FREE

EPOXYWORKS®

50 years
Epoxy Excellence Since 1969

BUILDING, RESTORATION & REPAIR with EPOXY

Number 49 ■ Fall 2019

In This Issue

EPOXYWORKS®

Editor/Designer Jenessa Hilger
Managing Editor/Copy Editor Grace Ombry
Contact/Subscriptions Mari Verhalen
Contributors Greg Bull, Brian Donaldson, Rachael Geerts, Don Gutzmer, James Macdonald, Terry Monville

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

Product Number 000-605

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

Visit epoxyworks.com to browse back issues or look for specific topics.

Using a Quick Mold

By Greg Bull - Technical Advisor

I determined where the part would work best before shaping.

The final mold shape covered with packing tape to make a smooth surface

Fiberglass applied to the mold. Small pieces were overlapped to follow the contours of the part.

Mold removed from the cured epoxy/fiberglass part

I used this quick mold method in order to move the mainsail traveler cleat from the transom of *Strings* to put it within easy reach of the helmsmen. The part I made had to be strong enough to withstand the loads of the traveler.

A male mold was the best choice for creating the shape to put the cleat where I wanted it. I began with Owens Corning® Foamular® 150 foam insulation, the "Pink Panther" rigid board foam sold at home improvement stores. It comes in different thicknesses and will bond easily with WEST SYSTEM Epoxy to build thickness or create the desired shape. This foam is inexpensive and easily contoured with basic hand tools. I used a piece that was 2" thick by 3" wide and 7" long.

Using a drywall saw, I shaped the foam by cutting the general angles I needed. To smooth the surface of the foam, and for additional shaping, I used both the rough and the smooth ends of a rasp, and 36-grit and 80-grit sandpaper on a hard sanding block. I then covered the surface with 2"-wide clear packaging tape. I didn't mind if the tape overlapped because this would be inside of the finished part and not visible.

With the mold shaped and covered with tape, I rubbed on one coat of paste wax as a mold-release agent. I was concerned it might not come off because the fiberglass was wrapped around the end of the male mold at a couple of different angles. Worst-case scenario, I would have had to destroy the mold to get the part off. Thanks to the paste wax, the part came off the mold easily.

After removing the part, I cut it to the shape I needed and test fitted it to the boat. Then the fun work started, filling the edges of the fiberglass with thickened epoxy and sanding them to make it smooth. I faired the part then coated the surface with WEST SYSTEM 105 Resin and 205 Fast Hardener tinted with 501 White Pigment. This pigmented epoxy coat served two purposes: it filled any pinholes and started to make the part white, acting as a primer for the white paint I applied.

Cover Photo: Strings, built by Gougeon Brothers, sailing on the Saginaw Bay.

Sanded, trimmed part being fit in place

Finished, painted, installed, and in use

I installed the part on the back of *String's* cockpit. My final task was installing the cleat, which was the reason for the quick mold-making project. After a summer of sailing, the part and cleat have not moved. I wish I had done this a year or two earlier.

The basics of WEST SYSTEM Epoxy

By Don Gutzmer - Technical Advisor

Each February Gougeon Brothers provides a Fiberglass Boat Repair Class for repair professionals. Here are some of the basic techniques we teach in the class, as well as helpful tips for working with WEST SYSTEM Epoxy.

Epoxy's Cure Stages

What is the difference between working time, pot life and cure time? All three are slightly different.

Working time, also called open time, is the amount of time epoxy remains liquid between when you mix the resin and hardener and when it begins to gel. During working time, the epoxy remains workable enough to wet out a surface. All assembly and clamping should take place during the working time to ensure a dependable bond.

Pot life is measured with a confined mass of 100 grams of epoxy (4 fluid ounces). The resin and hardener are mixed for 2 minutes, then timed until the epoxy starts to gel. This provides a good idea of how long the epoxy will stay liquid in a mixing container.

Initial cure indicates the amount of time before a thin film or coating of curing epoxy can be handled.

Here is how 105 Resin with 205 Fast Hardener behave at 72°F (22°C):

- Pot life 100 grams: 9–12 minutes
- Working Time: 60–70 minutes
- Initial cure to solid in thin film: 6–8 hours

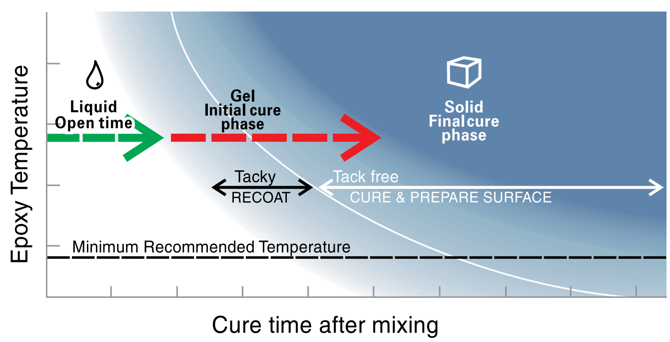
Controlling Cure Time

The easiest way to control cure time is to choose the hardener with cure speed that is a good match for your project and working temperatures. Our 205 Fast Hardener has a shorter working time while 206 Slow Hardener and 207 Special Clear Hardener have similar, longer working times. 209 Extra Slow Hardener is our slowest hardener and is best suited when lengthy working times are needed, or when you're working at very high temperatures. Beyond this basic approach, there are a few other steps for controlling cure time.

Keep your ambient working temperature ranges in mind when selecting the hardener for your application. Each hardener has an ideal temperature range. You'll find this listed on the hardener container.

The exothermic reaction of resin and hardener generates heat. To maximize your working time, don't leave the epoxy in a confined mass, such as the mixing pot. Pour the epoxy into a roller pan, or work with small batches.

When working on a large project, I separately pre-measure multiple small batches of the proper amount of resin and hardener ahead of time. As I'm working, when I need another fresh batch of epoxy, I can mix it together quickly and continue working. This saves time while I'm applying the epoxy and ensures an accurate mix ratio. You'll waste less epoxy by creating



As it cures, mixed epoxy passes from a liquid state, through a gel state, to a solid state.

← Cure time is *shorter* when the epoxy is warmer.

← Cure time is *longer* when the epoxy is cooler.

multiple small batches rather than one large batch that may kick off (start curing) before you're finished using it. No one likes to see a pot of unused epoxy smoking in its container.

Temperature affects cure speed. You can accelerate epoxy cure by increasing the temperature. The 18-degree rule is that every 18°F increase above 72°F cuts cure time in half. If you need to speed the cure process, after the epoxy cures to a gel state, increase the temperature surrounding the epoxy up to 120°F. Don't start this process before the epoxy reaches a gel state because the epoxy coating may run or sag on vertical surfaces.

Dispensing and Mixing

It is critical that you dispense epoxy resin and hardener at the correct ratio. *Altering the amount of hardener does not control cure speed.* Instead, it creates an epoxy mixture that can never fully cure and will have greatly reduced physical properties.

Epoxy can be accurately metered by volume or weight. Mix ratio information is on the hardener label and our technical data sheets.

Our 300 Mini Pumps are hard to beat for the price when metering small amounts of epoxy. One full pump stroke resin to one full pump stroke of hardener delivers the correct ratio. One pump stroke of each will total around 1 fluid ounce of epoxy. Depress each pump head fully then allow it to rise to the top before beginning the next stroke.

To measure resin and hardener by volume, pour each component into a straight-sided container like our 805 or 806 Mixing Pot.

Another method for metering by volume in a straight-sided container is to mark a paint stick at 5 parts 105 Resin and 1 part 205 Fast or 206 Slow Hardener. For example, put a mark at 1.25" for the resin, then another 0.25" above that, put a mark for the hardener, for a total of 1.5". Pour the resin into a straight-sided container to the 1.25" mark, then add hardener to the 1.5" mark. This can also be done for 207 Special Clear and 209 Extra Slow Hardener but at 3 parts resin to 1 part hardener.

When mixing, stir the epoxy for at least two minutes to ensure it is thoroughly blended. In cooler temperatures you will need to mix the epoxy longer. Scrape the sides, bottom, and inside corners of the container when mixing to ensure thorough blending.

Adding Fillers

If you need a thicker epoxy mix, add a filler. Add enough filler to achieve your desired consistency but be aware that adding fillers could affect the epoxy's cured physical properties. Be sure to mix the resin and hardener together before adding filler. WEST SYSTEM fillers fall into two categories: high-density and low-density.

High-density fillers

403 Microfibers

Primarily cotton flock, 403 is great for quickly thickening the epoxy. Use it for structural wood bonding applications. When mixed into the epoxy it is grainy, like oatmeal. Cures to an off-white color.

404 High-Density

A high-strength fibrous mineral, 404 will have the least effect on physical properties when mixed into the epoxy. It's a great option for fastener bonding applications and when the epoxy's highest strength needs to be maintained.

405 Filleting Blend

A blend of walnut shell flour, 405 turns epoxy dark brown. It's excellent for gluing joints and creating fillets on wood that will be naturally-finished.

406 Colloidal Silica

A fumed amorphous silica, 406 does not contain crystalline silica. It is an epoxy thickener that is perfect for structural bonding applications. If enough 406 is added, it can thicken epoxy to a smooth consistency similar to gel toothpaste. It cures to an off-white color.

406 Colloidal Silica is our most versatile filler. Epoxy thickened with this filler can be tinted with additives. Many woodworkers used it to thicken epoxy to a mayonnaise consistency, then add sanding dust from the wood piece to color-match the wood.

Low-density fillers

We offer two low-density fillers which make the epoxy easier to sand. When you need to do cosmetic work and surface fairing, use a low-density filler.

407 Low-Density

Primarily low-density hollow plastic spheres generically known as microballoons, 407 creates fairing putties that are easy to sand or carve. Cures to dark red/brown.

410 Microlight

These low-density plastic spheres are 30% easier to sand than epoxy thickened with 407 Low-Density filler. When 410 is added to the epoxy mix, the physical properties are reduced. While very easy to sand, 410 isn't the best option for use under dark finishes that will get hot in the sunshine, possibly contributing to softening. That is where 407 Low-Density is a better option. Cures to a light tan color.

Surface Preparation

When you are ready to apply the epoxy, make sure your substrate is properly prepared. For most substrates like wood, fiberglass, and metals we

WEST SYSTEM Fillers

recommend sanding the surface well with 80-grit aluminum oxide sandpaper. Avoid solvent wipes to prevent contaminating the surface. If you need to use a solvent to remove any surface contaminants, make sure to apply it with plain white paper towels. Wipe the solvent on the surface to remove contaminants, then dry the surface right away with paper towels before the solvent flashes away (evaporates). Paper towels are a safe option to reduce the chance of contaminating the surface when doing a solvent wipe. Common solvents used are acetone and lacquer thinner.

Bonding

Once your surfaces are prepared properly, it is good practice to do a two-step bonding technique. First, apply a thin coat of unthickened epoxy on all bonding surfaces, then thicken the epoxy with a high-density filler to a mayonnaise consistency and apply it to one side of the joint. When properly mated, you should see some epoxy squeeze out of the joint.

Applying Fiber Reinforcement

There are a couple of different methods of wetting out fiber reinforcement such as fiberglass.

The dry method is for lightweight fabrics, up to 12 oz. per square yard. The fiber reinforcement is applied to the substrate dry, and then the epoxy can be applied on top to saturate the fabric. A WEST SYSTEM 800 Roller Cover works well to roll the wet epoxy onto the dry fabric. A plastic spreader/squeegee is also a nice tool to help move the epoxy over the surface, saturating the fabric.

The wet method is best for heavier reinforcing fabrics. Begin by wetting the substrate with epoxy, then laying the fabric over the surface. Use a plastic spreader to force the fabric down onto the substrate. The epoxy should start to wet the fiber bundles. Apply more epoxy on the top surface until the fabric is thoroughly wet out. If there is any extra fabric hanging off the edge of your piece, avoid cutting or grinding by trimming it with a razor knife after the epoxy has partially cured to a rubbery state (towards the end of the gel phase). It is much quicker and a lot less mess to trim the excess before it fully cures as opposed to cutting or grinding the final part.

Recoating

When the epoxy cures to a tacky state (like masking tape) it's the ideal time to recoat. Recoating during this phase creates a chemical bond which means better adhesion and you can avoid sanding. If the surface is hard to the touch, let it cure so when sanded it will produce dust. The ambient temperature and thickness of the epoxy coating will determine when you can sand the surface. Before sanding the epoxy coating, wash it with water and an abrasive pad to remove any amine blush. The blush will feel like a waxy film on the surface of the epoxy coating. This water-soluble byproduct of the curing process should be removed before sanding the surface dull. Once the epoxy coating is sanded dull, you can apply another coat of epoxy or a UV-stable topcoat.

Understanding these basic epoxy techniques will help you prevent common epoxy problems. Please take advantage of our Technical Services department at 866-937-8797. For additional information on basic techniques, reference the WEST SYSTEM Product Guide or visit westsystem.com.

Mica powders can be used to create unique designs within a casting.

Casting Epoxy

By Rachael Geerts - Technical Advisor

Live edge tables with bright centers, clear coasters with stones, wood, or shells intricately placed, or even beautiful jewelry can be made with WEST SYSTEM Epoxy. With so many people venturing into using epoxy this way, I will address common questions about casting depth, colorants, bubble removal, and finishing.

Casting Depth

A customer's first question is usually about epoxy casting depth. Either they want to know how deep they can pour the epoxy at one time, or they have already poured an 8" by 10" by 2" deep casting and are wondering why the epoxy started smoking and cracked.

Epoxy cures through an exothermic reaction, generating heat as it cures. In large volumes, this can be a lot of heat (300+ °F). The slower the hardener you choose the better it can handle larger volumes of epoxy, because the exothermic reaction does not take off so quickly.

WEST SYSTEM initially developed its 105 Resin-based epoxy system as a laminating epoxy. It was meant to be used in thin films, so its chemistry creates enough heat to push the reaction through without requiring an external heat source to reach a full cure. We recommend 105 Resin and 207 Special Clear Hardener for casting projects. While it is a slower curing system, it still should not be poured more than ¼" deep at a time. We have found that building up castings ¼" at a time allows the epoxy to cure without overheating.

Here is how to add multiple layers seamlessly for castings deeper than ¼" overall: When the first pour is tacky like the back of masking tape, a second pour can be made. When the epoxy cures enough to become tacky, it means the previous layer has begun to cool down and will not contribute heat to the next layer. Adding another layer at this stage allows you to skip any surface prep. If the cure goes past the tacky stage, allow the epoxy to finish curing, then sand dull and clean the surface before applying the next layer.

Without proper surface prep, a visible seam may appear between layers and the adhesion of the new layer to the previous layer will not be as strong. Seams are more noticeable when the epoxy isn't pigmented, but are sometimes visible between layers of colored epoxy.

Stones from Lake Michigan cast in epoxy to create a coaster.

Colorants

I will refer to solid colorants, such as mica powder or pigments suspended in liquid resin (such as our 501 White Pigment, 502 Black Pigment, and 503 Gray Pigment), as pigments. I'll refer to liquid colorants such as alcohol dyes or acrylic paints as dyes. With so many brands and types of colorants, we recommend making a test batch when working with a new material or color before starting a big project.

Adding colorants reduces the properties of cured epoxy. We recommend adding no more than 5% by weight. When selecting a colorant, have an idea of what look you are trying to achieve. I have used mica powders in some of my small test projects. While they are fun and offer a variety of colors, they can be difficult to master in epoxy. Since they are solids, they typically make the epoxy opaque. They may also sink out or make unanticipated designs if the epoxy cures too slowly or heats more than expected. Some artists use this to their advantage. Once you've mastered colorants they can be a lot of fun. But it's important to create a few test pieces so your parts will turn out the way you intended.

Dyes also come in a variety of colors. They color the epoxy more consistently because they don't settle out. Use them when you want to add some color to create transparent, translucent, or opaque epoxy.

As with pigments, dyes can create interesting designs—just remember that we don't all start out as a Monet or Van Gogh. It takes time to master a new art media.

Experimenting with dyes, my colleagues and I have noticed that water-based dyes can boil inside the epoxy if it gets too warm. I recommend going with a slightly shallower pour or devising a way to release some heat from the casting. For example, have a fan blowing across the surface of the pour to circulate air around the part.

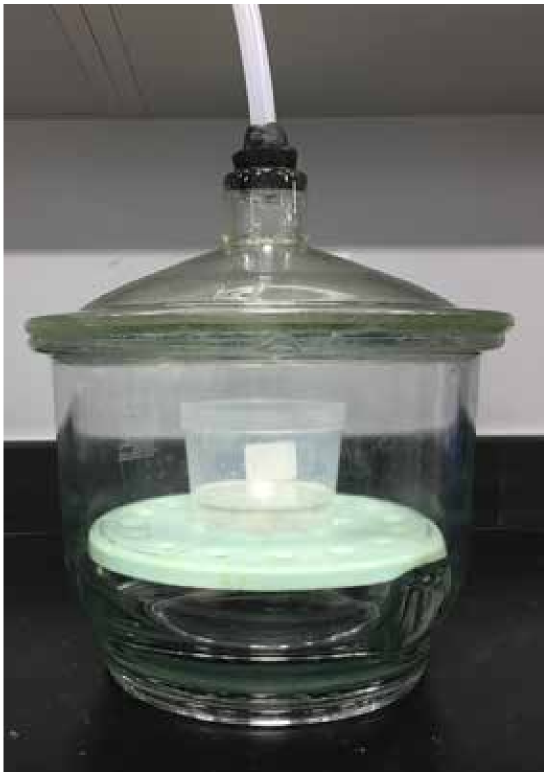
Bubble Removal

Many people ask about removing air bubbles from epoxy. This applies to casting inside wood or coating wood, such as with live edge tables and river tables. As the epoxy heats and starts to cure, the sides of the wood will release air trapped inside the wood. This "off-gassing" can lead to micro-air (tiny air bubbles) in the epoxy.

To prevent this, seal the edges of the wood with a thin layer of epoxy and let it reach the tacky stage before pouring epoxy into the cavity. The thin epoxy layer will seal off the wood so it can't release air into the casting. If the epoxy seal coat has fully cured, sand and clean the surface before pouring the fill layers.

Resin and hardener must be thoroughly mixed (about 2 minutes) in order to cure, but this mixing can introduce air into the epoxy. There are three effective ways to remove most, if not all, of this induced air.

The first method is to set the mixed epoxy on a vibrating table. The vibrations will help the air move to the surface and be released from the epoxy.



A vacuum chamber can be used to remove air bubbles from epoxy.

The second method is to put the epoxy in a vacuum chamber, which will quickly evacuate the air bubbles. Be sure not to pull so much vacuum that the epoxy starts lifting, which will look like it's boiling. Once you turn off the vacuum, slowly let the air back into the chamber. Opening the chamber valve completely at once can create a rush of air into the chamber, inducing air back into the epoxy.

The third method is to use a heat gun or small propane torch to remove air bubbles near the surface of the epoxy after it's already poured into the casting cavity. Waiting 5 to 10 minutes for the air bubbles to reach the surface will make them much easier to pop. Move the heat source over the area at a rate of about one foot per second while keeping the flame 15-18 inches away from the surface. Don't let the heat source heat the epoxy to the point that it gels or smokes.

Finishing

Just because the epoxy is hard doesn't mean it has fully cured. Wait at least 24 hours before sanding and applying a UV-stable topcoat over the epoxy.

The topcoat can be anything from an automotive clear coat to a two-part polyurethane, provided the instructions from the manufacturer are followed. Since the epoxy has fully cured, you are now top-coating an inert plastic surface.

If you don't want to add a topcoat over the epoxy because the project will not see sunlight, keep in mind that if you sand the epoxy, you may not be able to polish it back to its original high-gloss shine because it is not a hard enough surface. This is a good reason to use a clear, UV-stable top coat. You can sand the surface if there are any imperfections, then apply the topcoat to achieve a nice high-gloss finish.

If you prefer a matte look, wet sand the epoxy up to 2000 or 3000-grit, followed by a polishing compound to create a nice matte finish.

It is amazing to see how creative our customers can be with our epoxy. I hope this article helps you explore your creative side.

WEST SYSTEM offers pigments in white, black and gray.

The *Eat a Peach* Tribute Guitar

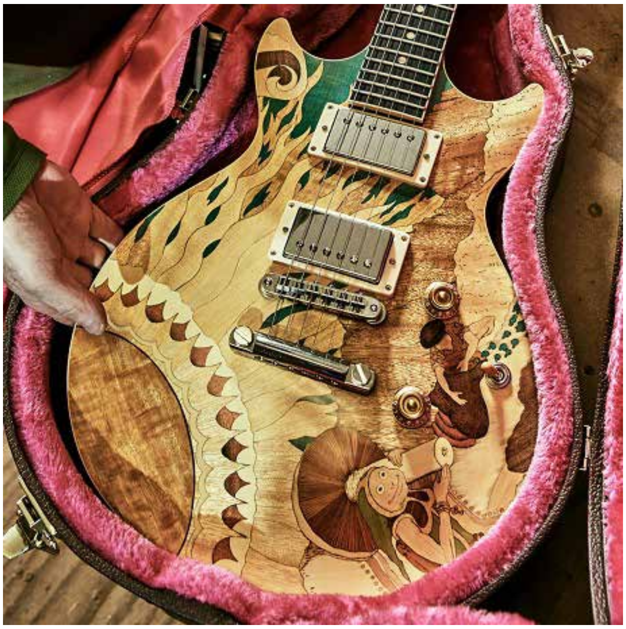
By James Macdonald

In the early days of my woodworking career, beginning in 1981, I spent time as a boatbuilder at Wood Boats, a restoration yard in Norwalk, Connecticut. From the first day of my job there I learned the importance of epoxy in all aspects of boatbuilding. Inspired by reading *Mother Earth News*, I moved to rural Maine, built my own home, and got a job at another boatshop (this one in a huge, defunct chicken barn) in Lincolnville, Maine. I started my own woodworking shop in 1988.

In 2013, I began building custom art guitars. Somewhere in the far reaches of my mind, I recalled that *The Gougeon Brothers on Boat Construction* had instructions on how to lay a teak deck. This became my justification for choosing WEST SYSTEM Epoxy to glue my wood veneer marquetry designs to my solid Honduras mahogany custom guitar bodies.

I accessed the digital version of the book (available free at westsystem.com) and found the paragraph I was looking for:

> *We have had excellent results with teak decks that have ended up measuring about 1⁄8" to 3⁄16" (3 mm to 5 mm) thick. We feel that 1⁄4" (6 mm) thick is about maximum for this type of system, and we advise against using any thicker strips. The reason is that WEST SYSTEM adhesive bonding is able to overpower the expansion-contraction forces which occur in these thinner sections. Teak strips of much thicker dimension, such as 3⁄8" or 1⁄2" (9 mm or 12 mm), might create forces so great as to overwhelm the adhesive, causing it to fail. We see no reason to go to any teak veneer thicker than 3⁄16".*
>
> *Page 354—The Gougeon Brothers on Boat Construction*



The finished Eat a Peach Tribute Guitar

The relevant wording of this paragraph for my application is "WEST SYSTEM adhesive bonding is able to overpower the expansion-contraction forces which occur in these thinner sections." They are speaking of teak veneers that are 1/8" to 3/16" thick. For my marquetry work, I am using commercially available wood veneers of many species, ranging from 1/42" to 1/28" thick: much thinner than 3/16." In the world of boatbuilding, Gougeon's research withstands the test of time. I've never had a veneer lift when using WEST SYSTEM Epoxy. Good stuff!

My guitar-making methods are always evolving. It's a huge subject and there are now more sources of information than ever. Gone are the days of closely guarded secrets won by years of long apprenticeships. The Internet has produced a tidal

105/207 is being applied for bonding the marquetry work. Using 105/207 to adhere the marquetry and as the seal coat, gives the finished product a unified appearance.

A vacuum press clamps the marquetry onto the guitar body with even pressure across the whole surface.

wave of information available to all. I could hide what I've learned, or I could just tell you. I will add the caveat that what works for me may not work for you.

In my first guitar designs, I used 105 Resin and either the 205 Fast or 206 Slow Hardener for gluing my marquetry design to the mahogany body. I was getting good adhesion but didn't like that the epoxy mix was not dead clear. In conferring with one of the nice folks on the WEST SYSTEM technical support line, 866-937-8797, they suggested I use the 207 Special Clear Hardener. From the WEST SYSTEM website:

> *105/207 Epoxy has strong physical properties, so it can be used as a structural adhesive for gluing and laminating. It has excellent compatibility with paints and varnishes. An ultraviolet inhibitor in 207 Special Clear Hardener helps provide a beautiful, long-lasting finish when used with quality UV filtering varnish. 105/207 cures clear and colorless.*

My method of finishing has a certain logic to it that I like. I am using 105/207 for adhering the marquetry work. I use a vacuum press in this process and there is invariably both saturation of porous veneers, and bleed-through in the many joints that are between the pieces of cut veneer. Using 105/207 for the finish, I'm able to achieve a unified appearance.

After the vacuum glue-up, I sand it level starting with 120-grit working up to 400-grit. I detail the marquetry using a knife-tipped wood-burning pen. I add lines or shading to accentuate the design.

I am then ready to apply a seal coat of 105 Resin/207 Special Clear Hardener. I let the epoxy sit on the surface until it has soaked in as much as it will, then remove the excess with a rag, treating it like a wipe-on polyurethane. I do this on the first coat to remove the risk of micro air bubbles ending up in the finish. I can then proceed with further coats through the course of a day, waiting until the tacky stage to apply the next coat. I repeat with more coats until I have enough of a surface film to sand the epoxy level without going through to the wood. Then I proceed through the grits until I have achieved a surface with sanding scratches so fine they are undetectable. I add one or two coats of semi-gloss wiping varnish and let cure thoroughly before the final buffing.

I've chosen one particular guitar to feature in this article with my construction images, the *Eat a Peach* tribute guitar, which I consider my love letter to the original Allman Brothers Band. I've been playing guitar all my life and was hugely influenced and am still wowed by the music and musicians of this group. The design features my marquetry rendition of some of the original artwork by Wonder Graphics on the inside cover of their epic *Eat a Peach* album, released in 1972.

I couldn't have foreseen the wild ride this

With the epoxy cured, the vacuum film was removed and the piece is now ready for sanding and detailing with a knife-tipped wood-burning pen.

guitar would take me on. I had been promoting it on my Facebook business page and received a message from Warren “Skoots” Lyndon, the younger brother of Twiggs Lyndon, the original tour manager for the early Allman Brothers. Skoots expressed deep admiration and appreciation for my guitar. We ended up writing, then talking, at which point he introduced me to Richard Brent, the Director of the Allman Brothers Band Museum at The Big House in Macon, Georgia. The talk turned to the notion that my guitar could find a home in their museum. It seemed right to go to the next step and travel to Georgia and meet each other, and to allow these guys to see, hold, and play the guitar.

Skoots arranged to have us meet him at a Deep Purple concert in Atlanta. Within two minutes of meeting, my guitar was plugged in backstage and was played like never before by Tommy Alderson, the guitar tech for the legendary Steve Morse of Deep Purple. He then handed the guitar to Doug Rappoport, Edgar Winter’s guitarist, who also tore it up.

We made our way to Macon the next day and met with Richard Brent at The Big House. We plugged in the guitar, made some music, and decided this instrument belonged in the Museum. While there, I met David “Trash” Cole, a former roadie for the Allman Brothers and a formidable musician. He invited me to join him at the famed Grant’s Lounge that night where we played the night away with some first-class musicians.

I returned home with the idea to use crowdfunding to allow friends and fans of the Allman Brothers everywhere to contribute a little bit to cover the cost of the instrument and the travel expense of delivery from Maine to Macon. In return, we offered T-shirts, posters, and even my own homemade maple syrup. Through this Indiegogo campaign, we reached our goal and made our plans to return to Macon.

Our trip couldn’t have been nicer. My previous friendships were strengthened and we were well taken care of. Southern hospitality is alive and well! I presented the guitar to the Museum at their day-long music jam on their outdoor stage as part of GABBAfest (Georgia Allman Brothers Band Association), an Allman Brothers celebration and music festival. I got to play a few beloved Allman Brothers songs on the *Eat a Peach* guitar with Trash and some other talented musicians before formally presenting the instrument to Skoots. Skoots spoke a bit then handed it off to Richard and the Museum. It now hangs on a special plaque that also displays the long list of names of people who contributed to the campaign.

This guitar has led me on a journey that has turned into one of the highlights of my life. I couldn’t be happier with the outcome. And just to put it out there, I’ve also created a Tribute to Clapton guitar and have been hoping for the lovers of Eric Clapton’s music to take me on another adventure!

Italmas Revisited

In Epoxyworks 47 we featured an article on the construction of *Italmas*. Today she's nearly complete, and true to reputation, Van Dam Custom Boatworks never disappoints. Here are a few photos of the boat showing off some of the craftsmanship Van Dam is famous for.

"*Italmas* is a world-class cruising design tuned and tailored for her owner to enjoy sailing the Great Lakes. She combines distinction with grace resulting in a traditional take from Stephens Waring Yacht Design that squarely pays homage to yachts of the '40s and '50s."

vandamboats.com

Cabin top and deck.

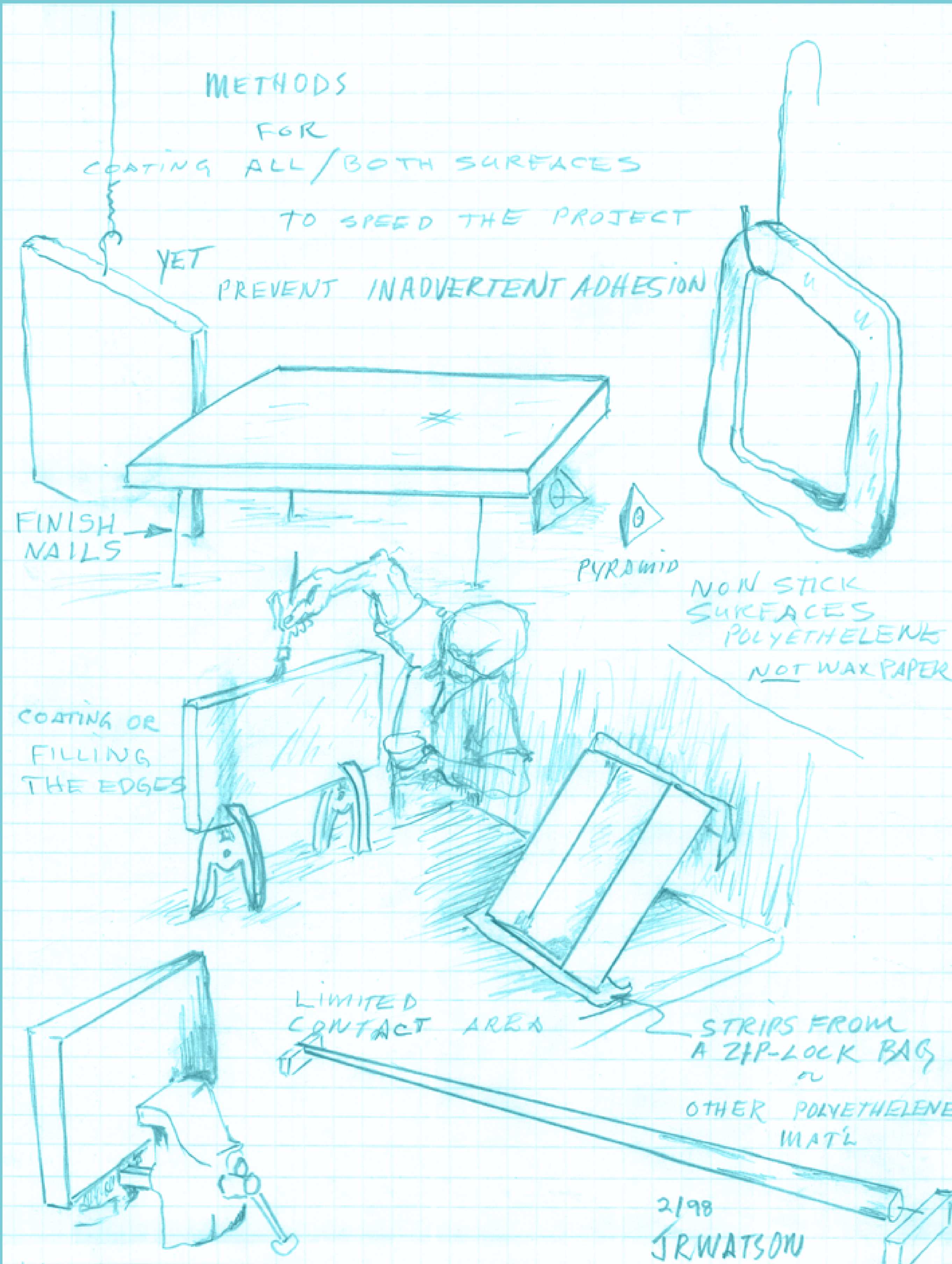
Winch mounting

Mast detail

Galley and custom cabinetry

Ample storage

Ceiling and cabin hatch


METHODS
FOR
COATING ALL/BOTH SURFACES
TO SPEED THE PROJECT
YET
PREVENT INADVERTENT ADHESION
FINISH NAILS
PYRAMID
NON STICK SURFACES
POLYETHELENE
NOT WAX PAPER
COATING OR FILLING THE EDGES
LIMITED CONTACT AREA
STRIPS FROM A ZIP-LOCK BAG
or
OTHER POLYETHELENE MAT'L
2/98
JRWATSON

Clear Coating with 207 Special Clear Hardener

By Terry Monville - Technical Advisor

Not that long ago, clear coating with epoxy meant that you were finishing a natural wood canoe or kayak, or the teak toe rails on your boat. Today, WEST SYSTEM 105 Resin and 207 Special Clear Hardener is used for clear coating in many different ways. Regardless of the project, there are some basic techniques to follow when epoxy coating and a few pitfalls to avoid.

Clear Coating Wood

Most of our customers' projects start with some sort of wood, so that's where I'll begin.

Sand the wood with 80 to 120-grit sandpaper parallel to the grain using aluminum oxide sandpaper. Avoid using specially coated or non-loading sandpaper its components can be left behind, contaminating the surface.

Once you have your wood sanded, remove most of the sanding dust with a vacuum, then wipe down the wood. We recommend a two-step wiping method. Step 1: Dampen paper towels with a solvent like isopropyl alcohol, acetone or lacquer thinner. Use a solvent wipe on oily woods like teak, white oak or ipe. Step 2: Wipe off and dry the surface with clean, white paper towels.

Using a solvent on oily woods both removes the dust and helps lift the surface oils from the wood to assure better bonding. For non-oily surfaces, you can use clean water to help remove the dust.

We recommend using paper towels with solvents. If cloth towels or rags are used, solvents may loosen contaminates such as fabric softeners and detergents from the cloth fibers and deposit them on your work surface. Stay away from tack rags as the wax can easily transfer to the work surface, especially if the solvent has not completely flashed off.

Wow, that seems like a lot just to sand a piece of wood and wipe off the dust. Like most projects, 90% of the work is prep but the 10% effort spent on finish coating gets all the credit.

Clear Coating Small Items

On some smaller projects, it's good to coat as much surface as possible. I've added in some sketches by my old friend Captain James R. Watson, who had good ideas on how to clamp, prop or dangle a small item in order to coat it all at once. (See left page.)

The Importance of Freshly Mixed Epoxy

Regardless of the project, you will want to use freshly mixed epoxy. Only mix an amount you can use in about 8 to 10 minutes, and put on a seal coat of epoxy first. Depending on the size of your project, use the roll and tip method or brush the epoxy on.

Three coats 105 Resin/207 Special Clear Hardener and two coats of two-part polyurethane

105/207 put on late in the day in cool weather. Temps down into the 50s with a heavy dew turned the epoxy milky. This was an extreme case of moisture exposure before being fully cured.

Preventing Air Bubbles

To seal the air into the wood without getting air bubbles in the epoxy, warm the wood slightly before applying the epoxy and let it cool as the epoxy cures. This is easy to do in a climate-controlled shop but if you're working outdoors, use a hair dryer to warm the wood just before applying the epoxy.

After the first coat gets tacky (2 ½ to 3 hours at 72°F) apply a second coat, taking time to fill any pin holes and fix any other flaws. Again, use freshly mixed epoxy.

We've reached the point where it matters what kind of project you're working on. I'll cover two basic types of coating projects: base coat for a varnish finish, and a natural wood finish clear-coated fiberglass.

Base coat for a varnish finish

Ideally, you would apply a total of three coats in the same day allowing 2 ½ to 3 hours between coats for the epoxy to get tacky. This can be your two seal coats plus one more if the seal coats look good and you don't need to fix any flaws in the wood.

After the coats of 105/207 have fully cured, sand the epoxy for the varnish using the varnish manufacturers recommendations. The epoxy should sand to a light powder. If the epoxy is not fully cured, it will gum up the paper and could affect the finish clarity.

If you're working outside and apply the third coat late in the day, keep an eye on the weather. 105/207 needs 8 to 10 hours above 60°F to cure before being exposed to moisture.

If the epoxy hasn't cured enough before it's exposed to high moisture, it may develop a milky appearance or even turn snow white. If this happens, let the epoxy finish curing, then sand until the white is removed. Apply another coat or two of epoxy and finish it with a UV protection top coat.

Natural wood finish with fiberglass

It's very common in wood/epoxy construction to apply a single layer of woven fiberglass over the wood. Coating a good quality 6 oz. or less woven fiberglass with 105/207 will result in a transparent finish. Freshly mixed epoxy flows better for wetting fiberglass.

Brush on epoxy

Ted Moores, owner of Bear Mountain Boats and renowned boat builder, suggests applying the epoxy with a paintbrush for uniform fiberglass wet out and the clearest finish. Using a roller or pouring a puddle of epoxy on the fabric and spreading it around with a plastic spreader may aerate the epoxy. While the initial results will look uniform, aerated epoxy will lighten after exposure to sunlight, obscuring the beauty of the wood grain.

Apply fiberglass one layer at a time

If you need to apply more than one layer of glass (such as in the bottom of a canoe), apply the layers individually. When you apply multiple layers all at once, the lower layers act as a cushion, making it harder to squeegee out all of the air. You can exert more pressure with the squeegee over a single layer of cloth.

Squeegee with care

The object of squeegeeing is to force the epoxy into the fiberglass while forcing trapped air out. Hold the spreader at a low angle, and with enough pressure, so there is about an inch of contact against the surface.

If you don't squeegee away excess epoxy after wetting out the cloth, it may float off of the surface at the epoxy puddle. The result will be a wavy surface and a heavier canoe. After squeegeeing, the cloth weave should project above the epoxy. If you drag the squeegee at too high of an angle, it may remove excess epoxy but won't force the air bubbles out. If you leave air bubbles in the interstices (the small hollow at the cross weave of the fiber strands), the sun may heat it enough to create blisters. If you notice little white specs where the fabric is not completely wet, you can work epoxy into these spots by dabbing at them with a short bristle brush and gently warming the area.

Apply buildup coats on the same day

For best chemical bonding, and to avoid sanding between coats, apply the fiberglass and all of the necessary buildup coats on the same day. Apply the first build up coat when the epoxy on the wet-out fiberglass begins to gel (about 3 hours at room temperature with 207 Hardener). Apply each remaining coat at the same interval. The epoxy buildup coats should be thick enough to provide a good moisture barrier and allow for sanding (to prepare for varnishing) without sanding into or through the fiberglass. For best results apply the buildup in thin, even coats.

Q. What should I wipe the surface with before applying WEST SYSTEM Epoxy?

A. Use water and paper towels. If using a solvent, like acetone, make sure to use clean, white, non-printed paper towels—not a rag.

Using printed paper towels with acetone or other solvents can make the ink rub off, contaminating the newly sanded surface. If solvents are used with a new or laundered rag, fabric softeners or detergents may contaminate the surface. It is rare, but I've seen cases where contaminated rags cause fish eyes in the epoxy surface.

Use only white paper towels and your sanded surface will thank you for it.

-Greg Bull - Technical Advisor

Building a Jericho Bay Lobster Skiff

By Brian Donaldson

Over the past three winters, the boatbuilding crew of the Saginaw Bay Community Sailing Association (SBCSA) strip-built a Jericho Bay lobster skiff. They used the plans from WoodenBoat magazine, which master boatbuilder Tom Hill measured from a Joel White-designed boat. More than twenty people have worked on the skiff.

The hull was planked with western red cedar ½" x ¾" bead-and-cove strips covered in a 12 oz. layer of fiberglass on the interior. Two layers of 12 oz. fiberglass and WEST SYSTEM Epoxy covered the exterior. The transom is laid up of okoume marine plywood with a mahogany veneer. The stem is laminated Douglas fir and the gunnels are ash with Cypress knees and breasthook. The seats are western red cedar and the steering console is painted okoume plywood with clear-finished black locust corners and a Cypress dash. Everything was coated with epoxy before painting and varnishing. Much of the boat is finished bright.

It has a 2018 Mercury fuel-injected, 4-stroke, 20hp motor controlled by a remote start, shift and throttle, along with wheel-steering from the console. During sea trials with a prospective buyer, the boat ran 21 knots with 500 lbs on board. The bow doesn't rise up when getting on plane: the entire boat rises level to plane for a very comfortable ride.

With so many people working on the boat at different skill levels, it's difficult to keep the level of finish where one would like it. Joe Parker, a retired Gougeon Brothers Employee and boat repair expert, took the boat home in late August and completed the touch-ups to a high level.

The group will be selling the boat to help fund SBCSA operations. SBCSA operates as a 501(c)3 in Bay City, Michigan. The mission of SBCSA is to provide affordable sailing lessons and access to sailing for the youth and adults of the mid-Michigan area, to promote interest in sailing as a life-long sport, and to develop teamwork, sportsmanship, and self-confidence in students through experiential learning.

In addition to offering sailing lessons for youth and adults in nine Optimist Prams, five RS Feva's and four Cape Cod daysailer 17s, they keep two keelboats at a local marina that are set up for sailing on the Saginaw Bay at no additional charge to members.

On the molds with the keelson added. Time spent fairing mold frames is time and materials saved in the fairing process. 410 Microlight filler added to WEST SYSTEM made for a nice fairing compound.

The hull off the mold and covered with fiberglass. The interior was faired before the fiberglass was applied.

Often pigment will be added to aid in fairing. In this case, 502 Black Pigment was used to contrast with the tan 410 Microlight Fairing Filler.

With the interior painted, the hardware was installed. It's important to seal all holes with epoxy after they are drilled.

Folding cleats add a nice touch to the bow and stern. The LED bow light is placed on a mahogany pad that was meticulously shaped to fit the rise of the breasthook. The boat was designed in the 1940s and the shape of the pad has a vintage feel.

The wheel installed. The helm station is built of okoume ply with a black locust corner post and Cypress dash and shelf. The seats are cedar.

What a sweet sheer! The waterline was applied from plans. Often builders float the completed boat and mark the waterline location to paint later.

The completed Jericho Skiff.

The donated trailer needed attention. It was completely disassembled, cleaned, primed and painted then reassembled with new bolts, lights and tires. Its vintage styling goes well with the boat.

Building Composite Parts

By Don Gutzmer - Technical Advisor

Creating things has been a passion of mine over the years, and I continue to improve my skills and grow more proficient at building composite parts. I also enjoy the challenge of helping others create one-off composite parts. I'm happy to share some of the materials and techniques I've used over the years to build composites with WEST SYSTEM Epoxy, and provide an example of a recent project.

When I am building composite parts, most of the time I will use a mold. There are a couple different kinds of molds, a male mold (sometimes referred to as a plug or buck) and a female mold. Each mold will offer a different finished part. A male mold is a form built to the desired shape of your part and then your laminate is laid up on it. The part will then need to be finished after the laminate is cured if a smooth final surface is desired. A female mold will provide a better cosmetic finish because you lay up your laminate on a smooth mold surface and the mold side of the part becomes your finished surface. I've built female molds of solid fiberglass laminates (no core) when I've needed to pull only a handful of parts. The laminate schedules I typically use are on the lighter side because I am usually okay with touching up the part after removing it from the mold. One advantage of using a female mold,

An old car body was loaned to be used as a plug to create a female mold.

Because the loaned car body could not be altered, this female mold was created to build a second body that could be altered.

An exact copy of the borrowed car body was created from the female mold.

Using an old windshield and flash tape attached to the car body, the new cockpit shape begins to form.

instead of a male mold, is that after removing the part you shouldn't need to do much more than trim the edges and apply a UV-stable topcoat.

Fairing

When I need to build a mold from an existing part, I first make sure the surfaces are fair. I use West System 407 Low-Density Fairing Filler and 410 Microlight Fairing Filler for fairing applications. Stirring these low-density fillers into the 105 System to the desired consistency makes the cured epoxy much easier to sand.

I have learned that sanding with an orbital sander should only be used to create profile and not used to fair a surface. Long sanding blocks work best for fairing to prevent creating low spots. I may check the fairness of the surface using a large metal ruler or a wood batten as a straight edge to see whether I need to add or remove additional material. If there are pinholes in the fairing compound, I use a plastic spreader to force epoxy into any small voids before rolling on coats of epoxy.

Applying Epoxy

To seal the faired surfaced, I roll multiple thin coats of epoxy onto the surface creating a smooth, uniform, bubble-free coating. The West System 800 Roller Cover works well for applying a thin coat. I tip off the coated surface by lightly dragging a foam brush or a section of roller cover over the wet epoxy coating.

To prepare the mold for the release agent, I wet sand the epoxy coating with 180-grit wet/dry sandpaper and may go to 600-grit to create a higher quality, smoother finish on the final part. I'll apply five or six coats of paste release wax if creating a part from the finished mold for the first time. I wait at least 30 minutes between coats, rubbing a thin coat of wax on the mold surface and wiping it off right away. For extra insurance, I will sometimes brush on a thin coat of PVA (polyvinyl alcohol) to ensure the parts will release from a new mold. Applying PVA in thin film with a bristle brush prevents runs in the coating. The PVA is water soluble and therefore can easily be removed from the part and the mold with water.

Epoxy does not adhere to certain plastic surfaces very well, so clear cellophane packaging tape or flash tape also makes a convenient release agent for some applications.

Modifying a Car Body

My recent project, modifying a fiberglass, open-wheel, race car body for a friend demonstrates my approach to building composite parts using different kinds of molds.

My friend wanted the fiberglass body to look similar to a 1967 Gurney Eagle F1 car body. To achieve that, he let me borrow an older car body to get the general shape and dimensions needed to fit the car's metal tube frame. The back half of the body needed to be built taller with an integrated cockpit fairing in front of the driver. The nose section needed to be flattened slightly and brought to a point creating the characteristic eagle's beak shape.

A fairing compound was applied over the flash tape to smooth the surface and stiffen the area. This will be sanded fair and sealed with epoxy.

A scrap of curved fiberglass panel was the perfect piece to extend the nose of the car body to match the new profile.

I first started by building a quick female mold off the borrowed car body. The female mold gave me the ability to build a body that could be modified to replicate a 1967 Gurney Eagle F1. Once the duplicate body was built, I decided to start tackling the project by creating the taller sides of the car body and cockpit fairing as one fiberglass piece to be bonded on with thickened WEST SYSTEM Epoxy.

Using drywall screws, I temporarily attached an old Plexiglas® windshield to the car body to serve as a mold surface for the fiberglass fairing and a guide for the height increase around the driver. I taped a thin layer of cardboard over the drywall screws so the surface would be smooth. Next, I applied flash tape over the entire surface to seal it. In order to make the surface as smooth as possible, I applied a layer of fairing compound with a plastic squeegee.

While the fairing compound is still soft, I use a cheese grater to help remove material quickly if needed. There is not a long wait for it to cure between coats, so I don't worry about trying to make the first application perfect.

Based on the size of this part, I like using sanding blocks ranging from 12 to 24 inches long to fair the surface. If the part had been larger, like the hull of a yacht, longer sanding blocks may be needed.

Next, I sealed the entire fairing layer with a two coats of unthickened WEST SYSTEM Epoxy. Once that cured, I wet sanded it smooth. This provided me with a uniform, sealed work surface. I then applied paste wax over the epoxy-coated mold to ensure that the fiberglass part I was about to make would release from the mold. Years ago I learned the hard way that even when a release agent (like paste wax) is used over fairing compounds, the part can still adhere to the mold. Sealing it with a

Left: Strips of 10 oz. fiberglass cloth were wrapped half way over the reinforced hose and attached to the car body.

Right: The fiberglass strips have been covered with 105/206/410 and ready to be faired.

coat of epoxy, then applying a release agent to the epoxy, prevents this from happening.

I determined that I needed a laminate schedule around 50 oz. to be thick enough to provide adequate stiffness. I decided that four layers of 12 oz. fiberglass cloth were needed to make the fairing and higher sides around the back half of body. I used West System 105 Resin and 206 Slow Hardener, and a plastic spreader, to wet out each layer of fiberglass over a flat workbench, then draped it onto the mold I built onto the car body. To avoid sanding between layers, I applied each layer wet-on-wet, one after the next.

Once the fiberglass part had cured for a day, I removed it from the mold and trimmed around the perimeter of the part with a jigsaw. I sanded the underside of the part with 80-grit to prepare it for bonding to the car body. I removed the temporary mold from the car body (the windshield, tape, and drywall screws) and wiped the surface with acetone using clean, white paper towels to remove any contaminants like residue from the tape. Then, I sanded the surface of the body with 80-grit where the part would be adhered.

Using 105 Resin and 206 Slow Hardener thickened with 406 Colloidal Silica to a non-sag consistency (like gel toothpaste), I bonded the cockpit fairing and sides to the car body and allowed the epoxy to cure over the weekend. To reinforce the joint, I then applied a couple layers of 12 oz. fiberglass tape around the outer edge of the cockpit fairing/car body seam. Using epoxy mixed with 410 Microlight to create a fairing compound, I smoothed out the surface then sanded it to create the final shape. My friend will provide the final preparations for paint.

Fabricating the Nose

The nose of the car body needed to be pointed, similar to an eagle's beak, so I had to find a way to recreate the desired shape. I decided the best approach would be to trim the nose of the original car body off about 3 inches before the end to create a large enough opening for the new shape.

For the rounded edge of the new nose opening, I used a reinforced plastic hose as a mold. I simply bent it to the desired "beak" shape and mitered the points at approximately a 90 degree angle in the center of both the top and bottom of the opening.

I had a curved fiberglass/epoxy panel laying around the shop that worked perfectly to bridge the gap between the cut off section of the old nose and the shape of the reinforced tubing of the new nose. With a bit of clamping, and some epoxy thickened to a non-sag consistency, I epoxied the curved fiberglass panel to the car body. I applied a release agent to the reinforced hose, then wet out multiple small strips of 10 oz. fiberglass cloth and wrapped them half way around the hose and back onto the fiberglass panel.

I faired the nose with West System 105 Resin/206 Slow Hardener thickened with 410 Microlight, which I applied with a 12" drywall knife. This helped maintain a fair surface and reduced the need for much sanding after it cured.

Once the epoxy had cured, I then removed the reinforced hose I had used to create the curved beak-shape opening.

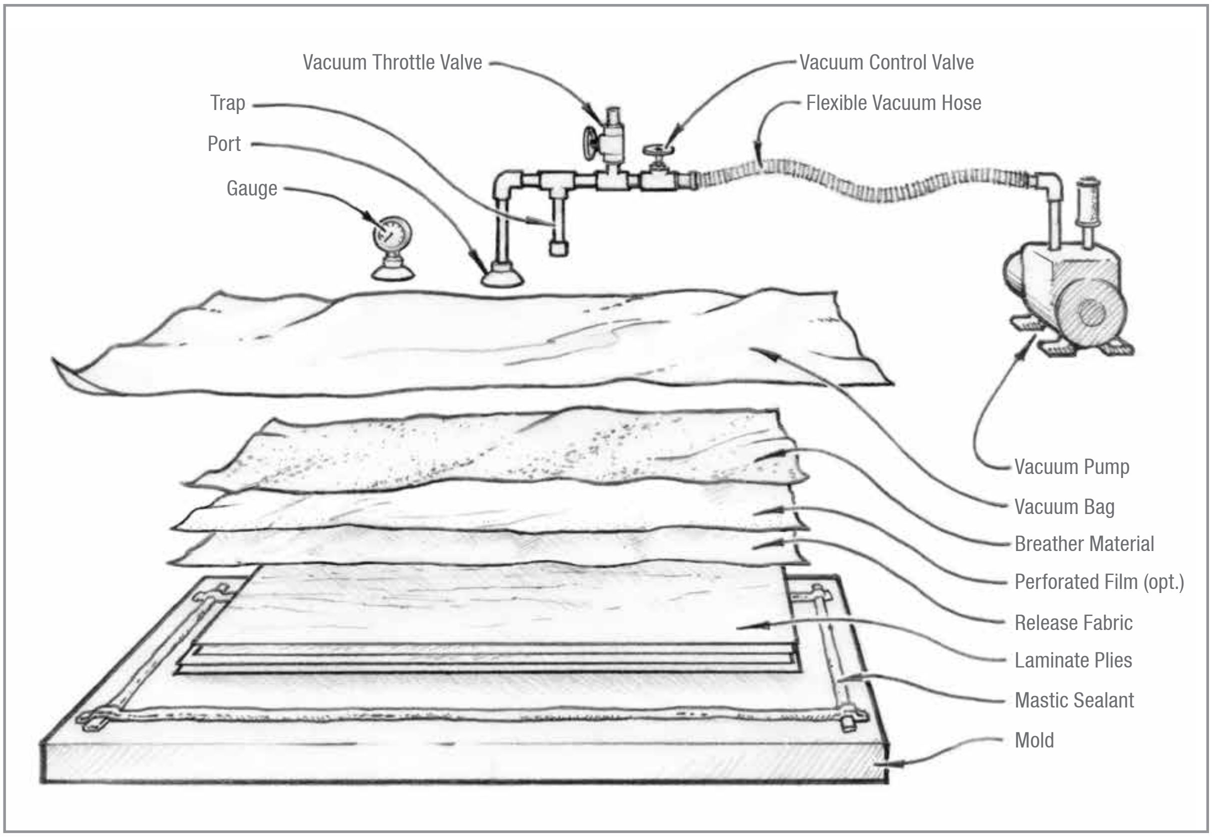
The fiberglass car body was a fun challenge to tackle using multiple different molding techniques and I think it turned out well. My friend was very happy with the new look of the car body and is excited to paint his new car body.

The new body being test fit on the car chassis. It has been faired, sealed with epoxy and is ready to be prepped for painting.

The new profile of the car body's nose.

Vacuum Bagging Basics

By Rachael Geerts - Technical Advisor



A typical vacuum bag set up

What is vacuum bagging?

Vacuum bagging is when a composite that is laid up and wet out by hand is then put under vacuum to compact the laminate and force out excess epoxy. Vacuum bagging has been a choice method of manufacturing and repairing composites for a long time.

Why vacuum bag a laminate?

The process of vacuum bagging allows for the ease of hand lamination while producing a part that has better properties because of its compaction. Vacuum bagging a laminate removes air voids and increases the fiber-to-epoxy ratio. All in all, it is a great process to improve your composite laminate.

What materials do I need and how do I use them?

Let's dive deeper into what materials are used in vacuum bagging and how to use those materials to achieve a great composite part. The materials and how to use them will be described in the order they should be put down on the mold or laminate.

Sealant tape

Lay down a layer of sealant tape around the perimeter of the part, leaving some space between it and the laminate. The area where the tape is put down should be clean and free of epoxy residue and stray fibers. Sealant tape is also commonly referred to as tacky tape or mastic sealant.

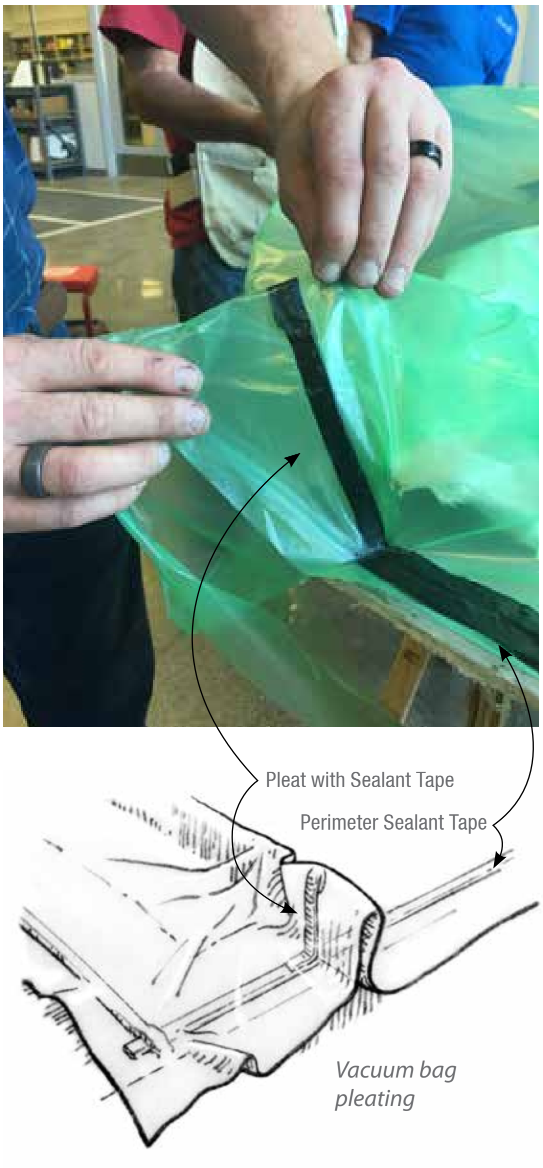
Release fabric

Release fabric should be laid directly on top of the wet laminate. Release fabric leaves a textured finish when it is removed, reducing the need for surface prep before secondary bonding.

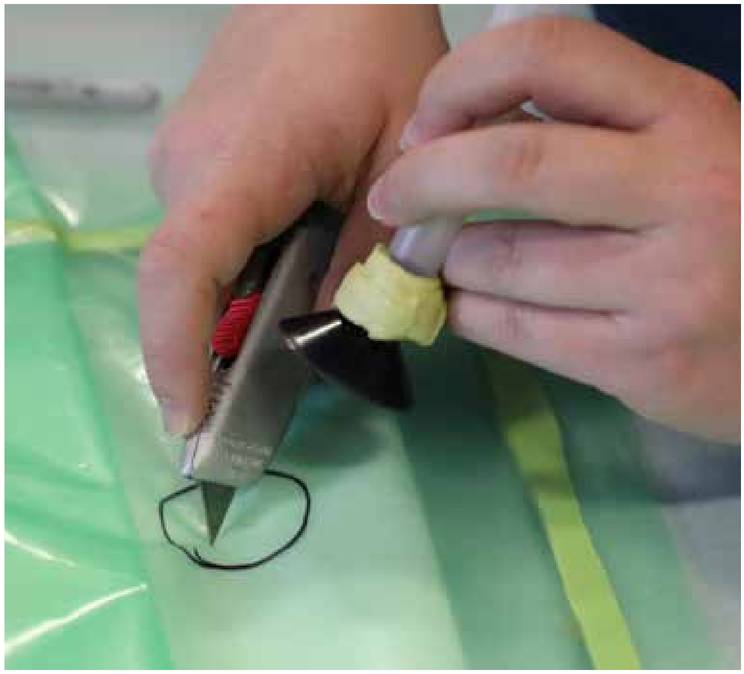
Release fabric is commonly referred to as peel ply. The most common types of peel ply are made out of nylon or polyester fibers. Some peel ply is coated with release agents.

Release film

Perforated release film is a thin plastic with small holes that control how the excess epoxy moves from the part to the breather fabric. This is an optional layer in the vacuum bagging process.



Vacuum bag pleating



Connecting the vacuum port and line to the bagged laminate

Breather fabric

The function of the breather fabric is really two-fold. As vacuum pressure consolidates the laminate, the squeezed-out epoxy goes through the peel ply (and the release film if you are using it) and is absorbed by the breather fabric. Because of its open structure, air flows easily through breather fabric allowing the air to be evacuated from the consolidated laminate. Breather fabric is also referred to as baby blanket.

Pleats

Where there is a corner or bend in the part, put a pleat in the bag. This is a fold that sticks up and allows the vacuum bag to move and conform nicely to the part under vacuum.

Without pleats, you may get bridging or cause a tear in the bag. Bridging occurs when the bag does not fold down completely on an edge and makes the edge more rounded (it will look like a filleted edge). This fillet area will not be compressed by the vacuum pressure. If there is no pleat on a corner, it may poke a hole through the bag and cause it to rip depending on how much force is on that spot.

When laying down the bag on your laminate you will also have to take into consideration where to position your vacuum port on the bag. The hole for the vacuum port should be small and easy to seal well so no air will leak into the assembly.

Vacuum port

The vacuum port is a fitting used as the transition point between the materials under the bag and the vacuum line.

WEST SYSTEM Vacuum bagging kit

Vacuum bag

The vacuum bag is a plastic film sealed to the mold so a vacuum can be pulled. This layer will need to be cut oversized to accommodate for curvature in the part.

Vacuum line

Vacuum line is an airtight flexible hose that connects the vacuum port to the vacuum. Other types of wire-reinforced hose may work, but they should be rated for crush resistance or tested under vacuum for the length of the expected cure time. Semi-rigid plastic tubing with adequate wall thickness can be used for a plumbing system, but it is often awkward to handle. If the laminate is to be cured at an elevated temperature during vacuum bagging, the tubing must also be heat resistant. Plastic tubing that withstands vacuum at room temperature may soften and collapse when heated. Rigid plastic elbows and Ts can be used for changes in direction in the vacuum line to prevent collapsing the line. Vacuum line is also commonly referred to a vacuum hose.

Vacuum gauge

The vacuum gauge shows how much vacuum you have pulled on the part. Vacuum-bagged parts should have at least 10" of Hg of pressure acting on them to properly consolidate the part. The vacuum gauge gets added to the assembly the same way the vacuum port does.

Vacuum source options

The purpose of a vacuum source is pretty self-explanatory, however, there are many different types of vacuums. Vacuum pump types include reciprocating piston, rotary vane, turbine, diaphragm, and Venturi. They may be of a positive or non-positive displacement type.

Positive displacement vacuum pumps may be oil-lubricated or oil-less. Oil-lubricated pumps can run at higher vacuum pressures, are more efficient and last longer than oil-less pumps. Oil-less pumps, however, are cleaner, require less monitoring and maintenance, and easily generate vacuums in a range useful for vacuum bagging.

Of the several types of positive displacement vacuum pumps useful for vacuum bagging, the reciprocating piston type and the rotary vane type are most common. Piston pumps are able to generate higher vacuums than rotary vane pumps, accompanied by higher noise levels and vibration. Rotary vane pumps may generate lower vacuums than piston pumps, but they offer several advantages. While their vacuum ratings are more than adequate for most vacuum bagging, they are able to move more air for a given vacuum rating. In other words, they can remove air from the system faster and tolerate more leaks in the system while maintaining a useful vacuum level. In addition, rotary vane pumps are generally more compact, run more smoothly, require less power, and cost less.

Non-positive displacement vacuum pumps have high CFM (cubic feet per minute) ratings, but generally at vacuum levels too low for most vacuum bagging. A vacuum cleaner is an example of a non-positive displacement or turbine type pump.

Air-operated vacuum generators are simple, low-cost Venturi devices that generate a vacuum using air pressure supplied by a standard air compressor. Their portability, relatively low cost and the accessibility of compressors in many shops and homes make Venturi generators ideal for smaller vacuum bagging projects.

Single-stage generators have a high vacuum rating, but move a low volume of air, limiting the size of the vacuum bagging operation. Larger two-stage pumps are comparable to mechanical pumps for most vacuum bagging operations, but require a proportionately larger compressor to run them.

Whichever vacuum generator you choose, it must hold a continuous vacuum until the epoxy reaches an effective cure. This may take 8 to 24 hours depending on the hardener selected and ambient temperature. After all the materials are in place, turn on the vacuum source and allow vacuum to be continually pulled until the epoxy has cured.

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.**

How-to Publications

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.

Look for Epoxyworks Online

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

Contacts for Product and Technical Information

North and South America, China and Korea

GOUGEON BROTHERS, INC.
P.O. Box 908
Bay City, MI 48707
westsystem.com
p: 866-937-8797

Europe, Russia, Africa, the Middle East and India

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

Australia and Southeast Asia

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

New Zealand and Southeast Asia

ADHESIVE TECHNOLOGIES LTD.
17 Corbans Ave./Box 21-169
Henderson, Auckland, New Zealand
adhesivetechnologies.co.nz
p: 64-9-838-6961
e: enquires@adhesivetechnologies.co.nz

Readers' projects

This is the wagon I am redoing the wood on. Some of the original wood will be reused. I bleached all the wood before I varnished it so it will match. On the panels I used 105 Resin and 207 Special Clear Hardener to epoxy mahogany veneer to the steel door panels. I clamped them by vacuum bagging them.

- Jeff Hobgood

I've been making art castings with your epoxy. The first batch sold out in 24 hours. Loving this resin!

- Tia Severino

8 11343 01280 9