl measured a loss of an average 2°F/hour at an ambient 72°F. McDonald's serves their coffee at 180-190°F as a point of reference.

I took a little different approach to making a coffee box of my own. I began by building a box using some leftover foam of Daryl's and WEST SYSTEM® Six10 adhesive. The dimensions were arrived at by simply measuring the length and width of the flat Mylar bag then blowing it up like a balloon to get the height. Epoxy is not just the ideal resin system for building and coating with foam, it is really the only system to use because





After glassing, the edges of the box were coated with 105/206 and 407 filler then faired.

WEST SYSTEM epoxies do not contain solvents. The styrene in polyester resin will melt foam.

I left the top of the box off in order to install the Mylar bag, which I scavenged from a Lightning Sailboat Regatta this spring. I cut a hole into the top using a hole saw, pushed the top through and glued it in place using Six10.

I wrapped the bag in a length of WEST SYSTEM 881 Breather Fabric, which we affectionately refer to as baby blanket, with two thoughts in mind. First, it should add a bit more insulation to help with heat retention and second, it will hopefully protect the bag from getting punctured by a sharp bit of cured squeeze out when the top gets installed.

It was time to make it a box and glue the top/bag assembly on by running a bead of Six10 Thickened Epoxy Adhesive and placing a weight on it until it cured. You can see how the baby blanket wrapped around the bag.

Now that I had a viable box, it was time to round all the corners and edges by sanding with 60-grit paper so I could easily apply some Episize® 731 3" wide glass tape with 105 Resin/206 Slow Hardener.

Both the top and bottom perimeter of the box were reinforced with the 731 glass tape.

Once all this taping cured, I sanded down the corners and rough edges with an orbital sander using 80-grit, then applied 105/206 with 407 Low-Density filler added to make fairing easier.

I was ready to apply fiberglass to the top and bottom of the box. I used Episize 745. The photo shows how to cut a pleat into the corner so the glass will lay down clean and flat, more or less. I cut a hole for the cap as well.

Once the top and bottom were cured and sanded, I faired the sides with a mixture of 105/206/407 and applied the fiberglass cloth to the sides directly into the uncured thickened epoxy mixture.

You can see the result was a bit gnarly but it all sanded out well enough.

Since this was made with scraps—the bag, the foam board and all the glass—my focus was on functionality, not creating a work of art. I sanded it mostly smooth and painted it.



The edges of the foam box rounded over then reinforced with 731 glass tape.



It's important to cut a pleat into the corner so the glass will lay flat.

You can still see the fabric weave and lots of areas that could use a bit more sanding, but there are no sharp edges and it will hold coffee—lots of it—and keep it hot for a long time.

One last tip that may be the most important one to make this all work: the box must be vented! Daryl learned the hard way when he was filling the box for the first time and promptly spilled hot coffee all over the place because the bag could not expand as it filled.

The box must be able to breathe to fill it to the brim with that tasty brew that keeps us all on our toes. To drill the hole shown here, I sucked the air out of the bag to collapse it flat in the box. I was very careful not to push the drill bit any farther into the box than necessary so as to not puncture the bag. A pressure test confirmed my success.

My coffee box will be a welcome addition to my sailboat next summer during overnight and long distance races. Thanks Daryl!

For more information on building coolers visit epoxyworks.com to read "Using Google SketchUp to Design a New Cooler" (*Epoxyworks 30*) and "Building an Efficient Icebox" (*Epoxyworks 19*).

Bruce's finished coffee box.





Rudder before work began.



After three coats of epoxy were applied.



The finished rudder and dagger board.



Rudder and dagger board sanded and the first coat of epoxy being applied.



Scraping the surface with a razor blade on a slight angle to remove high spots of epoxy.

Sunfish Wood Restoration

By Don Gutzmer

During the fall of 2016 I took a technical call from a customer who owned a Sunfish Sailboat. He lived in the area and was looking for help repairing a few minor gel coat cracks and restoring his wooden dagger board and rudder. I told him I would be happy to help because this would be a good opportunity to write an article about using WEST SYSTEM 105 Resin and 207 Special Clear Hardener for the wood restoration part of his project. The mahogany dagger board and rudder had weathered over the years because of only being varnished.

To remove all the varnish I used 100-grit sandpaper on an orbital sander, then sanded by hand with 120-grit sandpaper parallel to the grain. After everything was sanded a shop vacuum helped remove any remaining sanding dust.

WEST SYSTEM 105 Resin and 207 Special Clear Hardener were used to provide the clear

natural wood finish. The epoxy was rolled on the surface with an 800 Roller Cover and tipped off by dragging a section of roller cover over the wet epoxy to remove air bubbles and roller marks; this method is called rolling and tipping.

The epoxy was re-coated every three to four hours to build-up three coats on each side. One side was done each day. To make sure the epoxy coating was smooth and flat, a single-edged razor blade was used at a slight angle to scrape the surface. The razor blade would only remove the high spots of the epoxy. Then the epoxy coating was sanded dull with 220-grit sandpaper. Two coats of Captain's Varnish 1015 provided the final finish.

The customer was very pleased with the results of the finished boards.

Epoxy Bowl

By Joe Llewellyn

I am a woodturner working on a wood lathe making various round objects from bowls to bottle stoppers to pens.

I started turning irregular pieces of wood like burls and became frustrated with all the defects in the rotten or punky wood, and the various holes that needed to be filled or stabilized in order to keep the piece together. I started using the WEST SYSTEM 105 Resin and 207 Special Clear Hardener as recommended by the WEST SYSTEM technical advisors.

I pumped one stroke each of 105 Resin and 207 Hardener into a small paper cup and mixed them. I poured small amounts of the epoxy into voids in the wood piece, making a form from duct tape to hold the mixture. Of course the epoxy mixture runs flat, so it takes patience and time to get the desired results when filling a void. As the void fills I apply another cup full until it is filled

to the desired level. I then allow the epoxy to cure overnight.

The next day, I take the wood piece back to the lathe and turn off the excess material, apply more epoxy (using duct tape again) and fill the remaining voids. After this cures, I take it back to the lathe for the final removal of excess cured epoxy material to get the final piece I want, for example, a bowl with a window in the side.

After turning the piece to completion, I sand it starting with 60 or 80-grit sandpaper discs using a power sander, and continue sanding thru 2000 to 3000-grit to remove all scratches. This results in a transparent window that is very attractive in a bowl. People seem to like it.

I've learned that another way to use the epoxy mixture is to add a filler such as brass shavings I get from a key maker's shop, or sanding dust off the lathe. I mix these into the epoxy to fill the wood voids. This makes the epoxy more workable since it won't run quite so much. It also provides a rather stunning result, like gold from the brass and coloring from the wood shavings.

Of course nothing guarantees perfection but the result is attractive. It keeps difficult burl wood, which may be rotten, held together nicely.



Turned bowl with brass shavings accent



Bowl showing liberal use of 105/207



Epoxy is used to fill or stabilize voids or loose wood. The duct tape prevents the epoxy from draining out.



When using 105/207 you end up with clear windows through the side of the bowl.



WOW

17 Years Later

By Mark Bronkalla

WOW, the home-built runabout I completed in 2000, has been a focal point of summer activities for our family and friends over the years. We've spent hundreds of happy hours out on the water, and taken it on vacations to northern Wisconsin, Kentucky, and New York. The majority of *WOW*'s use has been in Lake Nagawicka in Southeast Wisconsin.

WOW is a 20' Glen-L Riviera with an inboard 350 cubic inch V8 engine. The hull is constructed of white ash frames, okoume plywood inner laminations, and a Honduras mahogany outer layer. The exterior is sheathed with 4 oz. fiberglass cloth on the deck, and 6 oz. on the sides and bottom. Primary construction was over one winter (see "*WOW*" by Mike Barnard in *Epoxyworks* 43). We started the build at the end of August 1999 and launched at the end of June 2000. The project continued with ongoing additions for the first several years, including upholstering the seats, installing a snap-on cover, a swim platform, cup holders, a wakeboard pylon, and a sound system.

I chose WEST SYSTEM Epoxy due to the ready availability of information on its use, the testing data available at westsystem.com, and the single best reference book I could find on boatbuilding: *The Gougeon Brothers on Boat Construction*. I have continued using WEST SYSTEM Epoxy products for *WOW*'s upkeep, as well as for a variety of unrelated furniture building projects and repairs. It lends well to the Craftsman style furniture I build, and my "finish first, assemble second" strategy. This works particularly well when you have dozens of pieces to assemble, such as a Craftsman-style bed.

The boat requires maintenance due to use and "abuse." We're fortunate in that we can leave the boat in the water from early May through late October, at a friend's house. But since this location isn't a good place for a boat lift, *WOW* is in the water the entire summer. There are tremendous advantages in not having to trailer the boat for each use—we have easier access to water, and we get to skip the boat launch lines, or worse, the "Boat Launch Full" sign that typically goes up in our area by 10:30 AM most summer weekends.

We've learned a lot caring for *WOW* over the years, and there are a few things we would have done differently regarding *WOW*'s construction, maintenance and improvements if we'd known better at the time. My hope is to fill in the gaps for others.

Don't bother staining the hull

When we built the freshly sawn and sanded hull, it looked too light colored compared to the classic look we wanted. After reading and consulting with the Technical Advisors at Gougeon Brothers, Inc., we decided to use an oil-based stain, dry it well and scuff sand prior to applying fiberglass. The deck, on the other hand, was not stained. The finishing board outer band is black walnut. Our goal was a three-toned design (dark mahogany hull, darker walnut edges, and a light mahogany deck with white stripes). Over time, it has developed a two-tone layout.

By the end of the first or second summer, the walnut had faded, to a lighter color than the mahogany. The mahogany on the deck grew nearly as dark as the stained hull sides. The staining was unnecessary, and it appears that it made the bond between the wood and fiberglass weaker. This shows up when the anchor gets banged against the hull—



the fiberglass debonds when the wood is dented. We repair the dented, debonded areas by slitting the glass and injecting fresh epoxy for a close—but not completely invisible—repair.

Rounding over the edges

We store skis, kneeboards, wakeboards, paddles, anchors and so on under the deck. In the course of use, these things bang into the boat's frame members, stringers, and battens. The damage is concentrated at the edges of the frame boards. The best treatment is to fully round over the edges. The larger radius of the edges will help deflect and absorb blows, reducing both wood compression damage and finish fractures. Consider a 1/4" radius the minimum. It's better if you can achieve 3/16".

After several spring repair sessions, I went through the frame members with a trim router, scrapers, chisels, rasps, etc. to create the larger radius edges. This was no fun, as I had to do much of it lying down inside of the boat. It would have been far easier to do during the initial build.

I treated these newly radiused edges with the normal triple coat of epoxy. They have held up quite nicely.

Fiberglassing the stringers

The majority of the framing is white ash. However, there was nothing available in the sizes needed for the stringers without a glue up and fixturing. This would have delayed the start of the build by a few weeks, and added more unknowns (for example, how straight could I make them on my basement floor?). So instead we built the stringers with redwood 2'x6's, which at the time could still be purchased in 20' lengths. These were quite straight. This worked well, but the redwood dents rather easily and became a focal

point of damage from the anchors (repeat offenders that they are), skis, wakeboards, etc. Each time the stringer edges were hit hard and dented, the epoxy would either crack or de-bond. Then water would get in, and the redwood would blacken and look ugly.

I solved the problem by sanding well, rounding over the edges, and applying fiberglass to the top and sides with 6 oz. glass and a double layer on top. It would have been much easier to do this at the initial assembly, but it has held up admirably.

Floorboard fitting and fiberglass application

We have floor boards only between the stringers. They were initially nicely fitted with small gaps. However, this made removing them difficult (for pumping the bilge, cleaning, storing ski lines and handles, etc.). As a result, the edges got dinged, the plywood chipped and they started to get ugly. The rear floorboard was replaced with mahogany and maple striped veneer to match the deck, and then glassed on top. One of these years I will get around to redoing the forward cockpit floorboards to match. The final recommendation—after much experimentation and repair over the years—is to leave a good 3/16" gap all the way around to allow for easy insertion and removal.

UV damage and Varnish vs Imron™

The boat is in the water for 5-6 months of the year and stored outside in the winter, which means UV damage, and scratches in the finish. Epoxy requires a top coat for UV protection. Common practice

The crazing pattern and underlying shiny varnish. It's on the side, near the transom in an area of high UV exposure.



The deck at the front edge of the rear cockpit has scratched varnish and the small blisters in the fiberglass.



is to use typical marine (spar) varnishes (Z-spar, Epifanes, etc.). However, halfway through the second summer after a coat of varnish had been applied, the finish would dull and start crazing. The next spring we'd have to scrape, sand and refinish.

For a boat stored indoors, this would not be anywhere near as much of an issue, but indoor storage is just not an option for us. For the third round of varnishing I used DuPont Imron 500s Clear, a 2-part linear polyurethane finish with excellent UV absorption. It is also much harder than varnish so it does not scratch as easily—which is important because we are constantly climbing over the deck for watersports. This is a better finish by far, and lasts 5-7 years. We are now on our second coating of Imron and it is still looking good.

To apply the Imron, all vestiges of the old finish must be removed. This means a thorough scraping and sanding. Additionally, it is best to remove the UV-damaged, topmost portion of the epoxy. Use a cabinet scraper to remove epoxy until the shavings change from yellowish to white. If you have to scrape a lot, you will have to rebuild the epoxy layer and allow that to cure before finishing with Imron.

Spraying Imron requires a substantial investment: A sprayer, the system's hardener, proper reducers, protective gear and a forced-air respirator. Before spraying this or any coating system, contact the manufacturer for accurate health and safety information.

Full Fillets

One of the drawbacks of leaving the boat in the water through October is condensation resulting in mildew inside of the hull and boat cover. Smooth and clean surfaces cut down on mildew growth considerably. It's important to create nicely full fillets in the corners. All of the edges along the battens, frames, and the hull planks are filleted. Most of these were done during initial construction but there were areas we filleted later, after discovering them due to the way they caught dirt and mildew. These required thorough cleaning before we touched them up with fillets. The fillet mix I used was epoxy thickened with 406 Colloidal Silica filler, and ash wood sanding dust in approximately equal parts for a color match to the ash framing.

It's also important not to skimp on epoxy when coating the underside of the deck. It needs three full coats of epoxy, just like everywhere else. Areas with only thin epoxy coats tend to develop mildew much faster.

Don't bother varnishing the interior

It seemed natural to varnish the interior to provide UV protection. So as part of the second varnishing, we cleaned, sanded and varnished the interior sides and bottom. This looked great initially. However, the constant moisture in the boat penetrated the varnish. After the first winter of storage, it was flaking off in big sheets, and the worst was in the bilge. I touched it up that spring, but the next winter it was even worse. It all came off (both naturally and with scraping). Now we just have the epoxy finish on the inside.

Heat damage due to the cover

Probably the most problematic item we had to deal with was the color and design of the cover. The cover is made of Sunbrella® which is an incredible fabric. However, I wanted it to match the chosen bottom color which was forest green. The problem is that this dark color absorbs far too much sunlight. In mid-summer, uncovering the boat required kneeling on a towel because the deck and hardware were too hot to touch. This was inconvenient. The real problem was that the excess heat caused a cross-hatch pattern to show up on the epoxy wherever there was a combination of tight-fitting boat cover and southernmost sun exposure. Eventually, this got to be unsightly. I used a hot air gun and a scraper to remove portions of the fiberglass along the port side deck by the engine hatch, which was not fun.

Some other builders had questioned my use of fiberglass on the deck. In another experiment, I coated the repaired section with epoxy without fiberglass. This was a mistake. The joints between the walnut opened up by the end of summer. The next spring I peeled back a larger area, from the front cockpit back to the rear cockpit and then applied new fiberglass and epoxy.

By this time I'd had enough, so I replaced the dark green cover with a new off-white cover. This one has posts to keep it lifted off the deck. This arrangement also provides better water runoff. The new cover also has skirts on the rear sides which cover the tumblehome and the transom. These are areas that get particularly bad UV damage otherwise. The new cover has been in use for a few years and has worked out very well. There has been no recurrence of the cross hatch pattern damage to the finish, and the boat is noticeably cooler when uncovering.

Be generous on your waterline height

I originally took the concept of the waterline junction of the bottom paint and the clear finish far too literally. I aimed for having this boundary right at the empty-boat, docked-waterline level. I hit this pretty darn close, unfortunately. The problem is stored equipment, bilge water and rainwater accumulation mean the boat is rarely empty. As such, the true water line might be 1" to 2" higher at times. Clear finishes are water permeable and will de-bond over time (especially over the winter). This resulted in the clear finish near the waterline flaking off and looking ugly. I raised the waterline and added the white accent stripe. It is probably 2" to 3" higher than it was originally. It no longer has a flaking finish.

Scraping vs. sanding

When building, and even more importantly when refinishing, scraping is far superior to sanding for:

- Ease of finish removal
- Judging the depth of UV-damaged epoxy to be removed
- Leveling of the epoxy and removing drips, runs, and sags

Learn to properly use cabinet scrapers and have several at hand sharpened and ready for each session. See Tom Pawlak's "Scrapers" article from *Epoxyworks 19* for more information on using and tuning cabinet scrapers.

Pay attention to the seat cushion construction

In a runabout, the seat cushions take a beating. They don't just get sat on; they are stepped on, kneeled on and stressed due to the sun. We are ready to recover the seat bottoms for the fourth time.

The backs are still OK. The bottoms get far more UV damage due to orientation. This shows up as hardening and cracking. The first to deteriorate are the seams on top. We had originally chosen a raised front edge and resulting seam. This was the first part to crack and tear. Next time, the seat bottom cushions will be smooth on top. Also, choose a light color. Just like the boat cover, dark seats get hot in the sun. Ours were originally maroon.

Prop selection

It was hard to find good data on what prop to use. I used the Michigan wheel prop calculator, which emphasizes a fully loaded boat, and this suggested a 3-blade 13x14P prop. This would easily let the engine over-rev if we were not careful, even with eight people in the boat. We then went to a 4-blade OJ 14x16P which was re-pitched to 17P with cup. This one almost keeps the RPMs in check at wide open throttle. We need a new prop because the old one has been repaired too many times due to damage from rocks in the channel where we keep the boat.

Remember that one of the major advantages of wood epoxy composite construction is that it is very light. Our boat is ~2000 lbs. all loaded up—minus passengers. The engine is rated at 325HP and we have a 1.23:1 reduction in the transmission. This is the same powertrain you will find in a fiberglass competition ski or wakeboard boat that weighs 1000-2000 lbs more. Even with the steeper prop, the hole shot is great. You can never just whack open the throttle or you will yank the handle out of the hands of a skier (even good slalom skiers who ask for a quick start). We have also done water skiing starts three people deep with no problem aside from "ski line macramé."

I'm confident that with continued care, maintenance and attention to detail, our family will continue to enjoy *WOW* for many years to come.



The first pass of scraping. Note the triangular sag in the upper left corner. My roll and tip technique still leaves something to be desired at times. The other ripples and general stippled surface show readily under the first scraping pass.



The third pass and ready for sanding. No hints of the major surface imperfections are left. The surface has a nice fine finish, ready for 150-220 grit sandpaper.



The teardrop all closed up and ready to travel.

One Small Trailer and a Teardrop

By Mike Lance

My good friend Orrin and I have been messing around with WEST SYSTEM products for the past forty years. After building and racing a hydroplane in the Seventies, we built a 21' cedar strip two-person kayak in 1980 and an 18'6" cedar strip canoe in 1981. In 1981 we placed second in the 320-mile canoe race across New York state using our kayak. Both boats are shown in May/June 1985 edition of *The Boatbuilder*, Gougeon's precursor to *Epoxyworks*.

After I had competed in the Sikaflex® Challenge races over a number of years, a book on teardrop trailers caught my interest. Having some plywood left over from the Seventies I started thinking that I could build a small camping trailer for my wife and me. There existed a real problem: would my wife actually sleep in something this small? With encouragement from my daughter, Karen, to build it for the sheer fun of building, I mentioned the idea to my wife, Terry, saying that I would understand if she declined. Her response: "How dare you try and exclude me from your next adventure?" Game on.

Construction started with an eight foot utility trailer from Harbor Freight Tools. My very talented neighbor, Tom, did all the necessary welding. This included raising the bed of the trailer 3" for road/tire clearance and moving the front part of the frame 15" forward as it would be in the way of people entering the cabin. With the welding done, a 5/8" plywood deck was fastened to the steel frame. Time now to mix up some WEST SYSTEM 105 Resin/206 Slow Hardener and start constructing the walls.

The four walls were built with select eastern white pine and 4mm okoume plywood. Each top frame piece was built using two pieces of Sitka spruce, 3/8" thick by 3/4" wide. Steaming was not necessary since the curve was gentle enough for the glue to hold the piece in shape when it came out of the jig. The door, vent, and windows were made



The "Go-Lo" with 6' headroom.



The finished interior of the trailer looking out the back window.



The custom trailer platform.

from scratch. After the portable toilet and fold-down sink were installed and the electrical work was completed, all that remained was the painting. Two coats of 105/206 were applied to the outside with a quick sanding between coats. Sanding was needed again after the second coat. The owner of a small collision shop allowed me to work with him on final sanding and taping before he sprayed the primer and the final coats.

The “Go-Lo” as we call it cost \$4,200 to build and weighs 840 lbs. This concluded my construction of trailers, or so I thought. My daughter and her husband visiting from Seattle one Christmas saw it and liked it. The next Christmas my son-in-law, Thadd, commissioned me to build one for them. They have two young daughters and wanted a true tear drop trailer, not one with 6' of head room. So, how do you squeeze two active kids and two adults into an even smaller trailer? The answer was a trailer with a slide out unit.

Some key differences would be necessary with the second trailer. I couldn't ask Tom to do all that welding again, so I started with a more expensive Sure-Trac trailer. Thadd loves to cook, so the galley in the back includes a sink, lift-up counter, and a reversible table for the stove or for outdoor snacks at night. The sharper curved top required steaming the ribs for the roof. To save time, I purchased a fan, door, and window. The second trailer cost \$6,800 and weighs 1,020 pounds. The teardrop does not have a potty, but they are young and sleep through the night. Now I am certainly done building trailers, but I will never be done using WEST SYSTEM Epoxy.

That became apparent 35 years ago on a golf course when my wooden three-wood shattered into three pieces. I used 105/206 to glue it back together. It's the best club in my bag today. Clearly I build and fix things better than I golf.



The teardrop set up with the slide out extended.



The kitchenette in the back of the trailer.



Vacuum bagging setup

Self Defense Canes

By Mark Copeland

After working for many years as a master plumber, followed by many more at Automotive Concept Studios where I fashioned conceptual car models from clay, I ended up with arthritis and two hip replacements. All the heavy work had caught up with me, leaving me disabled and dependent on a cane. I decided to leave Michigan during the winter months and move to Zephyrhills, Florida. I settled in and started looking for an activity to do, maybe metal detecting, fishing or golf.

Downtown, I happened by a martial arts school and stopped in to watch a class. Afterwards, the owner (Master Gary Hernández) and one of the instructors (Ms. Karuna) introduced themselves to me. Both have 4th degree black belts. I explained my health issues: limited mobility and the need to use a cane. They outlined a class Master Hernández teaches in Cane-Fu®, which is specifically beneficial to someone in my situation.

The class begins with the students stretching and warming up keeping both hands on each end of the cane—we stretch, bend and do a swinging motion. The instructors teach students to be keenly aware of their surroundings at all times. We learn to use our cane for different blocking techniques coupled with how and where to counter with cane strikes of our own. Students also learn how to use their canes to disable an attacker utilizing “joint traps” on knees and elbows. We make every motion count, which is very important when mobility is limited.

As students get used to the Cane-Fu curriculum, Master Hernández and Ms. Karuna take students out of the Dojo (martial arts school) and into real life scenarios: an ATM machine, a restaurant or coffeehouse, a park or public place, and in your vehicle. There are three different levels of testing required to pass onto the next level and earn that belt.

The canes we use are very well made from hickory, oak or sometimes exotic hardwoods. They are not the type you would find in a medical supply or pharmacy—they’re much more heavily built and generally of better quality. When I returned home in the spring, I set out to make a cane using carbon fiber. I didn’t have a mentor to show me the ropes, so I went online to investigate where to start. The vendor for my carbon fiber also sold WEST SYSTEM Epoxy and posted many good reviews of WEST SYSTEM products and services. I knew to expect some mishaps because I had no experience building composites. Each time I built a cane, I would learn something new and try to improve my process. I had one thing going for me: a lifetime of working with tools in the plumbing trade.

I first made wax castings and a ridged mandrel. The first cane I made with the wax castings was too light—it was incredibly strong, but it needed more weight to be useful in self-defense. I took it to class to see if anyone could break it, and no one could. The next cane would be built around an armature like sculptors use. Another would have fewer layers of carbon fiber. I tried one with an incorporated



*Two cane prototypes.
The lower cane has
palm swell making it
easier to grasp.*

palm swell which nicely fit my large hands. To make the epoxy black, I tried adding WEST SYSTEM 423 Graphite Powder to the mixture, but it was a bit dusty when I block sanded it. Don Gutzmer with the WEST SYSTEM Technical Staff guided me through my cane project. He suggested I try WEST SYSTEM 502 Black Pigment in my application. The new black tint worked great!

My canes have to serve as a medical device as well as a self-defense tool. I would show my canes to some of my doctors and listen to their opinions. I gave canes to my martial arts instructors and my class mates to test and evaluate, get their feedback and make changes. For a defense tool, it's critical to incorporate a solid contact point that can change an adversary's bad intentions.

I built a vacuum bag system with a twin diaphragm vacuum pump with draw down

tanks. The tanks allow me to cure the canes overnight under vacuum pressure with very little pump noise. I am working on a way to build a clamshell system, a technique I learned from my days in the Automotive Concept labs. One of the benefits of working in that type of environment is collaborating with some very talented mechanical and electrical engineers.

Master Gary Hernández and Ms. Karuna still have the first canes I made and have followed my progress over time. I would like to give a big thanks to Gary Hernández Martial Arts Studio and Ms. Karuna for their support. I will continue to stay with it and strive to improve the canes. Since starting my training I have experienced a real life encounter where I had to use the cane in a self-defense situation.

Tunnel Hull

By Ed Stubbs

I'm rebuilding and restoring this vintage tunnel hull race boat for Steve Roberge. It was his late father's boat and he wanted to restore it. We took it to my house to do as a home project.

I love using WEST SYSTEM Epoxy because there is very little odor or product waste, especially when compared to working with polyester resins in less than ideal temperatures.

I used G/flex 650 epoxy to fiberglass documentation numbers onto a bilge. I had vinyl numbers made, then stuck them onto dry fiberglass cloth. I then squeegeed G/flex into the cloth, laid another piece of cloth over the numbers, and let the epoxy cure overnight. I trimmed away the excess, then sanded both the back and the mounting surface. I used G/flex 655 Thickened Epoxy Adhesive to bond the numbers in place: no fuss, no muss, no polyester smell. It was easy!

The next steps will be wet sanding and restoring the deck, which has a lot of cracks from an accident some time ago.



Using G/flex 650 helped Ed avoid much of the mess of mounting documentation numbers onto the bilge.



The hull completely gutted of the original deck and transom wood structure



Two-ply of 3/4" marine grade fir bonded to transom



8mm Okoume bonded with WEST SYSTEM Epoxy on both sides, and tabbed to the edge of the hull



Deck, transom knees, and fuel tank mounts after glassing with bi-axial fiberglass and WEST SYSTEM Epoxy



The hull repaired, and faired with WEST SYSTEM Epoxy thickened with high-density and low-density fillers, then gelcoated in blue. We had no problems using the poly based gel coat over epoxy, as we took no shortcuts. Everything was sanded and properly cleaned before spraying.

My First Cadillac

Restoring a 1954 Cadillac Runabout

By Bruce Niederer

One never really knows when the Fickle Finger of Fate will be pointing in your direction, but it sure did one day early last fall in 2015 at my brother's shop—Nelson Niederer Woodworking in Bay City's south end.

One day out of the blue a young man walks into the shop and relates a story about an old boat he found in his grandpa's barn. He knew he wouldn't really have the money nor the time and expertise to restore the boat. Nonetheless, he would hate to see it forgotten and disintegrating. Nelson told him to bring it by and he'd take a look. What he brought back was an extremely rare 1954 Cadillac 14' Runabout—in great condition! Cold molded, no frames. Mahogany veneer hull construction with a mahogany planked deck. The seat cushions and bimini top in good shape. No rot in the hull—only a little on the ends of the splash rails.

Not to say it didn't need work. It had been on a trailer without moving for decades and had a permanent set of whoop-di-doo—uneven waviness caused by sitting so long on the trailer rollers—on the bottom, no outboard engine, the gas tank shot, the deck needed refitting, all the metal parts needed refinishing or replacing, the mahogany trim around the double cockpit set up needed replacing, the cockpit floors needed rebuilding and the trailer was too old to be practical anymore. Still... it was beautiful and love at first sight.

We were in!

Nelson struck a deal with the young man: he signed the title over to us for \$1.00 so the restoration could proceed under the shop's insurance. We would keep track of time and materials and he would get the first opportunity to buy it back after we show the boat at the Hessel, Michigan Wooden Boat Show in August of 2017. The restoration will cost in the neighborhood of \$18,000 to \$20,000 once completed. If he can't

raise the money for the restoration we will pay him \$1,000 and the boat becomes ours—lock, stock, and title.

Part of the fun of restoring a classic boat is learning its history—and this Cadillac is no exception. The Algoma Plywood Company of Algoma, Wisconsin (a subsidiary of US Plywood Corp.) produced molded plywood boat hulls and had patented a cold molding technique through its Molded Shapes Department. This operation was



U.S. Molded Shapes, Inc. advertisement, circa 1954

sold in October 1949 to the Wagemaker Marine and Boat Company of Grand Rapids, Michigan. Andrew Kolarik, a US Plywood employee, was loaned to Wagemaker to help establish production in Grand Rapids because he had helped develop the original process and was experienced in boat design and construction. Shortly afterward he was hired by the Wagemaker Company as Plant Supervisor and boat designer of the new subsidiary of Wagemaker Marine and Boat Co.—US Molded Shapes, Inc.

US Molded Shapes was a major supplier of cold-molded mahogany plywood hulls. Many manufacturers such as Delta, Milocraft, Yellow

Jacket as well as Cadillac used these hulls to build completed boats. Hulls were also available in kit form for home assembly.

A fire in April 1960 destroyed much of the equipment and production at the Grand Rapids plant. As a result, US Molded Shapes moved their operations to Cadillac, Michigan. Wagemaker Marine and Boat Company also moved operations from Grand Rapids to the plant in Cadillac. US Molded Shapes was combined into Wagemaker Cadillac's operation as the Molded Shapes Department. Interestingly, at some point GM sued Cadillac Marine and Boat Co. over the name. They lost because they cannot own the name of a city.

Another interesting aspect of these boats is the fact that there is no consistent or distinctive styling detail that might direct the restoration because the companies were free to finish the boats any number of ways, not to mention the kits finished by dealers and individuals. The hull that landed in our laps was built by US Molded Shapes in Grand Rapids, finished by Wagemaker Cadillac Boat and Marine Co. in Cadillac, and sold by Harwood's Boat House and Marine Sales Detroit.

We found some "interesting" repairs and small modifications that must have been done by the original owners. For instance, refastening loose boards with construction nails instead of new screws. The nails were countersunk so that they were nearly impossible to find. Fun stuff like that is common in old boat restorations.

A wealth of early photos Nelson took using his phone are now lost forever because he dropped it in the drink. (Cloud...what's a cloud? From now on I'm in charge of the photo record.)

Ours is laid out with the steering wheel in the front and the windshield is tempered glass split in the middle forming a sort of open book shape. This is new glass—the old glass had a crack on one side.

In my opinion, the glass windshield adds a bit



of class when compared to the plastic windshield. Neither is wrong—they're just different.

First we had to remove all the hardware and windshield, the seats, steering wheel and cables and the spray rails. This lightened the boat up so that we could easily flip it to start on the bottom.

As I mentioned, the bottom had what is commonly referred to as whoop-di-dooos. Before we could fair the bottom we wanted to see how flat we could get it by bonding in two new white oak stringers and a new mahogany inner keel. Originally, the outer keel was fastened to the inner keel through the hull with brass screws. We removed the outer keel then bonded in all three inner parts using slightly thickened WEST SYSTEM 105 Resin/206 Slow Hardener and temporary fasteners.

We strategically placed a bunch of bricks to try to force the bottom down as flat as we could manage while the epoxy cured. We let the stringer/keel assembly sit for about a week hoping it would reverse or minimize the wavy set the wood had taken. The temporary screws holding the stringers would be removed and the holes filled when we flipped the boat over. The screws were sprayed with Pam® cooking spray which makes a fine mold release for fastener threads.

With the hull flipped and the outer keel removed, we began sanding. Now, sanding is

The boat being restored with the open book shaped glass windshield.

Left: the inside bottom of the boat reinforced with white oak stringers to help flatten the whoop-di-doo before beginning to fair the hull.



Right: The freeboard is covered to protect it during the fairing process. The bottom has been coated with 105/206 with 501 White Pigment added followed by an application of 105/206/410.



always a lousy job but it must be done. It was made worse because the boat will be finished natural from the waterline up, meaning, no power sanding—only long boards in the direction of the grain. Cross grain sanding scratches would show under the epoxy and top finish coats.

Once we got to this point the bottom was somewhat flatter, but the whoop-di-doo were still obvious and measurable using a long level as a straight edge.

First we covered the freeboard at the waterline to avoid messing up the hull sides. We coated the entire bottom with two applications of 105/206 with a bit of 501 White Pigment added. Once that cured, we sanded it then faired with 105/206 thickened with 410 Microlight filler.

Then came more longboard sanding followed by more 410 fairing mixture in the low spots, more sanding, followed by a full coat of 105/206 pigmented with 502 Black Pigment. This provided a color change to index from.

Now we began wet sanding and eventually decided it was good and smooth, flat and balanced side to side.

Some readers may be asking themselves “Once an epoxy bottom is applied, how can a restoration still be considered original?”

The American Classic Boat Society (ACBS) determined some years ago that an epoxy bottom is now considered a safety improvement and in restoration competitions a boat will not be dinged because of it.

We fashioned a new white oak keel and bonded it in place using some Six10 Thickened Epoxy Adhesive. The keel was also temporarily fastened with screws while the adhesive cured, then these were backed out and the holes filled with epoxy. The oak was encapsulated with 105/206. The bottom was meticulously faired using spot putty to fill pinholes and small blemishes.

This was followed by rolling on a mixture of 105/206/410 thickened to a ketchup consistency so

it could be rolled over the entire bottom...followed by more long boarding, of course. Mercifully, this was the final sanding. We prepped the surface with a burgundy abrasive pad then painted the bottom with red Kirby's® Marine enamel, which is a traditional color for the bottom.

It took three coats of enamel to cover the patchwork of black and white—which we did even though this application was only intended to protect our work once we flipped it right-side up. The bottom will get a final coat before we're through.

The transom was messed up enough that repairing it wouldn't have looked good, so we sanded and faired the drilled holes and low spots then bonded a mahogany veneer over it.

Push pins were strategically placed with the intention of getting the veneer bonded nice and flat with no bubbles or bulges. It took us two attempts to get it installed to our satisfaction.

We may still decide to paint the transom—I wish we had used 3 mm mahogany plywood instead of veneer because no matter how carefully we worked to install it we always got bubbles under

Transom veneer temporarily held in place using push pins





Left: The bottom has been coated in 105/206 with 502 Black Pigment to provide a color change to index fairing from.

Right: You can see the faired final coat of 105/206/410 to the right of the keel. Being applied to the left is the red enamel bottom paint.

it, hence the additional fairing seen below prior to the application of a second layer of veneer.

Both the front and rear cockpits had mahogany trim that I'm sure was steam bent to bend around their curved shape. These trim boards were full of holes, had some splits in them and generally looked pretty nasty. We decided they needed replacing.

Both front trim pieces were removed so we could trace their shape onto some chipboard which we used to build a jig. This would allow us to build new trim boards without using steam. I didn't think it was necessary to bother with steaming if we employed a technique I used to build some support davits for canoes in the GBI shop (*Epoxyworks* 39 "Simple, Effective Home Repairs and Projects")

The technique follows typical cold molding principals—we cut two thinner boards that equaled the thickness of the original trim pieces. We sprayed them with hot water getting each piece good and wet to soften the wood as we slowly, over a couple days, pulled the pieces tight to the jig. Each time we snugged up the clamps we sprayed the wood again.

Below is the jig fixture we built for the two front trim pieces with one new piece almost pulled into shape. Once the pieces were clamped tight to the jig, we left them clamped for a week so they would hold the curved shape. Then we applied 105/206 thickened with 406 Colloidal Silica to glue the two laminations together, clamping them back in the jig until the glue cured.



The jig fixture we built for the two front trim pieces with one new piece almost pulled into shape.

Transom faired before another layer of veneer is applied.



Once removed from the jig, the new pieces were trimmed to the correct width and sanded then clamped to the original to check the basic shape. The new pieces turned out as close to a perfect match as we could hope for.

Well, after taking the summer off it's time to get back to the restoration. Stay tuned for the exciting conclusion to the tale of the Cadillac Runabout restoration. Hopefully we will have earned 1st place at Hessel by then.

Nelson's work has been featured in *Epoxyworks* many times: #28 "Building an Arch Davis Sand Dollar", #33 two articles about building bars and pouring 105/207 Special Clear Hardener on a bar top, and #41 Restoring a 1964 Chris Craft Super Sport 17.



You Can Build It With Fiberglass

By Clayton Woods

Using WEST SYSTEM Epoxy Resin and fiberglass products, I have created numerous helmets, props, and pieces of armor for costuming and cosplay. Cosplay means to dress up as a character from a book, movie, or video game. Employing unorthodox and oft times experimental methods, I have kept costs low and my creativity heightened.

Just about anything you dream up can be built with fiberglass. The only real challenge is to get a close initial shape. After that, you can add or remove material with relative ease. As it is impossible to hang fiberglass in the air, you just need something to put those initial layers on.

Over the course of my various projects, I have used a multitude of techniques to get started. I have created patterns using clay, foam, cardboard, plastic, metal, wood, and sand. Release agents I have used include wax, plastic wrap, waxed paper, and paint. Anything that will let you pry that cured fiberglass shell off your pattern can be used. Or, you can simply cut and grind the pattern out from the inside of the cured shell.

If one plans on producing more than one piece, then a mold can be made using silicone, but this increases costs and is unnecessary for a one-off creation.

WEST SYSTEM Epoxy is ideal for this kind of work. I use it exclusively in all my projects, and have on occasion applied it to carbon fiber and



Above: Finished Darth Vader helmet.

Left: Fiberglass pieces cut to size and laid out, ready for application.

Bottom Left: The helmet mold with the fiberglass pieces applied.

Bottom Right: The fiberglass shell after 105/206 and 407 filler has been applied and faired.





Kevlar®. Mostly I use fiberglass mat due to the randomly oriented fibers. Fiberglass cloth has its uses also, but it does not work as well as mat for the type of things I usually build, and you'll see why later in the article.

Editor's note: For more information on using fiberglass mat with epoxy, see "Chopped Strand Mat & Epoxy" in Epoxyworks 21, Summer 2003 at epoxyworks.com/index.php/chopped-strand-mat-and-epoxy/

When crafting something from scratch be cautious about who you listen to. I cannot count the times that I have been told "That won't work." or "You can't do it that way." or "You have to make a mold." These people take the fun out of the endeavor. I have seen people give up on something they wanted to do because they listened to the wrong person.

We build things from scratch because we enjoy it. The whole purpose is to stretch your imagination and let those creative juices flow. Don't be afraid to try a new idea. Experiment, test out crazy notions, and think beyond the obvious.

Occasionally an idea will not work out the way you intended, or maybe not at all. Sometimes those little setbacks or failures lead to an even better idea. My dad used to say that some of his best ideas wound up in the scrap pile. But, he always came up with something.

My first freehand fiberglass project was my Star Wars: Episode IV A New Hope Darth Vader helmet. It taxed my creativity to the limits, but turned out better than I had expected. Don't worry about how you will build everything, just start with something. One step at a time.

My next helmet was Odin's helmet from the Marvel movie Thor. Quite a bit more challenging than Vader, but I got to exercise a little artistic

license and add a few of my own touches.

Currently, I am working on a helmet of my own design, one that will complete my vision of a medieval armored Joker. This has been the most fun project I have attempted. I am putting much more detail into this helmet than any of my previous ones, and the challenge of figuring out how to make it all come together has been quite intriguing.

So, if there is something you want to build, take the leap. You can build it with fiberglass. Believe in yourself and take it slowly. Head on down to your local WEST SYSTEM dealer and pick up some 105 Epoxy Resin and 206 Slow Hardener, a package of fiberglass mat, and a few tools.

Check out my tips and tutorials on my Facebook page "CosplayGlass." Your skills will improve with time and you will soon find yourself creating things you never would have imagined.

Sequence shows the progress so far on my interpretation of a medieval armored Joker.

I built Odin's helmet based on the representation in the movie Thor. On the left are the foam pieces shaped before assembly. On the right is the finished piece.





A modified 808 Flexible Spreader creates a fillet in one quick pass.

Bonding with Fillets

By Tom Pawlak

Gluing plywood structures together with epoxy fillets saves considerable time constructing the joints and reduces overall weight of the structure compared to more traditional methods using wooden cleats and screws. The strength and gap-filling qualities of epoxy eliminate the need for precisely fitted wood cleats that otherwise require time and skill to create. When gluing with conventional adhesives, that are non-gap filling such as resorcinol glue, wood cleats need to be well fitted, need to be wide enough to provide sufficient glued surface area and provide enough thickness for screws to be driven into. Building with epoxy fillets is especially beneficial when attaching bulkheads to hull sides, attaching hull sides to hull bottoms where the faces of the plywood are coming together at ever changing angles.

Because epoxy can be thickened with high density fillers into a non-slumping consistency it can bridge large gaps in wood joints, without loss of strength, thus saving a great deal of time labor otherwise needed to create a strong joint.

A fillet is a continuous bead of thickened epoxy mixture applied to the angle created between two parts. It increases the surface area of the bond and serves as a structural adhesive and brace.

Filleting creates an effective glue joint that requires no fasteners of any kind and can result in a joint that is as strong as the parts being joined together.

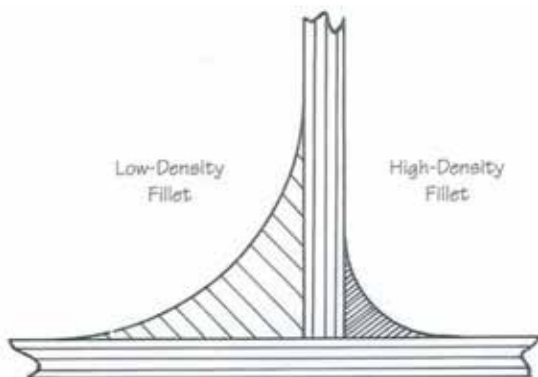
If wood components have not previously been sealed in epoxy, it is good practice to apply a thin coat of epoxy to saturate the surface prior to applying the thickened epoxy fillet so the edges of the fillet don't soak into the dry wood and cause a dry edge.

You can let the initial coat of epoxy cure, then sand it in preparation for applying the fillet; or you can allow the initial coat of epoxy to tack up a bit before applying the thick epoxy fillet; or you can wipe off uncured epoxy remaining on the surface with paper towel so the uncured epoxy does not cause the thickened epoxy to slide or slump. In this last scenario, by wiping off the remaining liquid uncured epoxy from the surface you can now apply the thickened epoxy fillet without it sliding off of the wet and uncured liquid epoxy.

An epoxy fillet can be especially effective when joining parts that meet at difficult angles like where bulkheads meet the hull sides near the bow. Other instances would be where plywood hull sides meet the hull bottom or chine, where hull sides meet at the bow and where hull sides join the deck at the sheer. Historically these joints required well-fitted pieces of wood that the plywood could be glued and screwed into.

The illustrations in this article are taken from The Gougeon Brothers on Boat Construction pages 102 and 103.

Cross section of low-density and high-density fillets. Low-density fillets require a much larger radius than high-density fillets to make joints of the same strength.

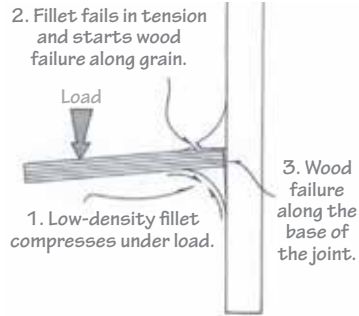


Determining fillet size

Fillet size depends on whether you are using low-density (less strong/less dense thickener) or high-density fillers (stronger/denser thickened epoxy). The chart shows the recommended radius size for fillets. Experiment to find the proper radius for the materials you are using.

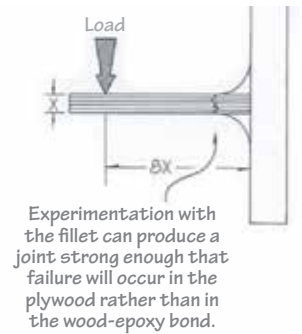
	Plywood Thickness	Fillet Radius
High-density Fillets	$\frac{5}{32}$ (4mm)	$\frac{5}{8}$ (15mm)
	$\frac{3}{16}$ (5mm)	$\frac{3}{4}$ (18mm)
	$\frac{1}{4}$ (6mm)	$\frac{7}{8}$ (22mm)
Low-density Fillets	$\frac{5}{32}$ (4mm)	$1 \frac{3}{4}$ " (44mm)
	$\frac{3}{16}$ (5mm)	$1 \frac{3}{4}$ " (44mm)
	$\frac{1}{4}$ (6mm)	$1 \frac{3}{4}$ " (44mm)

Low-Density Fillet



Failure mode for an improperly sized fillet radius. Joint bond failure.

High-Density Fillet



Failure mode for a properly sized fillet radius. Wood failure.

Applications where fillets are common and helpful:

Stitch and glue boatbuilding

Gluing plywood structures with epoxy fillets has become extremely popular because it allows extremely thin plywood panels to be bent into compound curves and temporarily stitched together at varying angles with plastic wire ties or copper wire that are then permanently joined together with epoxy fillets.

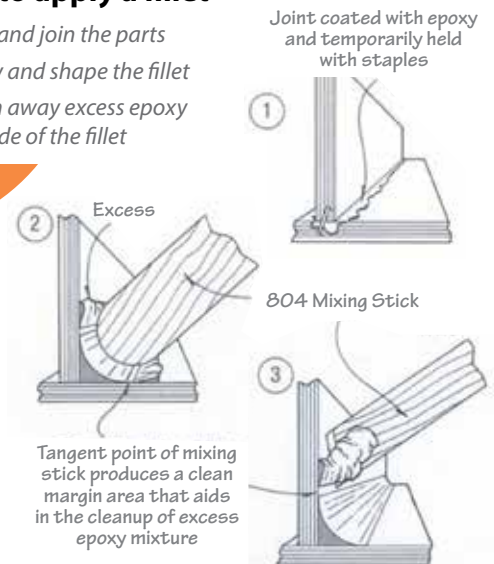
More often than not, these fillets along the chine and at the bow and stern are fiberglassed to provide fiber reinforcement over what would otherwise be a butt-glued joint. Once the fiberglass is applied and cured, the joints are amazingly resilient and strong.

Gluing stringers and frames into hulls

Fillets are also used when gluing stringers and frames into hulls. In these applications, fiberglass fabric (called tabbing) is often applied over the fillet that extends and onto the hull and stringer 2-3" to reinforce the joint. Smooth rounded fillets bridge the hard corner and give the fiberglass reinforcement something to be attached to. Without the fillet, fiberglass fabric won't go into a square corner well, and the strength would be decreased.

How to apply a fillet

1. Coat and join the parts
2. Apply and shape the fillet
3. Clean away excess epoxy outside of the fillet



Fillet Tools

A wide variety of objects can be used to make fillets. Plastic spoons and rounded off 808 Plastic Spreaders can be particularly useful.



Color-matched fillets



Three different wood types with four dollops of thickened epoxy on each. The first dollop (white on the far left of each) is thickened with all 406 Colloidal Silica filler. The second one is thickened with 406 filler and a bit of wood sanding dust. The third one is thickened with 406 filler then thickened with significantly more wood sanding dust. The fourth one is thickened with wood sanding dust exclusively and is by far the darkest of them all. The dry sanding dust of each wood type is set next to the last thickened epoxy dollop.

When hull interiors are to be finished natural, epoxy fillets are often colored with a blend of thickeners to achieve colors that match the natural color of wood.

One way to achieve a natural brown fillet would be to use our 405 Filleting Blend filler. It is a blend of dry powder fillers designed to produce medium brown thickened epoxy.

You can also make your own color-matched fillets. Some people use sanding dust, taken from their palm sander dust pickup bag after sanding the wood that they are trying to match. If you use sanding dust exclusively however to thicken the epoxy, it will be grainy to work with and it will be significantly darker than the original wood that it was created from.

A better approach is to initially thicken a batch of epoxy with 406 Colloidal Silica filler to a mayonnaise consistency (this will create a translucent white/smooth and creamy epoxy) then add wood sanding dust until you arrive at a color you are happy with. The translucent white color of the 406 filler is easily overcome by the wood sanding dust. Add a little wood sanding dust and you'll get a colored epoxy that is lighter than the wood. Add a lot of the wood sanding dust to the 406 filler thickened epoxy mix and it will become dark. See the photos of three different wood types with four dollops of thickened epoxy on each.

You will discover that if the 406 filler is used to thicken the epoxy alone it gives the mix a translucent white look that will nicely off-set the darkening effect of wet wood flour (sanding dust) allowing you to arrive at a color that perfectly matches the wood tone. To do this well though, you will need to have a varnished wood surface or an epoxy-coated surface to see what the wood looks like as you try to color match the thickened epoxy for making fillets. What the epoxy looks like while uncured is what it will look like after it cures.

So, if a natural wood finish is desired, you can add to the overall beauty and elegance of a glued plywood structure by using color-matched epoxy fillets.

GLBBS 2016

The Employee owners of Gougeon Brothers, Inc. are proud to congratulate the Great Lakes Boat Building School Class of 2016.

Comprehensive Program Graduates (1st year)

Justin Bensley, James Biernesser, Daniel Cinal, Lauren Gaunt, Robert Hankenhof, Sam Hoffrichter, Wayne Marmon, James Nelson, Mark Pugh and Ariana Strazdins

Career Program Graduates (2nd year)

Mark Bilhorn, Caleb Gulder, Sean Libby and Danton Thon.

Photo taken June 3, 2016 at the ceremony.





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

Free literature (US and Canada only)

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

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

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

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

How-to publications

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

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

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

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

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

Contacts for WEST SYSTEM product and technical information

North and South America, China and Korea

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

Europe, Russia, Africa, the Middle East and India

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

Australia and Southeast Asia

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

New Zealand and Southeast Asia

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



Look for Epoxyworks online

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

We came across the historic Rocket ice yacht at the WoodenBoat Show in Mystic, Conn. The Rocket is 50' long, has a 900 sq. ft. sail, and was built in 1888. After many decades of deteriorating in storage and some stop and start restoration



attempts, the surviving parts (cockpit, plank and rudder) were sold to a foundation that formed to restore the historic vessel. In 2003, the Rocket Ice Yacht Foundation of New Jersey purchased what remained of Rocket for one dollar from the North Shrewsbury Ice Boat and Yacht Club. The project was led by boat builder Bob Pulsh, a retired plumber from Port Monmouth N.J. Bob and his team of volunteers used WEST SYSTEM Epoxy to restore and reconstruct the ice yacht's parts. The project was completed in 2014.

Rocket weighs about a ton, and requires ice that's about 12" thick and strong winds to sail. In the right conditions, this ice yacht may reach up to 100 mph.



Readers' projects



Larry Columbo built WILDEST DREAMS, a 30' tall, swan-shaped floating sculpture on his front lawn in Brewster, New York. The unusual watercraft has a cabin that sleeps two just below the neck. The swan's wingspan is 60'. Larry is a commercial artist who has built other boats, including a 16' Viking ship and a 42' Roman Galley. He uses WEST SYSTEM Epoxy.



This Maloof style rocker was built by Ed Kreusser of Corvallis, Oregon. He used fiddleback maple and ebony. The runner bodies are made up of 9 laminations, and their leg platforms have an additional 11 laminations each. All is fused together with G/flex epoxy. He began using G/flex to bond oily cocobolo rosewood, and appreciates the long open time, gap-filling qualities, strength, and creep resistance.

