FREE

GOUGEON EPOXYWORKS®

BUILDING, RESTORATION & REPAIR with EPOXY

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EPOXYWORKS®

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Editor/Designer Jenessa Hilger
Managing Editor/Copy Editor Grace Ombry
Contact/Subscriptions Darlene Auman
Contributors Bill Beran, Bruce Niederer, Daryl Brunette, Dave Story, David Sianez, Don Gutzmer, Grace Ombry, Jon Fox, Matt Assenmacher, Michael Marquis, Mike Barnard, Nelson Niederer, Tom Pawlak

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Mailing address Epoxyworks
P.O. Box 908
Bay City, MI 48707-0908

Email epoxyworks@gougeon.com

***Epoxyworks* Online** epoxyworks.com
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Third place winner at the AutoRAMA 2014 Pedal Car Challenge

Cover Photo: First place winner at MITES at both the regional and state level.

Pedal Car

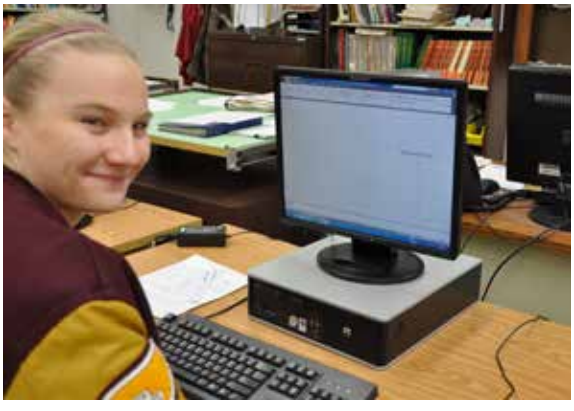
By Jon Fox

For the past two years, the Drafting/Pre-Engineering class I taught at Tuscola Technology Center in Caro, Michigan has been invited to participate in a contest sponsored by Summit Racing. Students build a custom pedal car that is displayed and judged at the AutoRAMA show at Cobo Hall in Detroit. Summit Racing either supplies participating schools with one of their stock pedal cars which can be modified and customized, or students may build their entry from scratch. We constructed our entry from scratch both years. Our first car was inspired by the Delehaye roadster and built of aluminum in an Art Deco style.

This year we made our car look like a 1957 Corvette and constructed it from composite materials. We initiated our design by drawing the wheels full size and in their accurate wheelbase positioning. We then downloaded and printed every 1957 Corvette profile image we could find online and sketched the shape proportionally on the wheelbase layout. Once sufficiently refined, the sketch was converted to measurable geometry and drawn in CAD in multiple 2D (orthographic) views.

Full size CAD drawings were generated and used as patterns for shaping a glued up, rigid foam plug. We carefully shaped and detailed the plug, then layered it with WEST SYSTEM® 105 Resin/205 Fast Hardener and a mix of donated and scavenged fiberglass cloth. Initially the idea was to build a multi-section mold from the plug, but we only had two and a half months so time constraints made it necessary to construct the final body on the plug. When the layup was complete we melted the foam out with acetone. We covered the body shell with gelcoat made of epoxy thickened with 406 Colloidal Silica, 407 Low-Density Filler and 503 Gray Pigment, then sent it to the Tech Center's auto body class for final surface refining and paint.

With the body sent to be finished we turned our concentration to the mechanical aspects of the car. While a '57 Vette would have had independent suspension on the front and a



Full size CAD drawings were generated and used as patterns for shaping a glued up, rigid foam plug.

The plug shaped and over-laid with WEST SYSTEM 105/205 epoxy and fiberglass cloth.

The students manufacturing a part for the car's suspension system

The fiberglass was coated with thickened WEST SYSTEM Epoxy and 503 Gray Pigment.

The Tech Center's auto body class did the final paint job.

traditional straight drive axle on the rear, four wheel independent suspension would become a trademark on future models. Our Pedal car would have independent suspension all around so we designed front and rear cradle assemblies which housed control arms and spindles. The front features fabricated ball joints and shocks. The rear incorporates articulated axle shafts which move with the suspension. Suspension geometry keeps both front and rear wheels vertical through 2" of travel. Nearly all suspension parts were hand fabricated out of aluminum sheet. Control arms were fabricated on hammer forms and welded together.

Additional features include working head, tail and front marker lights compliments of our electronics class. They also added a pair of speakers and an MP3 player. A student designed and etched a printed circuit board and added components to build a power supply and amplifier. Headlight lenses were made by cutting flat plexiglass then heating and forming them over the end of a round metal shaping hammer.

The Corvette has competed at AutoRAMA and both Regional and State MITES conventions. It received third place at AutoRama and first both times at MITES. It represents a huge effort by students from four Tech Center programs and hands-on experience in a broad range of technical specialties. Few students will ever be exposed to a project so broad and technical in nature.

My class was always blessed by the stewardship of people like Tom Pawlak and Joe Parker (now retired) of Gougeon Brothers. Joe has been on our advisory committee for many years and has been a regular guest speaker in the classroom. We're grateful to everyone at Gougeon who has helped us.

Overhead view of the award winning car.

The students created a four wheel independent suspension (left) and installed working head, tail and marker lights as well as speakers and an MP3 player.

National Sailing Hall of Fame

By Grace Ombry

Meade and Jan Gougeon will be inducted into The National Sailing Hall of Fame (NSHOF) in October of 2015. Meade and Jan, along with their brother Joel, founded Gougeon Brothers, Inc. in 1969. They were selected because of their pioneering work in the use of epoxies for boat construction and because each are accomplished sailors.

Meade is still sailing competitively as he approaches age 80; in July of 2015 he raced his trimaran Adagio in the Bell's Beer Bayview Mackinaw race. Annually he competes in the 300-mile Everglades Challenge, a grueling race of small boats powered only by wind or muscle. He came in first in his class (sailing kayaks and canoes) in 2014.

Jan also sailed competitively from age 11 until shortly before his death in late 2012 at age 67. He dominated the DN ice boat fleet from 1971 to 2000, winning 11 national championships and four Worlds. He is the only member of the 2015 NSHOF class to be inducted posthumously.

NSHOF announced that a total of six people will make up its 2015 class of inductees. In addition to Meade and Jan, inductees include sailing school founder Steve Colgate (Ft. Myers, Fla.), Olympic medalist Paul Foerster (Rockwall, Texas), Olympic medalist and author JJ Fetter (San Diego, Calif and U.S. Olympic Yachting Committee Director Samuel V. Merrick (Bay Head, N.J.), the recipient of the NSHOF's 2015 Lifetime Achievement Award.

Meade and Jan on Rogue Wave , a 60' trimaran they built in 1977

Meade and Jan on Adagio , the 35' trimaran they built in 1970

"The six members of the class of 2015 join 42 previously-recognized individuals as the National Sailing Hall of Fame continues to fulfill its mission by focusing attention on Americans who have made outstanding contributions to the sport of sailing," said Gary Jobson, President of the NSHOF. "Those achievements—on-the-water, at a drawing board or in the administration of the sport—have inspired and affected competitive sailors and recreational boaters alike. By recognizing these contributors and sharing their stories, the NSHOF is preserving the history of the sport and its impact on American culture while inspiring the next generation of sailors."

About the NSHOF: The National Sailing Hall of Fame is a not-for-profit educational institution dedicated to: preserving the history of the sport and its impact on American culture; honoring those who have made outstanding contributions to the sport of sailing; the teaching of math, science and American history; inspiring and encouraging sailing development; and providing an international landmark for sailing enthusiasts. The NSHOF has partnered with U.S. Sailing and the U.S. Naval Academy, and is associated with yacht clubs throughout the country, in its efforts to recognize role models of outstanding achievement. For more information on the NSHOF, visit: nshof.org

Techniques for Fiberglassing Overhead

By Tom Pawlak

The prospect of having to fiberglass the bottom of a hull can be a bit ominous. Any type of overhead work can be frustrating, but the thought of trying to hold fiberglass in place while applying epoxy can produce nightmares for some people. This is especially true if you will be working alone.

You can fiberglass overhead alone without going crazy in the process. Having faced this demon in the past we struggled until we found a relatively easy method. The technique is similar to hanging wallpaper. We trim the dry fiberglass fabric into narrow strips like wallpaper and wet it out on a flat surface. Then we roll the wet fabric onto cardboard tubes, carry them to our project and unroll them onto the prepared overhead surface.

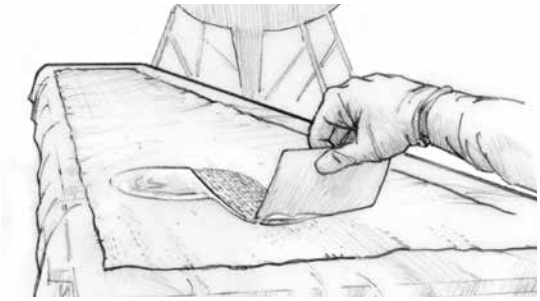
Fiberglassing Large Sections Overhead

1. Precut fiberglass into sizes required for your project. Cut the fiberglass into manageable widths of 24"-30" (half of a standard 4' or 5' wide roll). Roll the dry fiberglass onto cardboard tubes or sections of PVC plastic pipe that are 3"-4" in diameter. Plan to orient the fabric strips vertically, working from the top down. Gravity will work in your favor if you apply the fabric this way. Label the fiberglass rolls so you'll know where to locate them later.

2. Prepare the surface of the project for epoxy. Be sure the surface is clean and freshly sanded.

3. Prepare a flat surface for wetting out the fiberglass by covering a workbench, old door or plywood panel with heavy (6 mil or greater) polyethylene plastic. Ideally the surface should be at least as wide as the fabric, and located close to your project. Having it nearby will help reduce the time between when you apply the epoxy to the fiberglass and when you unroll it onto the project.

Apply a coat of unthickened epoxy to the hull



Wet out the fabric by pouring epoxy onto it and spreading it out with a plastic squeegee

4. Apply a coat of unthickened epoxy to the hull but only to as much area as can be fiberglassed before the epoxy gels. When working overhead, it is especially important to wear gloves, protective clothing and safety goggles to keep epoxy off of your skin, hair and eyes.

5. Unroll a single piece of fiberglass cloth onto the plastic covered work surface. Wet out the fabric by pouring epoxy onto it and spreading it out with a plastic squeegee. Apply a generous coat to ensure thorough wet out of the fibers, but don't use too much because you've already coated the overhead project. Additional epoxy adds weight, increasing the fabric's tendency to fall or slide off.

6. Roll the wet fiberglass fabric onto the pre-cut tubes to allow ease of handling. Carry the fiberglass covered tube to the project quickly. Epoxy generates heat when confined in mass. There is a limited amount of time to apply the fabric before exotherm (excessive heat build-up) occurs. This can result in epoxy-coated fiberglass curing on the tube.

7. Carefully position the fiberglass roll at your chosen starting point. Wear protective gloves. It's generally a good idea to start high and

work low. Unroll 6" of fiberglass from the roll. Press the fabric against the hull. It should stick to the epoxy coated surface without pulling away. Unroll the fiberglass/cardboard tube onto the surface with one hand. Use the other hand to spread out wrinkles and press the fabric against the surface, removing air.

If the roll is not tracking where you'd like, roll some of the fiberglass strip back onto the tube. This will enable you to redirect the fabric slightly by shifting the short section still attached to the hull. Unroll the fabric again making slight adjustments for position along the way. Use the tube like a rolling pin to press the fabric into the surface. Pick up the roll from the surface to stretch the fabric occasionally. This will minimize wrinkles and make the going easier.

Light-weight fabrics will cling to a recently coated surface. Heavier fabrics may require an extra step to get the fabric to stay put. If necessary, after the wet out coat apply a light application of epoxy that has been thickened with 404 High Density filler or 406 Colloidal Silica filler to the hull before applying heavier fabrics. The layer of thickened epoxy gives the wet fiberglass something to nest into and only needs to be put in the top and bottom 4" of fiberglass to help keep the fiberglass from starting to peel.

8. After applying the fiberglass strip, use a plastic spreader to press the fabric securely against the hull. Use this step to draw off excess epoxy and force out trapped air bubbles.

   If additional layers of fiberglass are required, repeat the process. Apply additional layers while the previous layer is still tacky. This saves time and eliminates the normal wash and sand step required if the epoxy were allowed to cure hard between coats.

   You can apply multiple layers of fiberglass like shingles on a roof. The first piece of the second layer should be narrower than the piece below it, followed by normal width strips, so that all of the joints are staggered. Stagger the layers so each edge falls at least 3" from the nearest edge below or above it. The individual strips can usually be butted because the adjoining layer laps the butt joint. Apply all of the strips using the techniques described above. Repeat the process until the hull is covered.

   This technique allows you to stop and start without causing a problem. If you get tired, take a break before wetting out the next piece of fabric. Just be sure to get back on it with additional layers while the previous layer is still tacky. If the epoxy will be past the tacky cure before you get back, consider applying release fabric to the areas. This saves the wash and sand surface prep normally required for bonding to a cured surface.

Unroll the fiberglass onto the surface with one hand—spread out wrinkles and press the fabric against the surface with the other hand.

   If it looks like the epoxy will cure too far before you can apply the remaining fiberglass strips, you can buy more recoat time by rolling on a fresh coat of epoxy while the previous coat is still a bit tacky. The period when a curing epoxy surface or coating is still tacky is the ideal time for applying subsequent layers of epoxy, fiberglass, or epoxy fairing putties.

Applying a Small Patch Overhead

Wet the fabric out on a flat surface covered with heavy polyethylene plastic a bit larger than the fabric patch. Carry the plastic with the wetted fabric on it to the overhead surface. Stretch the plastic and fiberglass fabric in position against the surface.

Smooth the plastic and fabric, from the center to the edges, to remove wrinkles and air bubbles. To remove stubborn air bubbles, puncture the plastic directly above the bubble.

This method is neat (epoxy doesn't drip all over you) and you can leave the plastic in place and strip it off after the epoxy has cured.

Use a plastic squeegee to press the fabric securely against the hull.

Carbon Skinning
Why reinforce with carbon fiber?

By Don Gutzmer

Carbon fiber has a very high strength-to-weight ratio and higher stiffness compared to many other reinforcing fabrics. These special properties make it ideal for applications in aerospace, automotive, military, and even sporting goods. When combined with WEST SYSTEM® Epoxy it can be used to build high-end composite parts.

Although it's one of the strongest and most lightweight materials used in the composite industry, the expense can make it cost prohibitive. To achieve the same look of a carbon fiber part without the cost, a process called skinning/wrapping can be used.

Carbon skinning is often done cosmetically, where the look of carbon fiber is desired but the strength (and expense) of a true carbon fiber composite is not necessary. A part manufactured from a less expensive reinforcing fabric is "skinned" with carbon fiber. It's a popular look on motorcycle parts, car interior panels, and mirrors. In addition to the standard reinforcing fabrics, there are eye-catching hybrid fabrics that are a blend of carbon fiber, Kevlar™, and glass that come in a variety of colors. There are so many different choices of fabrics on the market now, there's one to suit most everyone's needs.

For my project, the use of carbon was to take advantage of its cosmetic appeal. I decided to wrap the fiberglass air scoop for my boat motor with one layer of 5.8 oz. plain weave carbon fiber.

The air scoop coated with epoxy tinted 502 Black Pigmented to prevent the orange from showing through the weave of the carbon fiber

The scoop was originally painted orange, so I needed to make the surface black before applying the carbon to avoid any orange paint from showing through the weave of the fabric. The first step was to sand the painted scoop well before applying WEST SYSTEM 105 Resin and 207 Special Clear Hardener, which was tinted black with 502 Black Pigment. Because this is not a structural application it is acceptable to bond to a well sanded painted surface. The

Wrapping the air scoop with carbon fiber.

The finished air scoop installed, creating the perfect look.

following day I sanded the cured surface dull with 120-grit sandpaper.

The next step was applying the carbon fiber to the scoop. A light mist of spray tack (3M Super 77) held the carbon fiber on the surface and prevented the fabric from distorting and moving. Using too much spray tack can cause adhesion issues, so I used only a little. The carbon fiber was then ready to be coated with 105 Resin/207 Hardener. I wet out the carbon with epoxy then applied multiple

Once the fabric was laying smooth, it was trimmed to size.

light fill coats of 105 Resin/207 Hardener to provide a high quality clear finish. I applied these coats every 3-4 hours with a bristle brush to prevent the epoxy from running.

After the epoxy cured it was wet sanded in preparation for a UV protective topcoat. I had many different topcoats to choose from, but I wanted to keep it simple so I sprayed a couple coats of lacquer to provide the smooth high gloss finish. I'd say the project was a success and turned out looking pretty nice on the motor.

The air scoop wet sanded and ready for the final UV coating.

The Carbon Fiber Look

By Daryl Brunette

Blake Rivard

I was talking to my friend Blake Rivard about doing something different for his motocross bike. We settled on a carbon fiber air filter cover. On his bike the air box sits just below the handle bars where the gas tank usually is. I started with removing the plastic piece and cleaned it so no dirt would be present in the final product. The original air box would serve as a mold for the finished piece.

I cut a piece of carbon to size, then covered the original air box in a mold release. Next I coated the back side of the carbon fiber with a thin layer of WEST SYSTEM® 105 Resin/207 Special Clear Hardener colored with 502 Black pigment to prevent light from shining through the carbon fiber weave.

The air box (above) used as a mold for the new carbon fiber part (right).

When the epoxy was tacky but not wet enough to stick to my glove, I covered the original air box with the carbon fiber like I would a sticker, and smoothed out the fabric. The stickiness of the epoxy allowed me to place the carbon fiber in tight spots and over angles that would otherwise have the carbon fiber lift up. I let the piece cure for another two hours, then applied 105/207 to the topside of the cover. I recoated every two hours until I had four coats applied. I let the new carbon fiber air filter cover cure overnight, then sanded it to knock down the high spots, taking care not to sand into the carbon fiber.

The new air box installed.

After washing it with water and wiping it down with paper towels, I applied four coats of clear coat paint from a can to help protect it in the sun.

Blake qualified for Loretta Lynn's Amateur Motocross Race, which their website describes as "The first step in the world's largest and most prestigious amateur motocross championship race." It's a regional Championship that seeds riders into the national championship. We wish Blake the best of luck in this enduring sport.

Big Jon Needs a Little Help

By Tom Pawlak

Here is the repaired reel installed on its summer home.

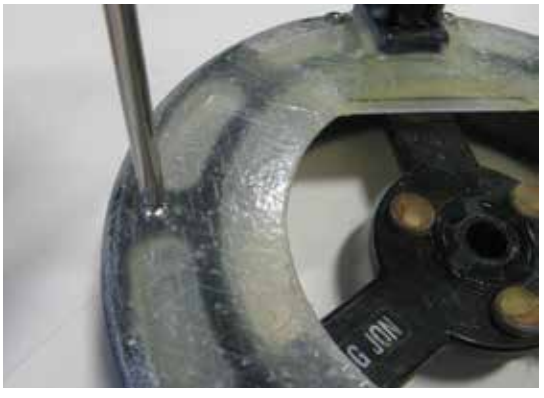
Big Jon (BJ) serves as a reel for retrieving and letting line attached to floating planer boards in and out from the boat while trolling. Planer boards are used to get fishing lures off to the side of the hull so the lures aren't following directly behind the boat while trolling for walleye. The further the planer board is reeled out, the further the lures are from the side of the hull. BJ has served Tom and Lorraine Klinski well but recently developed some cracks in what appears to be a black nylon plastic.

The cracks in the nylon plastic needed to be reinforced before they completely failed.

Knowing that nylon can be difficult to glue I used G/flex to test adhesion after prepping the surface two different ways, 1) by sanding with 80-grit sandpaper and 2) by sanding with 80-grit and flame treating with a propane torch. I glued one end of cured fiberglass strips to the different prepared surfaces and pulled up on the unglued end 24 hours later. I discovered that sanded and flame treated surfaces resulted in superior adhesion compared to surfaces that were just sanded.

Testing adhesion to a strip of fiberglass to determine the best repair method

Unfortunately, I could not flame treat down into the cracks unless I was willing to create gentle bevels along both sides of the crack. In the end, I decided instead to reinforce the reel face by gluing and screwing a thin fiberglass composite laminate across the face of the sanded and flame treated reel face to globally support the reel. The laminate was made of two layers of 17 oz. biaxial fiberglass wet out with West System Epoxy. I added another layer of fiberglass laminate where the handle meets the reel face to significantly reinforce the area.



Screws were used in addition to gluing as an added reinforcement.

I cut and dry fitted the fiberglass laminate and drilled my pilot holes ahead of time.

Like before, the surface of the reel was sanded with 80-grit sandpaper and flame treated just prior to applying G/flex 650 (the liquid version). The cured fiberglass composite was cleaned with alcohol and sanded with 80-grit just before applying G/flex 650.

The screws were installed in the pre-drilled holes to hold everything together during the cure and left in place for extra support.

The G/flex was allowed to cure, the part was cleaned, sanded dull and painted with a black gloss auto paint.

G/flex Epoxy was used to adhere the fiberglass ring to the reel face.

For more information on testing adhesion to unidentified plastics, see "Plastic Engine Cover Repair" by Jeff Wright in Epoxyworks 28.

The reel face painted and ready to be installed.

Hartland Boatbuilding

By Matt Assenmacher

As summer approaches, keeping students interested in learning while wrapping up the school year can be a challenging task. I teach mechanical engineering at Hartland High School in Hartland, Michigan. My students learn the principals of technical design through a fun, hands-on, year-end design project.

Each spring, the students design and build lightweight boats out of a 4' x 8' sheet of lauan plywood. Before construction, the students must successfully design and build a scale prototype of a boat out of balsa wood. Through this process the students discover the limitations of the design based on the materials that are used. It also helps them understand how all of the pieces work together to create the entire boat.

The students are then divided into groups of three. Each group is given a sheet of lauan that they will use to create the patterns for the sides, gussets, and transom of the boat. The groups use a jigsaw to cut out the patterns, then drilled and zip-tie the sections together to form the general shape of the boat. The gussets are then installed along with side rails in order to improve the overall strength and shape of the boat.

The students worked in teams of 3 to cut out the patterns (above) and assemble them (right) with the stitch and glue technique.

The students testing out their handy work on the creek behind their school.

To make the boat watertight, all edges are sealed with WEST SYSTEM® 105 Resin mixed with 206 Slow Hardener and 2" fiberglass tape was applied to the seams. The epoxy is cured overnight. The next day, students turn their boats over and fill the inside seams with a combination of resin, hardener and 404 High-Density filler. Once again, the epoxy must be cured overnight. The following day the students patch and complete any overlooked areas.

The boats are then ready to set sail on a creek behind Hartland High School. Students launch their boats to test whether they'll float. This year 25 boats successfully floated on the creek. Students, teachers and other school employees typically come out to watch this fun event. All of the boats travel up the creek (about ¼ mile away) to a second dock where the students can then pull their boat out of water.

I have been doing this project for the past five years. I inherited the idea from a former Hartland teacher and mentor, John Naughton, who had done this project with his students since 2002.

There are many types of boat building projects for the classroom setting. Some plans call for alternative materials, such as cardboard, plastic or other wood laminates. The WEST SYSTEM products ensure that the joints are sealed in order to allow the boats to float properly. It is a fun project for the students and a great way to end the school year.

Launching the newly built boat

That's a Fact!

Useful information about West System Epoxy

By Mike Barnard

Using Gelcoat over West System

It's a myth that if you plan to gelcoat over a repair, you must make the repair with polyester. We've used gelcoat over epoxy for decades, shown it in our instructional videos on repairing fiberglass boats, and discussed it in past issues of Epoxyworks.

There are three key factors for success with gelcoat over epoxy. First, the epoxy needs to be mixed on ratio. Second, it should be fully cured, and third, the should be free of amine blush before applying gelcoat.

Gelcoat manufacturers shy away from approving the use of non-air inhibited gelcoat over epoxy because they're concerned amine blush will interfere with the gelcoat's cure. All that's required to remove the blush is washing the surface with plain water. The resulting surface is inert epoxy that can be sanded to accept paints and gelcoats.

Release fabric can also be used to remove amine blush quickly and easily. As the epoxy cures the blush forms on the outside of the release fabric. When the release fabric is removed it takes the blush with it and the resulting surface is ready to be prepared for paint or gelcoat.

Epoxy's Penetration into Wood

Epoxy does more than sit on the surface of wood. Some of the epoxy will remain on wood surfaces, and some of it will penetrate into the wood. The amount of penetration depends mostly on how the wood fibers are oriented. Face grain will not absorb nearly as much epoxy as end grain. But since West System Epoxy® has very high strength and excellent adhesion, it strengthens the wood and makes it water proof.

Epoxy Batch Size and Cure Speed

In larger quantities, epoxy will cure much faster. This is because epoxy generates heat as it cures and also cures faster at higher temperatures. This snowball effect increases until the epoxy cures—which in very large batches could be as short as a couple of minutes. Large pots of mixed epoxy can generate enough heat to cause a runaway exothermic reaction, smoking, melting the mixing cup or even starting a fire. Spreading epoxy thin allows the heat to dissipate and slows its cure.

Epoxy Casting and Shrinkage

West System Epoxy has a very low percentage of shrinkage. In fact, the standards used to measure shrinkage of other resins (polyester and vinyl ester) cannot be used with West System because it shrinks so little.

When epoxy is used to fill holes drilled into wood, it soaks into the end grain and this can give the appearance of shrinkage.

Back in the late '70s and early '80s, Gougeon Brothers, Inc. manufactured over 4,000 wind turbine blades and their molds using West System Epoxy. It was commonplace to see a 70-foot long mold shrink 3/32" over the entire length. That is shrinkage of .01% on a laminate consisting of fiberglass and West System Epoxy.

When casting epoxy, heat buildup can become an issue. Excessive heat can make West System Epoxy shrink some. Pouring epoxy in great depths creates the potential for the epoxy to get very hot due to the exothermic reaction resin and hardener have. The shrinkage that does occur generally happens while the epoxy is still liquid, but when an intense amount of heat is present, epoxy doesn't stay liquid for very long. As the heat dissipates, the difference in temperature between the top and bottom of the casting can shock the now solid epoxy and it may crack. This can be avoided by making deep castings in layers.

Adding Sawdust to Epoxy

While it's possible to add wood sanding dust to epoxy to change the color and viscosity, it does pose a risk when bonding to an absorbent substrate like wood end grain. Adding wood dust to epoxy doesn't increase the viscosity; the epoxy is just being absorbed into the wood dust leaving it free to drain back out on absorbent surfaces. For example, if you blend sawdust into epoxy to achieve a peanut butter consistency and place the mixture on a dry paper towel, you will notice that the paper towel soaks up a lot of epoxy as it cures. Because the sawdust is not actually thickening the epoxy the way our fillers do, the epoxy runs out of the mixture with ease. If this mixture were used on a joint, given enough time, the epoxy can drain out of the sawdust creating a glue-starved joint with a puddle.

An exception to this is our G/5 Five-Minute Adhesive. It is more viscous to begin with, remaining liquid for only about five minutes, so there is not enough time for the epoxy to drain out of the added wood dust fibers.

With products like 105 Epoxy Resin and 205 Fast Hardener, a more reliable way to thicken epoxy is to add 406 Colloidal Silica. The particles interact with the epoxy rather than absorb it, thus increasing the viscosity of the epoxy. Then a very fine sanding dust or wood flour could be added to tint the mixture if needed.

On the left is epoxy mixed with our 406 Filler. On the right is epoxy and sanding dust mixed to the same consistency as the filler. Notice the puddle of epoxy draining out of the epoxy/sanding dust mixture.

Adding Extra Hardener

While adding extra catalyst to polyester resins can lead to faster cure, it doesn't work to add extra hardener to epoxy. Epoxy reaches cure when the resin molecules crosslink with hardener molecules. When there is too much of either resin or hardener, unlinked molecules are left, which can result in uncured epoxy or compromised cure strength. Always be sure to mix resin and hardener as close as you can to the recommended ratio.

Clamping Force

Unlike traditional wood glues, WEST SYSTEM Epoxy is stronger than wood. Because of this, it is beneficial to have some epoxy between the objects you are gluing together whether they are wood, fiberglass or other materials. As long as the epoxy is contacting the entire surface of both substrates, no clamp pressure is needed. With epoxy, the goal when clamping is to simply ensure the epoxy contacts the entire surface for the duration of the cure time. Moderate clamp force is all that is required. Using high clamp pressure may cause glue starved joints, especially when using unthickened epoxy. Glue starved joints are weaker than their counterparts. Avoid glue-starved joints by following the one- or two-step bonding method described in the WEST SYSTEM *User Manual & Product Guide*.

Filler and Epoxy Strength

While certain fillers will increase the density of epoxy, this does not correlate to higher physical properties or increased adhesion strength. Epoxy is strongest without filler added to it, but the fillers are necessary to increase the viscosity of the mix, prevent the epoxy from soaking too far into the wood, bridge gaps and prevent glue-starved joints.

Epoxy and Rotted Wood

Rot eats away the cellulose fiber in wood. Since cellulose is the structure of the wood, replacing it is not as simple as brushing on a coat of solvent-thinned epoxy. Solvented epoxy can restore some of the strength, but it isn't a permanent repair because it won't restore the strength of the wood fibers. In order to make a permanent repair, the entire rotten area should be replaced with fresh wood and sealed with epoxy. Doing the repair in this manner may actually make the repair area stronger than it was before the rot occurred.

Rot needs four major components in order to continue growing: food, moisture, oxygen, and warmth.

Cutting off one of these components is enough to cause the rot to go dormant. Solvented epoxies are supposed to cut off rot's food source by encapsulating and contaminating the wood that the rot spores consume. The remaining three components: moisture, oxygen, and warmth, can still penetrate the wood coated with solvented epoxy. This is because solvented epoxy is a poor moisture barrier. Rot spores will remain in the wood, and even when encapsulated in solvented epoxy, they will only go dormant. The spores that are not isolated will continue to devour the cellulose and "rot" the wood. This is why we recommend removing the rotten wood and replacing it with fresh, rot-free wood that is sealed with a few coats of WEST SYSTEM Epoxy.

Big Nose Pete

Male Mold Plug and Composite Shell Construction Techniques

By David M. Sianez Ph.D.

Composite shell construction became a pursuit for me following a visit to the Smithsonian National Museum of American History. While walking through the exhibits I came across a human powered speed vehicle called *The Gold Rush*. It had been ridden by cyclist Fast Freddie Markham, the first person to exceed 60 mph on a faired bicycle. Going that fast under human power alone was an idea that challenged me, and developed into my passion.

Figure 1.1 - Human powered vehicle "Big Nose Pete"

After many years of pursuing techniques for mold plug creation and composite shell construction, I've developed a method that is inexpensive and fast. It calls for sheets of rigid foam insulation stacked and screwed in multiple layers to achieve a desired mold shape, then covered with multiple layers of carbon fiber and Kevlar cloth. WEST SYSTEM® Epoxy is used to bond the composite structure and cures at room temperature.

The step-by-step process is illustrated here through the construction of a speed trike called *Big Nose Pete* (Figure 1.1). *Big Nose Pete* was designed to compete at Battle Mountain, Nevada in the 2013 World Human Powered Speed Championship. It is a tadpole trike (multi-track category) with two wheels in the front and one drive wheel in the rear. All three wheels are 29-inch with the rider in a recumbent position. The top speed for this vehicle was 46.5 mph.

Thousands of students from secondary schools and universities compete yearly in national and international vehicle competitions designed to provide academic content with hands-on design and building experience. This offers students an opportunity to explore, succeed, fail, re-design and get experience with Computer Aided Design (CAD), Computer Aided Manufacturing (CAM), machining practices, 3D printing, composite construction, materials analysis, aerodynamics and welding. Giving students a common goal that incorporates science, technology, engineering, art, and mathematics expands their education.

This article will explain how we construct composite shells for vehicle competitions efficiently and effectively in the face of common limitations on time, finances and skill levels. The techniques discussed here are by no means the only way to build mold plugs, but they have been refined through trial and error over many years and have proven appropriate for single-product composite shell construction.

Figure 1.2 - Rider and support crew for "Big Nose Pete" at the 2013 World Human Powered Speed Championship held in Battle Mountain, Nevada.

Figure 1.3 - Male mold plug constructed from 2 inch thick foam sheets.

Mold Selection

Both male and female molds can be used to create vehicle shells. The major difference between a male mold and a female mold is what side of the finished product will have a smooth surface.

When you apply fabric over a male mold (Figure 1.3) the interior of the part will have a smooth surface. Fabric laid over a female mold (Figure 1.4) results in a part with a smooth exterior. The choice for building a vehicle shell seems obvious: a female mold for a smooth exterior. However, we soon discovered that this isn't necessarily the most logical decision.

Building a female mold is typically a two-part process that begins with constructing a male mold plug and then using the male mold plug to create the female mold. Unless you have access to high-quality CNC equipment that will allow you to directly create a female mold, you are stuck constructing the male mold first.

This is where real life steps in. Designing and constructing vehicles for competitions is usually done in a one-year cycle. Your team has a finite amount of time to design, build, test, fix, and prepare the vehicle for the event. An academic year is much shorter than 365 days due to summer break and other obligations like going to class. Factor all of this into your decision, and remember to include the skill set of the group of individuals working on the project. Consider also that the team will want to implement new designs on a regular basis, so the female mold will most likely be used for no more than two years before being discarded.

If you do decide to create a female mold, expect to spend more time and resources during the mold construction process but your final part will look more like a finished product.

Keeping these factors in mind, especially time constraints, I build most shells over male mold plugs. The finished product requires additional exterior finish sanding to create, but the time savings is a major benefit. The method covered here is the construction of a single-use male mold plug that will be destroyed when it is removed from the final shell in what is called a lost mold process. (This is the same process used in *Pedal Car* on page 1.)

Figure 1.4 - Female mold with left and right halves built with WEST SYSTEM Epoxy and 404 High Density filler

Materials Selection

The materials you select to create molds will depend on your abilities, funding, time constraints, and the machinery you have on hand. The key is finding materials that are easy to work with and don't cost a fortune. Many molds can be constructed from inexpensive and readily available materials such as paper, plywood, foam and aluminum. Other materials may require special ordering and delivery.

Unless you are planning on performing production runs with your mold you will probably use it once, then it will take up space in your work area. Building a mold is time consuming and challenging, and when you're done they can be hard to get rid of. Only spend as much money as needed to complete your mold to the required specifications for the specific project. Keep in mind that many projects have been doomed by cheaper materials that quickly warp or disintegrate.

For *Big Nose Pete* we used Owens Corning FOAMULAR® insulation board, 2" thick and 8' long by 2' wide. This reasonably priced material is easily machined and hand sanded. Other companies offer similar products in different colors which work equally well. Thirty sheets of foam were required to construct Big Nose Pete at a total foam cost of $600.00. When purchasing foam, look over each sheet to avoid damaged pieces. I like to purchase an entire pallet that is still shrink wrapped. The top pieces may be a little deformed from the pallet straps, but the rest of the foam is typically damage free.

Tools Selection

We all like tools that make the job easier, more efficient, and precise. The first vehicle mold our team created was built using common hand tools. That mold took one year to build with hundreds of construction hours and assistance from many people. It was essentially carved by hand with

power tools and Stanley Surform® planes and shavers. With CNC machines and experience, that same job can be performed in less than 30 hours.

Speed versus cost is always an issue. You can hire someone to build your mold plug design and get it done quickly or you can spend the time building it yourself and save some money. The same applies to the tools you purchase. An appropriate CNC machine is expensive but will save you a tremendous amount of time after you learn how to use it. The shaping method you choose will be determined by the tools you have available and your skill set. There are many high schools, colleges, universities and pattern maker shops that have CNC machines capable of machining molds, but you may have to take a class or pay a nominal fee to get access to these resources.

Safety Considerations

Safety is more important than the finished product. Be aware of any health hazards associated with the materials you select to construct your molds and final designs. Read the safety data sheets (SDS) prior to using any material. If you are working with high school or college students be diligent about health and safety precautions. Young adults may not recognize the long-term health risks that can be associated with short-term exposure to some materials or chemicals. Provide guidance and set good examples with personal protective gear and proper clean up and disposal procedures.

Working Environments

An appropriate workspace is vital to project success. Whether your crew is working in a closet or has an entire building, the work area must provide proper lighting, ventilation, dust collection and enough space to accommodate the task at hand.

Time Management

The amount of time needed to complete this type of project is often underestimated. One seasoned race coordinator told me that design and engineering competitions were actually time management events. The successful teams learn what can be accomplished over the allotted time frame and select reasonable objectives that will allow them to finish a vehicle and compete at the event. There is nothing more disappointing than spending all of your spare time on a project over the course of a year and coming up short on time and being unable to compete. Time management is the main event.

Figure 1.6 - Sheets are stacked and held in place with weights prior to fastening with 3" screws

Figure 1.5 - Platform used to keep foam sheets from warping during assembly

Mold Plug Construction

A male mold plug was used to create *Big Nose Pete's* shell with Owens Corning FOAMULAR insulation board that was 2" thick and 8' long by 2' wide. Thirty sheets of foam were CNC machined on a 4'x8' router and then stacked and joined with 3" exterior grade deck screws. The widest section of the mold was greater than 24 inches so each layer was made from more than one foam section when required.

CNC Machining

The mold plug was designed using a CAD software package to create a three dimensional solid model. The CAD model was sliced horizontally into sections 1.8 inches thick in preparation for machining the 2-inch thick foam sheets. The CNC router table has a vacuum system that holds down the pink foam and keeps it flat to the table while cutting it with a ½ inch ball end mill. Once each piece is shaped, the top surface of the foam is machined down flat to bring the thickness from approximately 2 inches to exactly 1.8 inches thick.

Joining Layers with Screws

I used to build molds by gluing together each horizontal section to prevent movement and misalignment. This was a messy process that made it difficult to remove the solid mass of foam from the shell. I switched to 3" deck screws to join each layer of foam together. They go in quickly and hold really well. This is a rapid process and allows a layer to be easily removed if

Figure 1.7 - Screw heads filled with drywall joint compound.

Figure 1.8 - Upper and lower plug sections separated following final sanding.

there is an alignment issue or machining error. It also speeds up the removal process.

A stable platform is created from MDF or other similar material (Figure 1.5.) and provides a flat surface for the first foam sheet to rest on. This is vital to prevent the mold from warping or curling. Once a few layers are attached together, movement is minimal due to the rigidity of the foam sheets.

Each layer is weighed down (Figure 1.6) prior to screwing in order to maintain a flat surface throughout the assembly process.

Fairing the Foam Plug

The mold sections have been screwed together and are ready to be faired. Take care not to dig into the mold when moving it (fingernails and tools) or take too much material off while sanding. Errors can be fixed at a later stage, but means more time spent working on it.

I was an automotive paint and body man in a past life and those skills are relevant at this stage. Your final finish will depend on a number of steps in this process and a lot of sanding. This is not hard work, but it requires patience. Pick up a long board sander from an auto body and paint shop, and 100 grit sandpaper. The long board helps keep the mold plug straight and true while you remove machining marks and raised areas on the foam.

There will also be low lying areas and recessed screw head holes on the mold plug. These are easily filled in with drywall joint compound (Figures 1.7). Use it sparingly and remove excess compound with a moist sponge before it dries. The compound sands off rapidly like dust, so use a light touch. A second or third application may be required to fill up an entire area.

Once the plug is faired, the upper and lower sections can be separated (Figure 1.8), the plug can be waxed for easier eventual removal and then Kevlar and carbon fiber cloth can be applied.

West System® Epoxy

All of the lamination and fairing processes we used with *Big Nose Pete* were done with West System Epoxy, additives and application tools. Cost, availability, dependability, ease of use, and customer service are just five of many reasons I continue to use the product line. Please refer to the West System *User Manual & Product Guide* for proper usage and disposal procedures.

One thing that will enhance your experience is a mobile epoxy cart (Figure 1.9) that contains all of the epoxy supplies to create your shell. This will save you much time searching for supplies and allow you to bring the epoxy to the project versus the project to the epoxy. The cart need not be fancy but must provide a stable platform that will not flip over when in motion. You can build a custom cart or re-purpose an existing one.

After the foam plug assembly was sanded to create the desired final look and shape, the plug was covered with one layer of Kevlar cloth and two layers of carbon fiber cloth to provide a durable and strong shell in the event of a rollover. West System Epoxy was used to bond all the composite materials at room temperature. The exterior of the shell was faired with West System Epoxy blended with West System 410 Microlight fairing compound to achieve a uniform smooth finish.

To see the full gallery of photos for this project, visit:

Epoxyworks.com/big-nose-pete

Figure 1.9 - WEST SYSTEM Epoxy products organized on a rolling cart.

Michael at Breck before the board was damaged.

Snowboard Repair

By Michael Marquis

At the end of the season this year while riding in a local terrain park, I misjudged the approach to a pipe and ended up crashing the nose of my snowboard into the end of the pipe. Fortunately, I was able to ride away from the impact. Later in the day, I noticed that the nose of the board had been deformed. When I got home, I studied the damaged area closely and determined that it was not safe to ride the board in that condition. The entire nose area had become soft and flexible because much of the wood core in that area had been broken. In addition to the bent nose edge, the top sheet had cracked. Left as is, this would have allowed water to penetrate to the core of the board which would have made it irreparable. The technicians at my local board shop told me it could be repaired but cautioned that I needed to use an epoxy that remains flexible after it cures to prevent the repair from breaking.

I found West System on the internet and was drawn to their epoxy because it was slow cure and remains flexible. I contacted West System® Technical Advisor Don Gutzmer via email and asked if this epoxy would work on snowboards (all of the write ups I saw were for boat repairs). Don assured me that G/flex would perform as needed at the temperatures that the board will see.

After planning out the repair process in my head for about three days, I began to actually make the repair.

Bending the metal edging back to its original shape

I clamped a steel plate to the underside of the board with 3/8" wood shims between the plate and the board. This allowed me to use a C clamp and over bend the board and edging. After

Below and right: Shots of the damaged area before beginning the repair

A C clamp, shims, and a metal backer plate were used to straighten the damaged area before gluing back together.

several attempts, I was able to get the shape close to what I wanted.

Cleaning the damaged area

The broken wood fibers and loose debris in the damaged area needed to be cleaned out before the repair could be carried out. I did this by inserting a chisel and then a pair of screwdrivers between the layers at the damaged section of the nose. I was able to pry the layers apart slightly to allow me to use a pick to remove the loose debris (wood fibers).

Masking and planning a clamping scheme

I applied several pieces of masking tape next to the repair areas to prevent any epoxy that squeezed out from adhering to the decorative top sheet. Once the protective tape was in place, I planned how to best apply pressure to the repair. After several trials, I decided to use a combination of spring clamps and C clamps. I wanted to keep pressure on the repair, but not squeeze out all of the epoxy.

Mixing and applying the epoxy

The 650-K Aluminum Boat Repair Kit had everything I needed for this repair including the resin, hardener, mixing cups, gloves, and a syringe for inserting the mixed epoxy deep into the repair area. I followed the instructions on the repair kit. G/flex 650 epoxy was ideal for this repair because it remains flexible in the temperature ranges that my board will see in the winter and bonds very well to dissimilar materials.

After thoroughly mixing equal parts resin and hardener, I poured the mixture into the syringe. I gently pried the snowboard's top and bottom sheet apart with a screwdriver and stuck the long thin nose of the syringe as deep as I could into the damaged area. The syringe allowed me to apply the epoxy much deeper into the repair area than I could have managed with an applicator stick. Once the epoxy completely filled the damaged area, I worked the screwdriver back and forth in an attempt to get the epoxy to flow even further into the damaged area.

Clamping and allowing the epoxy to cure

With the epoxy in the repair area, it was time to apply the clamps. I started with spring clamps as far away from the edge as I could place them. I then used additional spring clamps and C clamps closer to the edge. As I was clamping the board, epoxy started to squeeze out around the nose. I wiped away the uncured epoxy and left the board standing upright for about 35 minutes (the epoxy has 75 minute working time). I then placed the board on my bench, face-side up. I applied a thin coating of epoxy to the cracked top sheet between the pieces of tape I had placed on the board earlier.

Spring clamps and a couple C clamps were used to exert the right amount of pressures for a strong repair.

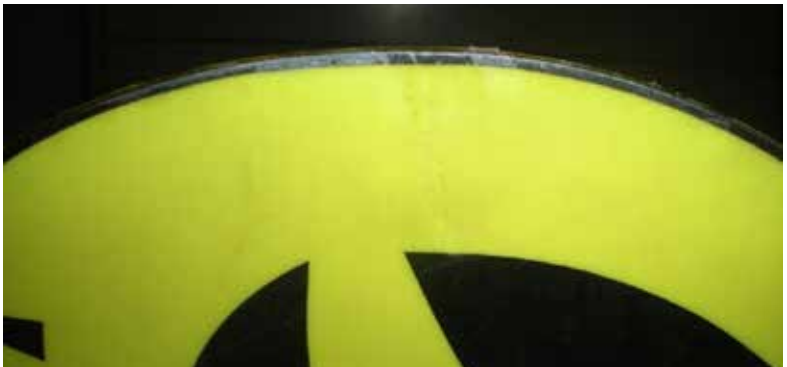
Removing clamps and cleaning up the repair area

After allowing the board and epoxy to sit for 24 hours, I removed the clamps and tape. I was able to use a razor knife to clean up the epoxy that had squeezed out of the joint.

After the repair was completed the area has cleaned up nicely. If you look closely, you can spot the repair, but it is nearly invisible from more than two feet away. The entire nose area of the board has stiffened, but has roughly the same flexibility as the tail of the board. I am extremely happy with the results.

I'm looking forward to testing the board on the snow next winter. I did several nose presses on the grass and the board felt and performed like new.

The repaired board looking almost as good as new



Part One

VAN DAM CUSTOM BOATS

By Bruce Niederer

In this issue I begin a two-part series that will feature a custom boat project being built at Van Dam Custom Boats in Boyne City, Michigan. We featured a Van Dam boat built in *Epoxyworks 14*, the beautiful and unique *Alpha Z*. We want to give our readers a glimpse into what is currently happening at this world-class boat shop.

I traveled to Boyne City in early May and was graciously greeted by Steve Van Dam, the owner and founder of the company. We chatted as Steve showed me around. He introduced me to the guys working on various projects including a modified Sandbagger sailboat and a 32' VZ custom power boat reminiscent of *Alpha Z*.

We then went into the room where the *Limousine* was sitting. There were a couple guys working diligently on it installing one of the engines and fitting other various components. There certainly is no moss growing under anyone at this shop. Steve expected the boat to be completed and launched fairly early this summer. But this story begins much earlier, in autumn of 2014.

Limousine Build

The build begins by constructing a strong-back and ladder frame. Steve explained that they like this method because it quickly allows for the station frames to be installed with the basic hull shape in place.

Always multitasking, while the station frames were being installed the transom was being laminated and vacuum bagged in a jig.

This is a view from the bow with all the frames in place. The boat is now ready for installing the keelson, bulkheads and spreaders.

We see here the bulkheads and "girders" installed viewed from the port side. There are two girders (stringers) mounted 1' off center on both sides. Notice the guy working on the installation–his head is where the keelson will go along the centerline. The frames are removed to install the girders. The permanent bulkheads are also in place.

The battens are installed and faired on both sides of the hull. Dave Snyder checks the fairness of his work. He hand planed high spots to keep the contours of the battens exact. The first layer of plywood is already dry fit and nailed in place temporarily on the bottom.

The second layer of plywood is dry fit by Justin Halteman and secured to the bottom temporarily to insure uniformity and structural integrity. Both courses of plywood planking will be removed and bonded with epoxy in the exact position as initially placed.

Good quality Honduran Mahogany is getting harder and harder to find. Van Dam buys entire logs or even entire tree trunks from sources developed over many years of building boats. These slabs are 2"x12"x15' and will get run through the band saw to a thickness of ¼" then planed to 3/16"+. These planks become the show planks on the hull. When complete, the show planks will match on each hull side port and starboard.

Before the final "show planks" are bonded with epoxy to the hull, templates are made and placed on the hull to make sure the characteristics of the wood are uniform and parallel to the lines of the boat. Each of the templates are numbered to make sure that the planks, when cut using the templates, are placed in the exact position as they were intended. Chad James is seen here hard at work making the templates.

With the bottom and the show planks glued on, stain is now hand processed prior to the application a of clear coat using West System® 105 Resin and 207 Special Clear Hardener to protect the hull during the roll over process and while the build continues.

Typically the bottom gets glassed with either 2 layers of 6 oz. cloth or 1 layer of 10 oz. cloth.

The rolling of the *Limousine* begins. Large eye hooks fore and aft are used to secure the belts during the roll. Steve Kim and Michel Berryer control the boat as it's rolled.

Now that the boat is right side up, interior structure and deck framing are fitted and installed. You can see the bulkheads and battens that were installed while the boat was upside down.

The deck consists of ¼" plywood bonded with epoxy to the deck frames followed by mahogany deck strips. In this photo you can see both the plywood underlayment and the mahogany decking as it gets planed smooth by Ben Van Dam and Chad Buras.

Another look at the interior structure and battens showcases the craftsmanship of the Van Dam crew.

The Van Dam crew all apply stain by hand to get it done quickly. Steve hires graduates from The Great Lakes Boatbuilding School in Cedarville, Michigan; The Landing School in Arundel, Maine; and the Northwest School of Wooden Boat Building in Port Hadlock, Washington. Each of these schools turn out quality trained boat builders and each has been featured in an Epoxyworks article. Hard at work staining are Trevor Brazell, Dave Snyder and Chad Buras.

To finish part one of this two part series, I'll end with a photo of a custom built stainless steel Cutwater built in the Van Dam metal fabricating shop, a fairly new addition to the business. Jess Brown checks the fit during installation.

In part two, I will cover the build starting from where we stopped in this issue. You'll see the cabin top, steering/nav station, the engine and electrical systems installed, finish applied and the completed boat.

The 16' runabout cruising along at about 35 mph

The Lemniscate Hull, a Chineless Gull Wing

By Bill Beran

I built this 16' runabout in my garage over the course of a few years. It was the culmination of an idea I long had for a design that would provide a soft ride with its deep vee hull, but at the same time exhibit excellent fuel economy. It's best described as a chineless gull wing. The hull shape captures and efficiently redirects otherwise wasted bow wave energy downward to create lift. It also safely captures ram air under the "wings" (noticeable starting about 40 mph) and attains a comfortable top speed close to 50 mph with the 115 hp outboard motor.

The boat is essentially plywood construction glued together with WEST SYSTEM® 105 Resin and 206 Slow Hardener, thickened with 404 High-Density Filler. It is also fastened with stainless steel screws. The internal structure in the higher stressed transom area has its thick plywood intersections reinforced with epoxy-glued 1 ½" wood gussets. For thinner parts, I reinforced the epoxy glued joints with epoxy thickened with 405 Filleting Blend. I also used epoxy and 407 Low-Density Fairing Filler to fair the hull surfaces.

It's configured as a hull within a hull, with all enclosed spaces between the hulls filled with pour-in-place 2 lb./cu.ft. urethane foam to make the boat virtually unsinkable.

Having designed and constructed seven other types of boats over the years, I paid a lot of attention to durability by encapsulating all exposed wood with 6 oz. fiberglass and five coats of 105 Epoxy using either 206 Slow Hardener or 207 Special Clear Hardener. On the hull bottom, I impregnated the last two coats of epoxy with 423 Graphite Powder. This gave me the black color I wanted and also provided long-term UV protection for the epoxy without the need for paint. The rest of the boat is painted with two coats of "Mist Gray," a one-part polyurethane to protect the epoxy and reduce the surface temperature when in the sun. The transom, dash, and a few other areas are finished bright (not painted); these have a #0000 steel wool surface finish with UV-inhibiting wax coating protecting the epoxy.

Bow cavity filled with foam and rough cut in preparation for sanding it fair (total amount of foam in boat gives a buoyancy of 3600 lbs)

Normally kept trailered in my garage, the boat looks, sounds, and feels as good as it did when launched in the fall of 2012. I expect to see these qualities extended for many years to come, derived in no small part to the commendable caliber of WEST SYSTEM products.

The windshield frame and its bracing in the final stages of laminating.

The Restoration of *The Rebel*

By Nelson Niederer

In March of 2013, after 42 years, my Mom and I sold the family business, a party store, that she and my Dad started in 1971. I was still in high school when I started working for my parents, and as a result, I have never filled out a job application or been to an interview. At 56 years old I wasn't about to start now! So in the spirit of following one's own path I turned my hobby into a new business and opened Nelson Niederer Woodworking.

My wife Jodi and I converted an old laundromat building on Broadway St. here in Bay City; finally, I had my name in lights on Broadway. Previously my garage served as my shop. Many of you will appreciate the routine—unplug the table saw and move it to plug in the planer, etc. Now I have the room and power to have all the power tools plugged in at the same time.

Bob Reed, a friend and old customer from our party store days came to visit my new shop and asked me to restore a 1964 Chris Craft Super Sport 17. The story behind this particular boat is quite a tale. While Bob was growing up, his family had a '64 Super Sport 17. He had fond memories of learning to ski behind it. Now, at 52 years old, he has reached a point in his life where he has the resources to find, purchase and restore a boat like the one from his childhood memories. He found a promising prospect on eBay right here in Michigan and checked it out. The owner gave him all the old paperwork he had for the boat. In the owner's records he found his family's name—this was, in fact, the exact same boat he grew up with! Forty six years later it's back in the family.

The emptied boat before work began

We started the restoration in the end of February 2013. I hadn't yet moved into my new shop so I rented some shop space. The first chore was to strip everything to the bare hull—engine, seats, and windshield—everything, in order to flip it and start on the bottom first. The flip proceeded smoothly with a little help from my friends. You can find a time lapse video on YouTube (just search William Bauer/Rolling Chris Craft). The bottom was trashed. The previous owner had hit something and drove the prop up through the bottom of the hull. The strut and rudder were broken off. The motor had, for a lack of a better term, blown up and spewed oil throughout the bilge. The boat was left in this condition, covered with a tarp and parked in a building for 18 years.

The boat rolled over with half of the bottom removed.

Now with the boat upside down we began the tedious chore of disassembling the bottom. The bottom is mahogany planks over a plywood underlayment. Removing over 1600 slotted screws was quite a chore—some came out easily while others had to be drilled out. We soon discovered that a plug cutter was the best tool to cut around the head of problem screws which allowed us to pull the screws out by grabbing the heads with vise grips. We numbered and saved the mahogany planks as templates for making new planks later. The plywood was nailed to the frames, a common practice in 1964, which made it difficult to remove them intact to save as templates.

With the bottom removed we stripped and sanded the inner hull sides to bare wood. The

longitudinal stringers had some small rotted areas so we dug out the bad wood and filled it with 105 Resin and 206 Slow Hardener thickened with 406 Colloidal Silica and coated the interior with 105 Resin and 207 Special Clear Hardener. Once the epoxy was cured and sanded we painted the entire interior with Chris Craft mahogany bilge paint.

Now it was time to reinstall the bottom beginning with new Douglas fir plywood. The sections were cut to shape (using the old ones as templates) and coated with two coats of 105/207. We paid close attention to the edges where all the end grain is. The sections were then dry fit and holes drilled for the new SS screws. Next we removed the fitted plywood sections in order to apply glue and then bond them to the stringers and chine log using G/flex 650.

The next job was to cut new mahogany planking for the rotted pieces using the old planks as templates. I decided that the first plank on each side needed replacing, so we removed the old ones and cut new ones. These planks went on before the bottom planks, getting glued to the chine log with G/flex 650. After dry fitting and making any necessary adjustments we installed the bottom planks by applying G/flex 650 to both the plywood and mahogany. These planks were all edge glued together as well.

We cleaned all the seams on the hull sides using a custom tool our friend Bill Bauer loaned to us. Once all the seams were opened we installed mahogany splines using 105/207, hammering them gently into place.

The next day we used a sharp chisel to trim the excess spline sticking out.

After two weeks of intensive stripping and hand sanding, always in the direction of the grain fore and aft, what I had was a bare hull ready

Rotted wood planks restored with new boards.

The bottom of the boat restored with new plywood (above) and the reinstalled and new mahogany planking (right).

for finishing. I applied six coats of epoxy to the bottom, wet sanding between coats to make it smooth as glass. Now we thought we were ready for Interlux® 1959 hard copper/bronze racing paint, but I forgot the golden rule—always read the directions! The directions say to hand sand with 100 grit paper. So we had 20 hours of needless sanding behind us only to rough it up again.

Moving to the hull sides we applied Interlux Interstain® 573 Chris Craft Mahogany. I was very pleased to find that the splines were really hard to see after staining. I had to look real close to find them. At this point we flipped the boat upright and placed it on the trailer. We made and installed new floor boards, seats, engine box and dashboard. We were forced to build a new dashboard because the previous owner had cut a hole in the dash to install an 8-track player.

Bob took care of all the mechanical aspects of the restoration—rebuilt engine and transmission, electrical wiring and the gauges which were sent out and restored to original. All the chrome was sent out and re-plated.

While all this work was underway at the various shops around town, we applied six coats of Captain's varnish to the hull sides and any interior surfaces left natural mahogany. When the varnish was fully cured we took the boat to an auto body shop known for their painting expertise. They painted on the white coping stripe, then sprayed on two coats of automotive clear.

We took the boat to Dave Julian of Linwood Upholstery and he installed period-specific white vinyl on the deck and recovered the seats. Finally, all the rebuilt parts and the restored hull came back into my shop for final installation.

The seat and the new dash reinstalled complete the restoration of the neglected Chris Craft.

The bottom paint helps bring the old boat back to life.

In every aspect, the Rebel was restored and rebuilt to be as original as possible. This was the first job in my new career and I can't say enough about the great work Bob and Jennifer Reed did. They didn't want any corners cut. Bob tirelessly searched for the correct parts from all over the country. All of our hard work really paid off.

In August of 2014 we took the restored boat to the 37th Annual Antique Wooden Boat Show in Hessel Michigan, in the beautiful Le Cheneaux Island area on the southern shore of the Upper Peninsula. The boat, renamed *Passing Thru Time – Rebel II* earned 2nd place honors. Bob and Jennifer are happily enjoying their "new" boat and the success of the project opened doors for more restoration work at my fledgling shop.

In 2014 we:

- Restored a 1954 Lyman previously owned by Jan Gougeon which he left to his ex-wife, Pat Huddy.
- Restored a 1964 DC 14 catamaran and re-painted in the Oracle paint scheme.
- Restored a 1964 Thompson that needed a new deck.
- Built a new stem knee for a 1965 65 ft. Stephens Motor Yacht.

Not knowing where this woodworking journey would take us, we now have finished projects in three states and sent fudge making paddles to England. We completed restoration work at the Grace Dow Library in Midland, Michigan. We restore antique furniture and build new custom furniture which led to a job in Southfield, Michigan refinishing 10 floors of office furniture for Federal Mogul Corporation.

Currently we are restoring a 1915 Defoe dingy for the *Amycita* that was donated to the Saginaw River Marine Historical Society Museum.

I am very excited about a personal project we've just begun—restoration of a 1955 Cadillac hot-molded 14' Runabout with my brother Bruce and my son in-law, Brian. We plan on showing it in Hessel in 2016.

The completely restored boat.

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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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

adhesivetechnologies.co.nz

Phone: 64-9-838-6961
E-mail: enquires@adhesivetechnologies.co.nz

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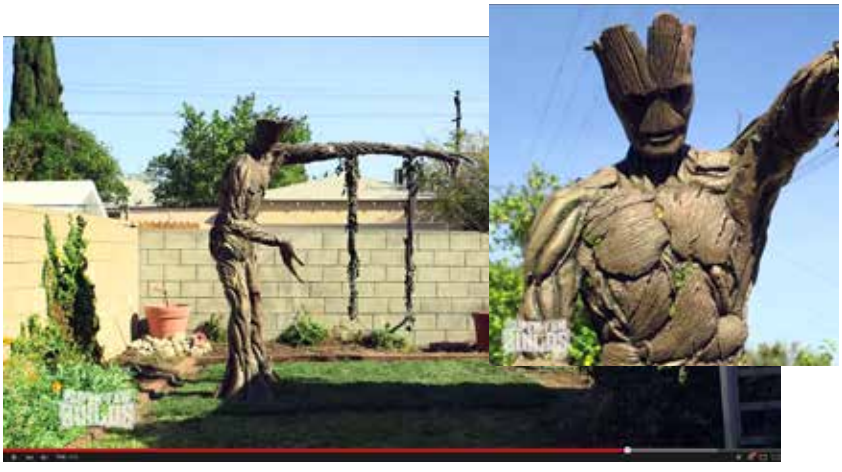
Readers' projects



Super Fan Builds created this Groot Swing for one of their nominated Super Fans. The structure was made from a steel frame encased in foam and covered with fiberglass and WEST SYSTEM Epoxy. Search "Groot Swing Set" on YouTube.

This little sailboat was built by one of our talented readers.

At the Mystic Seaport Wooden Boat Show this beautifully restored 50' Iceboat made an appearance. To restore it to racing condition it took over 33 gallons of WEST SYSTEM Epoxy.

Ron Hyatt made this beautiful table for his fire station out of scrap wood and WEST SYSTEM Epoxy.