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In this issue

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2009 is the 40th Anniversary of Gougeon Brothers, Inc. 1969 marked a point in the Gougeon brothers' careers when they applied all they had learned about wooden structures and epoxy technology to manufacture, for the first time, a product utilizing wood/epoxy composite construction. The full story of Gougeon Brothers, Inc. begins long before that date and is sure to continue well into the next 40 years.

Looking back

How WEST SYSTEM® products got their start

By Meade Gougeon

Our early years of trial and error in boat construction planted the seeds for the eventual development of WEST SYSTEM Epoxy products and the knowledge base for using them properly.

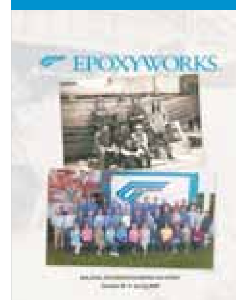
It began after World War II when boats were hard to come by. My brothers and I were growing up on Lake Huron's Saginaw Bay, and took to building our own boats. Our first attempts were crude and leaky but we progressed to better fitting parts held together with bronze Anchorfast™ nails and Weldwood™ glue. Later, some of the newer resorcinol adhesives offered better gap filling properties that improved overall bonding capability, but we still had to rely on fasteners to hold together our structural components.

A new epoxy technology came to our attention in the late Fifties to early Sixties. Detroit's automotive patternmakers were switching from resorcinol glues to epoxy adhesives to laminate pattern stock because the epoxy required less clamping pressure. One pattern maker, Victor Carpenter, became enamored with this new bonding potential and used it to build a small sailboat. His project turned out so well that he gave up patternmaking and became the first professional boat builder to use epoxy, along with traditional fasteners, to assemble wooden boats. In 1959 at the age of 14, my youngest brother, Jan, began working for Vic after school and on weekends. He helped Vic build several boats including an S&S 37 keelboat. The things Jan learned from Vic at an early age provided a significant boost to our later work in boat construction and epoxy development.

After graduating from college in 1960, I moved to Kansas City and began making a living as an industrial salesman. I lined up a local source of epoxy, then designed and built a Sunfish-type 14' sailboat. My goal was to eliminate the use of fasteners. The results were disappointing; several of the bonded joints failed. The problem was an inappropriate epoxy product compounded by lack of experience. But even then, the revolutionary potential of epoxy technology was clear. Over the next several years Jan and I would work hard to learn as much as possible about epoxy-bonded joinery. Our goal was to eliminate fasteners in wooden boat construction.

Two early racing trimarans—the *Funky Tri* and *Victor T*— that led to the development of *Adagio* and other Gougeon designs.

Cover story



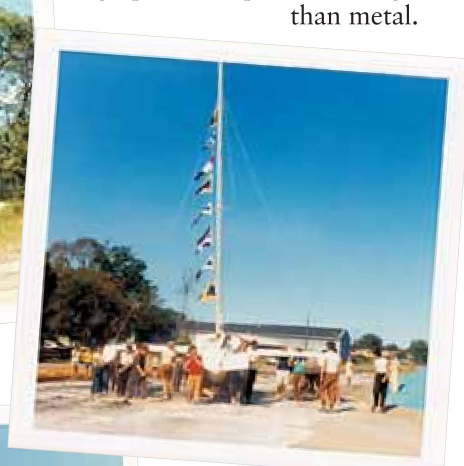
Top photo—Building *Golden Dazy* in1975. Back: Jim Gardiner, Tom Taylor, Meade Gougeon, Craig Blackwell. Front: Joel Gougeon, Jan Gougeon, Norm Baker, J. R. Watson.

Bottom photo—The Gougeon Brothers Inc. team in 2008.

In early 1970, *Adagio* under construction in a small boat shop on Sophia Street in Bay City, Michigan.

Wooden boat building was on its way out in the early Sixties, replaced by newer fiberglass reinforced resin technology. Over thousands of years, wooden boat building had evolved to become totally reliant on fasteners to hold together the parts and pieces that form a boat. The problem with this traditional method is that even the best designed joints can transfer only 25% of wood's ultimate strength. To accommodate joint inefficiency, wooden boats of the past were heavier than necessary. Wood's real potential became evident during World War II when hot-molded laminate made with veneer and resorcinol glues under high pressures proved stronger than metal.

Adagio is picked up and carried to her launching by Meade's family and friends in the summer of 1970.



A good example of this is the all wood deHavilland Mosquito bomber—still one of the lightest airplanes ever built for its horsepower rating. It has long been known wood can be a superior engineering material if the joint problem can be overcome.

The only problem with building the Mosquito bomber was the need to bond it all together with a minimum clamping pressure of 125 psi. This was done at a huge cost both for tooling and labor, which could be afforded only during wartime when metals for building planes were in short supply.

When it became apparent epoxy had the potential to eliminate this burdensome requirement of massive clamping pressure, it seemed possible to completely bond large wooden structures efficiently and at a low cost. The prospect challenged our imaginations and led us down a path of trial and error over the next ten years, culminating in the building of the trimaran *Adagio*.

Launched in 1970, *Adagio* was the first large, all epoxy bonded and sealed wooden boat built without the use of fasteners. Jan and I built her in just six months. This summer, *Adagio* begins her 40th season and will again be a serious contender in the Great Lakes Mackinac regattas.

More importantly, she has withstood the test of time. *Adagio* is proof that fully bonded, wooden monocoque structures can be built within cost and time constraints and last for generations

The trial-and-error projects leading up to *Adagio* included a series of five racing trimarans and numerous DN iceboats. Our goal for each of these projects was to build the lightest structures possible. We wanted to produce race-winning boats. Our emerging wood/epoxy technology quickly developed an advantage over the best fiberglass technology of that time. By continuously pressing the edge of material performance, we learned from both success and failure, contributing to our knowledge base.

The DN iceboat, with its highly loaded components continually operating at strain rates just short of failure, proved to be an excellent test bed. Many broken masts and runner planks put us on a fast-track learning path to understand what was possible and what was practical in wood/epoxy composite construction.

In 1969, with this crucial knowledge in hand, we began building DNs as our first product and would sell more than 200 iceboats over the next five years.

The epoxy system we were using worked well as an adhesive, but was difficult to apply as a coating. Where we really got lucky in our quest for epoxy technology was to be located 17 miles east of Dow Chemical Com-

DN iceboat production was in full swing in the Martin St. boatshop in the early '70s.

Joel Gougeon fits a plywood deck to the hull of one of the more than 200 DN iceboats built by Gougeon Brothers.

pany's world headquarters. Dow and Shell chemical companies were the major base-epoxy suppliers in the US, having imported the technology from Germany in the mid 1950s. The material was used mainly to replace the tin in cans, and act as a protective undercoat to metal surfaces. It created a tightly cross-linked coating resistant to water and moisture vapor.

Herbert Dow, grandson of the Dow Chemical Company's founder, was an avid sailor who we introduced to ice boating. After seeing what we were up to, Herb made it possible for us to work with several chemists in Dow's epoxy lab to help us develop epoxy resin and hardener products we could use as both an adhesive and a coating.

We were now seriously into both bonding and sealing wood with epoxy. Our goal was to solve one of wood's most difficult problems: its tendency to absorb moisture and swell. It was well known in the industry that epoxy-based technology had the potential to create a formidable moisture barrier. With Dow's help, we developed the formulations that became the basis of the WEST SYSTEM group of products we introduced in 1971.

In that year, my brother Joel returned from Vietnam having flown 131 combat missions. At the time, word was traveling as to what we were doing in our shop. Other boat builders were coming around asking questions and wanting to buy some of the epoxy resin and hardeners we were formulating for our own use. We were flattered, but with the frequent interruptions it was becoming increasingly difficult to get our boats built. Joel had saved some money during his four years in the air force, and arrived at exactly the right time to invest in our fledgling business and help start a new business venture selling our epoxy. Another family member, my brother-in-law Grant Urband, who had just moved his family back to Bay City from California, also joined our new enterprise.

We worked hard those first months, setting up production facilities and developing packaging and labels. But looking back, this was actually the easy part. Far more difficult was adequately educating our new customers on the proper metering, mixing and applying of the various components of the new WEST SYSTEM product line. Having worked with epoxy over the previous 10 years, we'd mistakenly assumed it would be as easy for the average customer to understand as it was for us. Instead, we found ourselves spending a good portion of our time on the phone explaining how to use the products, or providing tours of our shop to visitors who wanted to see with their own eyes this revolutionary approach to using wood as engineering material. To keep our boat building obligations on track, we hired J.R. Watson, Jim Derck and Craig Blackwell[1]. Later Jim Gardiner[2] and Robert Monroe came aboard. J.R. and Jim are still with us as technical advisors; Robert is our president and CEO.

"Building boats for the pleasure of it"—Jan and Greg Bull place the deck of Jan's latest boat in position on the freshly glued hull. The 40' wood/foam/carbon/epoxy catamaran (for now, Project X) is certain to be the subject of at least one future *Epoxyworks* article. Jan expects to launch her later this summer.

Jan clamps the foam/carbon deck skin to the hull with drywall screws and plywood blocks.

Meade's *Gougmaran* was launched in 2004. Like *Adagio's* launch decades earlier, it's good to have the support of family and friends and now a few more Gougeon employees.

In 1972, we introduced the first WEST SYSTEM Technical Manual to help our customers understand our products, which were like none other on the market. We expanded the manual over the next several years, focusing on answers to question our customers commonly asked. We later published other, more project-specific manuals including *Wooden Boat Restoration & Repair* and *Fiberglass Boat Repair and Maintenance*. We also wrote *The Gougeon Brothers on Boat Construction*, a definitive work on cold-molded construction with wood and WEST SYSTEM materials, now in its fifth edition. The key to our customers' success with these products was a dedicated technical staff offering one-on-one support by phone, mail and in person, combined with our growing library of informative publications. Satisfied customers made the WEST SYSTEM part of our business grow steadily over the years. Our technical support model is similar today but with the added modern conveniences of email, the internet and of course our new website featuring instructional videos and PDFs of all of our manuals.

The growing demands of our epoxy business made it difficult to continue our one-off and production boat building operations. We discontinued building boats in 1993, but the boat shop we began in long ago is still in operation. Jan and I have come full circle. I like to think we "successed" our way back to the boat shop, where we build our own boats for the pleasure of it and are still discovering new things about processes and materials. Jan is finishing up a 40' trailerable, self-righting catamaran he hopes to launch this summer. I have been playing with small boats, mostly sailing canoes. And of course we both are still into iceboats, which is our first love. We supposedly are retired, but I think we are still doing research and development, just as we did in the years leading up to the introduction of WEST SYSTEM products.

[1] In 1988, Craig Blackwell established Blackwell Boatworks in Mann's Harbor, North Carolina. His company has built more than 60 sportfishing boats ranging from 28 to 72 feet. www.blackwellboatworks.co

[2] After leaving Gougeon Brothers, Jim Gardiner went to South Florida where he worked for or with a number of top firms such as Schoell Marine and Derector Florida. Jim was a principal at Consolidated Yachts and a cofounder of Egret Boats. He and his wife Ginger live in Washington, North Carolina, operating Compmillenia and Egret Boats.

Attaching line guides to fly rods with G/flex®

By Tim Veale

Fly fishing, particularly for Atlantic Salmon, has been my lifelong hobby. The fly rod itself has an ancient past but its technical prowess as an instrument to launch line and fly to a designated spot on the river was epitomized by the arrival of handcrafted split bamboo rods in the late nineteenth century.

But bamboo, not withstanding its nostalgic appeal, cannot compete with a rod made from the carbon and nano-fibers available today. Carbon composite rods have reached new heights in flexibility. Their ability to deliver line and fly over long distances is reflected in the 'modulus,' or stiffness, rating borrowed from aerospace and mechanical engineering's modulus of elasticity. The higher the rating, the more energy is stored in the rod and by extension, the farther it will cast a line.

It occurred to me that a new carbon fiber rod could only deliver its claimed 'modulus' when it was unencumbered by line guides, which are typically spaced every few inches down the length of the rod. Such guides are typically double-footed and bound to the rod with tightly wrapped nylon thread. I asked myself "What happens to a rod's highly touted modulus when it is hobbled every few inches by rigidly wrapped line guide? Does installing line-guides destroy the rod's original modulus ratings?"

As a subscriber to *Epoxyworks*, I have been intrigued by the new G/flex flexible epoxy and decided to try it as a means of attaching the line-guides to a carbon fiber fly rod. The G/flex would need to be tenacious enough to keep the guide in place under stress, and flexible enough to allow the rod's natural stiffness to work as intended.

Here is the procedure to construct a finished fly rod using G/flex to attach the guides:

1. Mark the location of each quide and scuff an area of the rod's surface, exposing native carbon fiber (not too much—just enough to create a pad for the guide foot, plus 10%).
2. Remove any paint from the top and bottom of guide foot with 5⁄32" chainsaw file and 80-grit sandpaper.
3. Slide a half inch long piece of heat shrink tubing (sized correctly for diameter at guide location) onto the rod blank and leave loose on the foot side where the glue joint will be.
4. Thoroughly mix a small amount of G/flex and spread it on the underside of the guide foot and on the scuffed pad area of the rod. Place the guide and slide the tubing up over the foot. Heat to shrink the tubing. Gently re-position the guide under the tubing if necessary.
5. Leave in 65°–70°F area, undisturbed for 7–8 hours then remove heat shrink tubing by peeling with a sharp thumbnail.
6. Inspect, gently remove any excess glue and leave to cure another 16 hours.

A graphite composite fly rod with all of the guides attached with G/flex to maximize the rod's flexibility.

If done properly with well-prepared parts, these guides will not only stay on the rod as predicted but the overall modulus rating of the carbon fiber rod blank will not be encumbered by the usual eight or nine lashed-down guides festooning an ordinary fly rod. ■

A line guide attachment with G/flex instead of the typical tightly wrapped nylon thread.

Saving the deck

By Jeff Blackmon

There are often interesting articles in *Epoxyworks* magazine illustrating the different uses of the WEST SYSTEM® epoxy. I admire the time and effort that goes into some of these handmade boats that are like art projects. But in my particular situation, I was most concerned about strength rather than the aesthetics. I was dealing with wood rot at the bases of the support posts for a large patio deck. There are two levels on this deck, with the patio furniture on the top level and a built-in hot tub in the lower level. The deck is constructed of 6×6 support posts, 2×12 flooring supports and 2×4s for the finished floor. All of this is redwood.

Blackmon's two-story deck is supported by 6×6 redwood posts resting on concrete footings.

Two of the posts that rotted where their bottom ends rested on footings. Soil held moisture against the bottom of the posts creating an ideal environment for rot.

Last spring after power-washing the deck, I began the once-every-three-or-four-years jobs of staining it. This deck is twenty years old now but still holding up well. But as I applied the stain to the 6×6 support posts, I noticed severe wood rot in some of the posts. Over the years I'd neglected proper landscaping around the base of these, which lead to soil surrounding the bottom two or three inches of the posts. This in turn held the moisture near the footings much longer than it should have. The resulting compromise of structural integrity had to be addressed. In some cases, up to 25% of the cross-section of the post had rotted away. My options were to replace the 6×6 support posts, or structurally repair them. I chose to repair instead of replace.

I cleaned out the wood rot as much as possible using a screwdriver and sometimes just getting my fingers into the voids and pulling out the dead wood. Then I used a wood preservative solution of copper napthenate (green preservative) to halt the rot's progression. This solution is a spray, but I also poured on directly when possible. This is one of those situations where more is better.

Using an expendable plastic sign, I built small forms to fit around the base of the posts. Each form was 2"–4" high based upon the wood rot on the posts. My idea was to pour a replacement base that enclosed the rotted section of the post, and then some of the remaining post. I sprayed the plastic forms with silicone spray in hopes of an easier removal process. Then I carefully taped them to the original cement footings to hold the poured epoxy inside of the form.

I mixed WEST SYSTEM 105 Resin® with 206 Slow Hardener®. This gave me plenty of time to get the epoxy into the forms. I thickened the mixture with 403 Microfibers, which made it much easier to contain in the forms. Before removing the plastic forms, I let the epoxy cure overnight.

The forms came away from the epoxy with a little work, but the ink from the plastic stayed with the cured epoxy. This wasn't an issue since my next step was to paint the epoxy bases to they blend in with the garden around them. I used a dull brown paint that was created for camouflage work to hide the glossy look of the epoxy.

Lessons learned

It is not worth the time or effort to sand the epoxy bases. Any finish work needs to be done with hacksaw or grinder. No matter now careful a person is, there always seem to be leaks in the forms. Use plenty of tape to seal the forms, and then tape some more.

The use of epoxy and 403 Microfibers helps immensely when trying to keep the mixture in the forms. All in all, this turned into a very successful repair of the deck with the use of WEST SYSTEM epoxy. This maintenance project should provide another 20 years of life for this deck, and at a significantly lower cost than replacing eight 6×6 support posts ranging from 4' to 16'. ■

After treating the posts with wood preservative, Blackmon used plastic sign material to make forms around the base of the posts.

The forms were removed from the cured epoxy revealing the ink that transferred from the inside of the form to the epoxy.

Blackmon finished the repair with a coat of dull brown paint to camouflage the epoxy base.

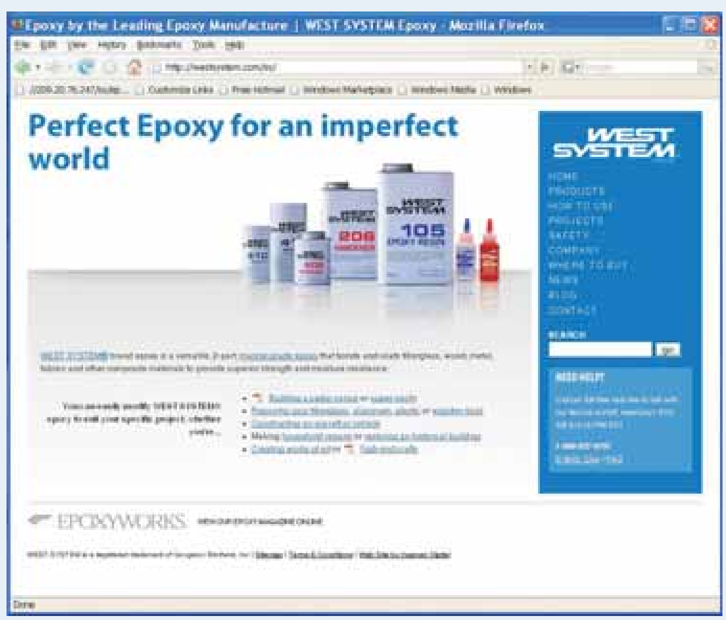
WEST SYSTEM® has a new website

We've launched an all-new website offering a wealth of information on using epoxy to complete many different kinds of projects, from boatbuilding to architectural repairs. At www.westsystem.com you can view short how-to videos, download free PDFs of popular WEST SYSTEM instructional publications, participate in blog discussions, get answers from our tech staff, or type in your zip code for a list of nearby WEST SYSTEM dealers.

The new site has a user-friendly interface with sidebar navigation, descriptions and usage suggestions for all WEST SYSTEM products as well as quick access to material safety data sheets, epoxy physical properties, current pricing and much more. The search function provides results from both westsystem.com and epoxyworks.com.

An intensive "projects" section comprises hundreds of articles about an array of epoxy-related projects. All were written by our experienced tech staff and our knowledgeable customers. These pages offer great ideas for putting epoxy to optimum use in all kinds of building and repair situations.

Visit us today at www.westsystem.com.



Building the Arch Davis Sand Dollar

By Nelson Niederer

We've had various types of boats in my family since the '60s, beginning with a painted canvas and flat-bottom wooden canoe my father built which we used for bow fishing. My grandfather bought a 1959 Lonestar fiberglass ski boat with a 35 hp Evinrude outboard for his kids and grandkids, among the first seen on Sand Lake in northern Michigan. Grandpa never set foot in it though. He preferred his little 14' aluminum rowboat powered by his trusty old outboard to take us fishing for largemouth bass and pike.

I have been using WEST SYSTEM® epoxy since about 1973 when my brother Randy and I bought a plywood hydroplane style boat with a 90 hp outboard. As teenagers we beat the hell out of it. We broke it on a regular basis and we'd glue it back together with epoxy filled with reinforcing fibers. We finally broke it beyond repair in '76—it made a great bonfire.

I cut my boat building teeth, so to speak, building a modified Optimist pram. I borrowed the patterns our local community sailing association (SBCSA) used to build their fleet (see *Epoxyworks* 18) and laid out the hull sides, bow and stern with 3" more freeboard. Rather than a sailboat, I intended to use it as a row boat tender for my 30' Sea Ray. With this project under my belt, I was ready to widen my boat building skills.

While reading my favorite magazine, *WoodenBoat*, I came across an ad selling plans for the Sand Dollar from Arch Davis. I took a chance and ordered a set online. I studied the plans for a few days and decided this was a project I could build by myself in my garage, which is set up as a woodworking shop. I've built a lot of furniture—bed frames, tables and clocks—which are in essence big square boxes with fancy trim. This boat would be anything but that. I found the plans, instructions and video to be excellent and very helpful.

I started by building the stem. I laid out the pattern (which comes full size on Mylar™ film) over a 1" mahogany board, then used a nail to poke holes defining the shape. It was easy to simply connect the dots and cut out the part. The rough shape was sawn from 2"×1" thick boards laminated together. Next I built the transom from two layers of ¼" okoume plywood, also laminated together. I used the two-step bonding technique as recommended in the WEST SYSTEM *User Manual* for each of these parts. I coated each mating surface with unthickened epoxy, allowed it to penetrate, then mixed resin and hardener and thickened it to a catsup consistency with 406 Colloidal Silica filler. I applied the mixture to one of the surfaces and secured the parts together until cured. This does take more time, but provides a more reliable bond by preventing glue-starved joints. Again, I laid out the Mylar film pattern and used a nail and hand pressure to create the

Left—Gluing the keel to the transom and aft bulkhead.

Right—Sanding begins on the coated hull to get it ready for varnish.

shape. I'm apparently not as hard as nails because this really hurt my hands.

With both ends made, I started building the strongback from 1"×10" clear pine. It is basically a long skinny box on sawhorses. After making sure it was level and square, I attached the frames to it. Next, I spray painted around the legs of the sawhorses so I could move the whole assembly and put it back exactly where I'd started if for some reason I had to move it.

The first parts mounted to the strongback are the temporary frames, which help define the hull shape but will not be a part of the boat. I cut these frames from ¾" particle board, but this time I tried using carbon paper under the Mylar pattern to trace the lines instead of using nails. This was much easier and faster. I defined and drew a centerline and starting point onto the top surface of the strongback so I could position and lay out the frames accordingly. I took care to mount them square to the centerline and perpendicular to the horizontal plane. I mounted the transom next, forming the last "frame." Then I mounted the stem to the front of the strongback and extended it into the first frame. There are two bulkheads, one each fore and aft, both cut from ¼" okoume and framed with Sitka spruce. These were secured to the appropriate temporary frame and remain a structural part of the hull.

At this point the basic shape of the hull was defined and it was time to mount the keel. I attached ¾"×5" mahogany plank to the transom with epoxy and clamps, bending the plank across the frames and securing it to the stem, again with epoxy and clamps. Next came the Sitka spruce stringers—one on each side of the keel and three on each side, glued into notches in the frames.

With the "skeleton" ready, I installed the bottom and side planks which I made from ¼" okoume. The overall length of the stock needed to be 11'6", so I needed to scarf the plywood to get there. The problem was I'd never made a scarf joint before. So I approached the tech guys at Gougeon Brothers, Inc. My brother Bruce, who is a tech advisor there, showed me a technique using a hand plane and belt sander. My first scarf joint turned out perfect, the last one—not so much. I pre-coated each plank with three coats of 105 Resin®/207 Special Clear Hardener™, prepped them for installation and glued them in place. I used deck screws as temporary clamps until the epoxy cured.

The lightweight Sand Dollar and its trailer tow easily behind a motorcycle.

Now came the character-building portion of the project—fairing the hull. My plan was for the outside hull to be dark blue, so it had to be perfect because any little divot or imperfection would stick out like a sore thumb. Fill and sand, fill and sand, fill and sand. Eventually it was done to my satisfaction and the hull was ready to be flipped right side up. Now, I would never pretend to know anything about the experience of childbirth, but as soon as I saw the hull upright and it looked like a boat, all the pain of sanding and fairing was immediately forgotten. I had a new baby boat.

The Sand Dollar is designed as a row-able sailboat but, since my father, brother, and I have about a dozen sail and power boats between us, mine would be a rowboat only. This meant I didn't need to build a centerboard and trunk, a rudder or a mast. The seats, bow deck and gunwales are made of mahogany with Sitka accents.

The interior was left natural wood—seats, bow deck and gunwales are mahogany with Sitka accents. The hull is painted with House of Color™ Midnight Blue Pearl.

The bow has lines of graphite filled epoxy between the strips for that classic look. But when sanding the graphite mixture I learned dust would get in the wood grain and cast a gray shadow that took some doing to get clean. I asked my brother how I could avoid the issue and he suggested using a black paint pigment instead of the graphite. (see *Epoxyworks* 21) This worked much better for me and sanded out clean. It's handy having family on the Gougeon tech staff.

I worked slowly and carefully to fit and install the trim because I wanted it to look like a piece of fine furniture. Once the trim was done it was time to paint the hull. I enlisted the help and expertise of my nephew Alex, who worked at Psycho Custom Cycle, a motorcycle shop, prepping and painting custom frames and tanks. He arranged for the use of the shop's facilities to spray paint the hull. We decided on House of Color™ Midnight Blue Pearl, which requires a four step process: primer, black base coat, midnight blue and four coats of clear. The paint is popular these days on cars—a "flip-flop" color that looks blue or black depending on the conditions at any given moment. The hull looks awesome and draws lots of oohs and aahs from many an admirer. Thanks Alex.

I took the boat home to varnish the interior woodwork, applying 10 to 12 coats of Captain's Spar Varnish™ over the epoxy-encapsulated surfaces. You know what that meant—more endless hours sanding between coats. I asked my pal J. R. Watson at Gougeon Brothers how many coats of varnish I should apply. He said three coats would be adequate, but just keep going until I couldn't take it anymore.

After addressing a few minor details I was finally ready to launch my Sand Dollar. It rows great—easy and fast. In the end, with all my complaining about sanding aside, the boat was no work at all to build, just pure fun. I don't know what I'll do with it now that the building is complete. I'll probably sell it (as of this writing it is for sale) and start another project. I've been eyeing plans for an electric launch. You know the story of the boat builder who won the lottery? When asked what he'd do with the winnings he replied "I guess I'll keep building boats until I run out of money." Smart man.

A final thought from Arch Davis for the amateur builder: "Don't point out your mistakes and nobody will ever know." ■

Three more views of the completed Sand Dollar. The varnished interior has 10 to 12 coats of Captain's Spar Varnish™ over the 105/207 epoxy-coated surfaces.

The bow has lines of black pigment-filled epoxy between mahogany and spruce accent strips for that classic look.

Plastic engine cover repair

By Jeff Wright

My wife's 2000 Audi TT has a very sleek shape, and these smooth lines are carried under the hood with molded plastic engine covers that provide a very clean looking engine. Unfortunately when I was servicing a burned out bulb, I attempted to remove the covers in the wrong sequence which caused a tab to snap off.

I couldn't justify going to a dealer to buy a new one, and I didn't want to spend time searching the salvage yards, but I needed to either repair it or try to convince my wife this part of her car is unimportant.

After looking at the part, I decided it could be glued back together with G/flex® or possibly G/5®. Since I didn't know what type of plastic the cover is made from, I needed to determine what adhesive and surface prep would yield the best results. Each of our technical advisors get phone calls from customers with the same question I had, "I have part made out of an unknown plastic, what do I do?" My advice is to perform a very simple test to decide on how to prep the surface and what product to use.

The Test

I was fortunate in that I could perform a test on the backside since that area isn't visible when it's assembled on the engine. I decided to test six combinations of adhesive and surface preparation.

I first prepared all six areas and then glued simple ¾" × ¾" blocks of ¾" plywood to the surface with the plywood veneers parallel to the surface (1). After a 24 hour cure, I used a set of large pliers to twist the blocks off (2). If the adhesion is good it would shear the plywood, but if the adhesion is poor the block will just snap off. This simple test provided very useful data as shown in the following table.

Testing surface prep for plastic adhesion

Adhesive	Preparation method	Results
G/5	None	Poor
	Sand with 80-grit sandpaper	Good
	Flame treat	Poor
G/flex 655	None	Good
	Sand with 80-grit sandpaper	Good
	Flame treat	Good

1—Test blocks glued to the underside of the cover.

2—The test showed which combinations of glue and prep worked best.

3—Fixing the broken tab with G/flex 655 and flame treating.

4—The repaired cover back in place in the Audi.

This method of testing doesn't show which surface preparation or adhesive provides the strongest bond. It shows only whether the bond is strong enough that the plywood fails first. Using our Pneumatic Adhesive Tensile Test Instrument (PATTI) is one way we can measure the exact strength of the bond. For many applications, including my engine cover, exceeding the strength of the plywood is acceptable adhesion.

Since the area I had to repair would be difficult to sand and the joint did not fit together tightly, I decided to use flame treating and G/flex 655. I used duct tape to hold the small tab in position (3). It was easy to remove the tape after the epoxy cured. I was then able to install the cover back on the engine just like before it was broken (4). ■

The first boat Brian Jones designed and built was published in *Epoxyworks* back in 1993. He recently completed his second design and build, the new BC27. The hull is hand laid S-glass and Kevlar™ over ATC Corecell™ using WEST SYSTEM® epoxy. The bowsprit, tiller, and foils are carbon with Pro-Set® epoxy used in the keel. Overall displacement is 2,400 lb with 1,200 lb of that being the lead bulb. Its inaugural regatta was Annapolis Race Week, where he placed 1,1,1,1,2,1. More information can be found on Jones' website, www.bcboatworks.com.

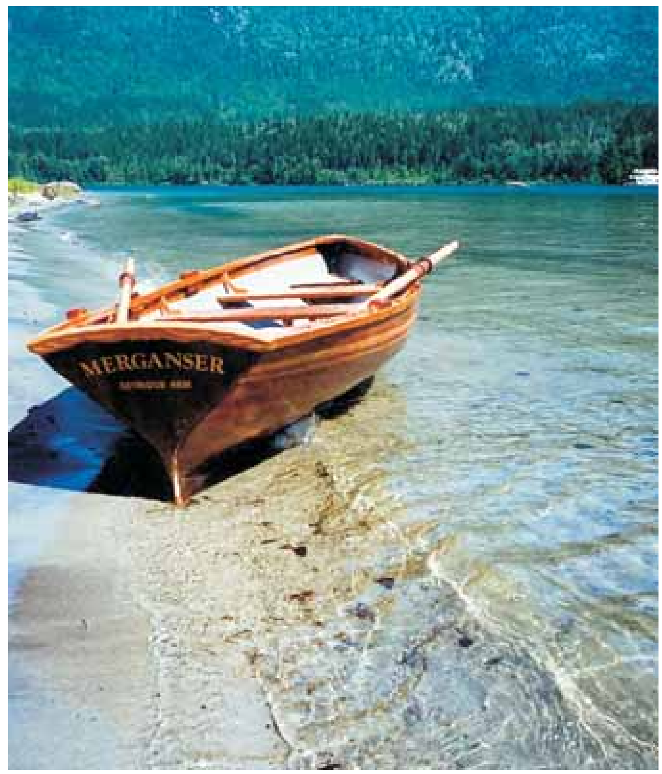
Steven Hirsh designed and built this 16'1" skiff. This is his second prototype of this boat. There are also a 12' and 14' prototypes in the works. The new models and the 16-footers will all be convertibles. That is, sailing rigs have been designed for them that incorporate a half-wishbone boom cypress and pivoting cypress mast. The PREMA 161, the model shown here is built of three layers of 4 oz fiberglass/epoxy over western red cedar, with an ash, sable and cypress accent stripe. The beam is 4'6" and the weight is 190 lb, with a maximum weight capacity of 561 lb. Contact Steven Hirsh, Deleon Springs, Florida, 610-462-3664.

Jerry Heller of Southport, North Carolina, sent this photo of his latest project. He used G/flex 655 to build this cherry rocking chair for a church fund raiser. He said he used G/flex because the chair comes with a lifetime warranty so he knows it will stay together.

Readers' projects

QUETZAL is a 13'5" single-handed sailing dinghy designed by Eric McNicholl for stitch and glue construction. It is a product of the Gatineau Hills Boatworks in Alcove, Quebec. Owners Frank Berinstein and Eric McNicholl estimate 200–250 man-hours to complete the project. They say it is a head-turning beauty with lots of horsepower. For more information on QUETZAL and Gatineau Hills Boatworks, visit www.ghboatworks.com.

Growing up in Wesley Hills, New York, Michael Fitzpatrick was influenced by his grandfather, a furniture maker and house wright. He set up his own studio in Boston a few years ago and makes exceptional, hand crafted furniture to order, like the two pieces above. He uses WEST SYSTEM epoxy for most of his projects, especially the bent laminated pieces. He is the furniture expert for the online source allexperts.com and fields furniture questions from a worldwide audience. He also just purchased a COZY license and is considering using epoxy for the experimental airplane. Visit www.bostonfurnituremaker.com.



Bruce and Pam Barrett of Kamloops, British Columbia built this "wherry" type rowing boat. Weighing a mere 80 lb, it is constructed of western red cedar and fir, cut from the family homestead. Bruce reports that the boat rows great—on one pull of the oars it takes off like a scalded cat. The photo was taken on Shuswap Lake in British Columbia.

Dejavu **was built on mahogany frames. Meranty plywood was applied over the frames with bronze screws and WEST SYSTEM Epoxy. Mahogany planking was applied over the plywood and the entire hull was encapsulated with epoxy. The exterior of the hull was covered with 12 layers of marine varnish, then sanded with 2500-grit sandpaper and buffed. Alex Neymark of Charlotte, North Carolina, spent five years (part time) building** ***Dejavu*****.**

Marquetry made easy

By Al Witham

There is a simple way for those of us who may be "artistically challenged" to produce inlaid furniture, jewelry boxes, canoe decks, trays, etc. with a modest investment in equipment and materials, in a reasonable period of time, and with eye-pleasing results. I have no formal training in making inlays, but have found a method which works for me. I showed this method to a friend who is a shop teacher; he now has students as young as ten incorporating it into their school projects with excellent results. My method is adaptable, user-friendly within limits and forgiving of minor cutting errors. Even novices can produce great looking marquetry.

The most challenging part of traditional inlay is cutting pieces that fit together within high tolerances. In contrast to the window method commonly used for marquetry, I accomplish this by cutting both the inlaid piece and the cutout in the background wood at the same time. (In the window method the design is drawn on a waste sheet of veneer, then selected parts of the design, or "windows" are cut away from the sheet. Choice sheets of veneer are then placed under the windows to reveal the best color and grain placement. The shape of the hole is marked through to the selected veneer and cut to fit the window.)

I use an entry level scroll saw that cost about $150 a few years ago, with a 16" throat equipped with fine 00 blades. On a given project I might go through as many as a dozen fine blades, but at $5 a dozen, cost isn't a big concern. The blade specifications vary, but might go something like this: width .026", 28 TIP, thickness .011"—this particular one is an Olsen 440R reverse tooth blade, but others could also be used.

I've found that wood species/density and thickness play a big part in determining ease and accuracy in cutting, and also affect how many blades break in the process. Because I do most of my inlay in hardwood, and my planer will take wood down only to about ⅛" thick, that's the thickness of most of my work.

I laminate the finished inlay onto a backing material like Baltic birch plywood to provide strength and thickness. If both surfaces of the work are to be visible, such as in a jewelry box top, I laminate another piece of the background wood on the bottom to make a sandwich with the fancy woods on the outside and the plywood in the middle.

Tom Pawlak captured this shot of Witham's marquetry at the Small Craft Builders' Rendezvous in Peterborough, Ontario last summer (*see page 22*).

For some canoe decks I've made the inlaid piece for the top layer, then laminated it to homemade plywood made from ¼"-thick layers of cedar strengthened with fiberglass and epoxy (with successive layers having the grain oriented at 90° from adjacent layers). This results in a light but very strong deck, with the inlay on the top in a highly visible location.

To create the inlay you need a pattern. Many of my pieces are given as gifts, with the recipient's name or initial inlaid in a contrasting wood. I've also used lettering for significant dates, for a wedding gift, for instance. For this type of pattern, I use a computer graphic program to produce the letters and numbers. To create my pattern, I print out whatever I want to inlay on regular computer paper. Other sources of patterns could be pictures, photos, children's coloring books, hand-drawn designs, letterset or newspaper headlines. The only limiting factors are your imagination, and patience in cutting out whatever form might take your fancy.

I spray the backside of the pattern with spray adhesive (available at craft stores) and stick the pattern on my inlay piece of wood which has been planed to thickness, say a nominal ⅛". Follow the instructions for "permanent bonding" on the spray adhesive; this keeps the pattern from separating from the wood during cutting. Later, you can remove the pattern and residual adhesive with a little lacquer thinner and elbow grease.

With the pattern adhered to the inlay piece, use double-sided carpet tape to affix the inlay piece to the background wood. This wood should be roughly the same thickness as the inlay piece, say a nominal ⅛" thick. Now you'll have a unit consisting of two contrasting wood pieces topped with the paper pattern. Take care to ensure the inlay is positioned accurately on the background piece. I usually make the background piece oversized to allow for trimming to final dimensions after the inlay is glued in place.

To cut out the inlay, drill a 1⁄16" hole through all layers at the edge of one of the inlay marks on the pattern. With the scroll saw blade attached under the table, feed the blade through the hole and attach the top of the blade to the top arm of the saw. Cut out the inlay following your pattern. When completed, you have cut out a two-layered piece: your inlay wood on top, and the background wood on the bottom. You still have your background piece, now with a cutout in it. Carefully separate the two layers, then drop the inlay into the background piece. Now you have your contrasting inlay. Because you have to cut through both layers in the same cut, the inlay must match up with the shape of the "hole" created in the background wood. Next it's a matter of gluing the inlay into the background color.

To facilitate gluing a number of pieces, some of which may be quite small, you need a glue with a long "open" time. In addition, the glue should provide good gap-filling qualities and accept coloring to match to the work. After experimentation, I settled on WEST SYSTEM® epoxy (which I use for coating strip-built boats) because it has the best combination of these features.

When I'm ready to glue an inlay I cover my working surface with waxed paper and arrange all my supplies: background inlay pieces, small cup for mixing the epoxy, epoxy resin and hardener, nitrile or latex disposable gloves, mixing stick, small artist's brush, lacquer thinner, paper towels, two pieces of ¾" plywood slightly larger than the workpiece, waxed paper, clamps and matching sawdust(s).

WEST SYSTEM 407 Low-Density filler is dark red-brown and 410 Microlight® is a light tan color. I do a lot of inlays using dark woods for the inlaid pieces—walnut, cocobolo, ziricote, etc., into a light-colored background like Birdseye maple. In cutting out the inlay in this case, I may favor the background color at the expense of the piece to be inlaid, and make up for minor imperfections in cutting by using the 407 Low-Density filler and walnut dust for coloring. The colored epoxy will match well with the inlay, and as long as your eye follows a smooth line along the contrast between the walnut/filler and maple, minor errors aren't noticeable. If the background was dark and the inlay light, I'd reverse the options, favoring the dark background during cutting, then using the 410 Microlight filler and other pale dust to color the epoxy to match the inlaid piece. It is possible to use different mixtures at different places on the same workpiece if you need to color one dark and another light in order to mask imperfections in your cut pieces.

The scroll saw is setup with light and magnifier.

The scroll saw setup shows the enclosed portions of letters and the "R" have been cut out. The blade has been fed through 1⁄16" hole ready to cut out the "ap."

The "ap" has been cut out with the two layers separated.

To start, I mix the WEST SYSTEM 105 Resin® and 207 Special Clear Hardener® in the proper ratio. Using a small artist's brush I paint the mixed epoxy on all mating surfaces of the inlay piece and the "hole" in the background wood. At least two sides of each part will be end grain, which tends to soak up much more epoxy than face or side grain, so after letting the epoxy soak in for a few minutes I apply a second coating. If the end grain absorbs this too, I repeat with another coat or two until the end grain cannot absorb any more epoxy. At this point, I thicken the epoxy mixture with 407 Low-Density or 410 Microlight filler and the appropriate colored sanding dust. A small putty knife or plastic glue spreader is useful for packing the thickened epoxy mixture into the saw kerf to fill any gaps. I try to remove any gross excess of this colored mixture from the surface, using a paper towel moistened with lacquer thinner, but don't fuss over every tiny bit because the surface will be sanded smooth after everything sets.

To ensure everything lines up, I clamp the workpiece between the two pieces of ¾" plywood covered with waxed paper and leave it to set overnight. For larger workpieces I use larger pieces of plywood, put them on my workbench and weigh them down with a cement block, a jug of water or whatever is handy and heavy.

After the workpiece has set overnight, I remove it from the sandwich of plywood and weights/clamps and sand the face reasonably smooth with a random orbital sander to 120-grit. Usually this reveals some gaps where the epoxy mixture didn't quite fill the kerf. If so, I mix another small batch of epoxy and color it with fillers and/or sawdust to match, then fill in any remaining gaps and let it set.

After sanding the face again, this time to 220-grit or more, I laminate this thin (⅛" thick) workpiece to a backing piece to provide strength and stability. Baltic birch plywood is reasonably resistant to changes in moisture, especially in the thicker pieces. For small pieces like trays, or if both sides are going to be visible I usually laminate another piece of the background wood to the bottom of the plywood. Having a sandwich with both outside layers of the same type and thickness of wood helps ensure that any seasonal changes in moisture absorption or release happen at the same rate in top and bottom layers, avoiding warping the finished work.

Helpful Hints

1. Use background wood and inlay wood of the same thickness, or have the inlay slightly thicker. If the background piece is thicker than the inlay, the inlay may be recessed, requiring an undue amount of sanding to get everything to level again. It's usually much easier to sand a proud inlay down to level with the background than vice-versa.

2. Good light and magnification help during the cutting process. I use an inexpensive clamp-on lens/light and remove my bifocals to be able to focus through the lens onto the cut.

3. Make changes in cutting direction gradually; avoid sudden changes except at corners. Watch the blade carefully and slow the feed rate while you make gradual corrections if you see the blade drifting off the line of your pattern.

4. When cutting a pattern with shapes within shapes (inside of letters like A or O, or islands in lakes, etc.) always cut out the smallest shape first. That way, you still have the larger piece to hold onto and guide through the saw.

A beautiful example of a completed jewelry box with inlaid top.

5. You can cut pieces larger than the throat dimension on the saw if you do them in sections then glue them back together. For example, I cut the deck of the Stony Lake Skiff by arranging the image on a lamination in the ash so the entry point for the first cut started right at the lamination before gluing that panel to the rest, and the cut continued across the north shore (i.e., top) of the lake. This allowed me to cut the long dimension from the rest of the work, leaving a piece of manageable size. I then cut out the rest of the islands and the south shore. After completing all cuts, I reassembled the pieces and side laminations and epoxied them together.

6. Multiple species of wood can be used in the inlay if you start with one species and the background wood. After you complete this cut, place the inlay in the background and repeat the process for the second species, etc. In this way, it is possible to build any number of species, and therefore colors and grain patterns, into the inlay.

7. Adding photocopier toner or WEST SYSTEM 423 Graphite Powder will darken an epoxy mixture. Use it to fill a kerf to produce a fine black line—for example, to replicate a kite string. The addition of white flour to a mixture can be used to lighten the final color.

8. For lettering, a script/handwriting font requires fewer holes to be drilled as entry points for the scroll saw blade as opposed to a font using individual letters. Drilling a 1/16th hole at an obvious turnaround spot (like the serif tail of a letter) facilitates making a clean change in direction with the scroll saw blade.

9. It can be easier to hide a drilled entry hole in dark wood filled with dark filler than in light wood filled with light filler. As the wood increases in darkness, subtle differences in shades of "dark" become more difficult to differentiate.

10. I try to save dust from other woodworking projects in a variety of species to allow more accurate color matching. Dust from band saw or scroll saw cutting, or sanding operations with the belt sander or random orbital sander seem to be best suited for this application. I keep my dust samples in spice jars or pill vials for easy color comparison.

There is really no limit to the process except one's own creativity. My artistic abilities are limited to drawing stick people, yet by tapping into others' designs and computer graphics I can adapt these to produce works that look pretty good. If it works for me, it can work for anyone. Give it a try. ■

Dear Epoxyworks,

I wanted to share with you some photos of the electric violins I have made using WEST SYSTEM® materials. It's been a very rewarding personal project that's brought together my four decades' love of the violin and my past "day job" working in biotech in new product development.

The instruments (which I build for my own enjoyment—I've changed careers and now am a college physics professor) are built using a body molded of carbon composite, fitted with a traditional hand-carved maple neck and fingerboard. The composite makes for a very light instrument that stays in tune well despite changes in temperature or humidity. WEST SYSTEM resins, hardeners, fillers and carbon powder all were used in fabricating the original plug, the molds, and the actual instruments.

I hand-wind the magnetic pickup units myself and pot these in WEST SYSTEM epoxy.

The finish is lacquer, either opaque color or clear to let the cloth show. The results are eye catching on stage. The techniques are fairly routine: female mold, hand lay-up, etc. Still, it's an attention getting and successful application of the WEST SYSTEM materials—that sounds great, as several CDs will attest. Prior to this project, I'd built electronics and done woodworking, but I was worried about attempting composite building. However, the WEST SYSTEM performed beautifully throughout making of the tooling as well as the instruments.

Thanks for making the technology behind my project!

Sincerely,

John Silzel

To get in touch with Jon Silzel or find out more about his violins and his music, visit www.silzel.com.

The mold (above) is epoxy/fiberglass with an epoxy/graphite mold surface. The violin body (left) is 2 outer layers of 3 oz bi-directional carbon fiber with a single inner layer of 6 oz fiberglass. Silzel demonstrates the qualities of his violin at a Christmas concert in Irvine, California (below).

Meet our newest tech advisor, John Thomas

Gougeon Brothers welcomed a new technical advisor in February. John Thomas is an avid sailboat racer who competes in several classes including E-scow, A-scow, Farr-40 and Beneteau 40.7. Last year he crewed with Meade Gougeon aboard the trimaran *Adagio* in the Port Huron to Mackinaw and Chicago to Mackinaw regattas. He has also written many articles and provided marketing services for SailingAnarchy.com.

While in high school, John packaged WEST SYSTEM products in our epoxy department. He returns to us a couple of decades later having attended Wright State University and succeeded in a high-tech career in controls engineering. He worked in the pharmaceutical and biotech industries, where he did regulatory compliance and quality assurance, as well as helped design manufacturing and environmental systems and validated these systems.

His strengths include technical engineering and technical writing. He is also part of the "next generation" in the Gougeon family business—our founder Meade Gougeon is John's uncle.

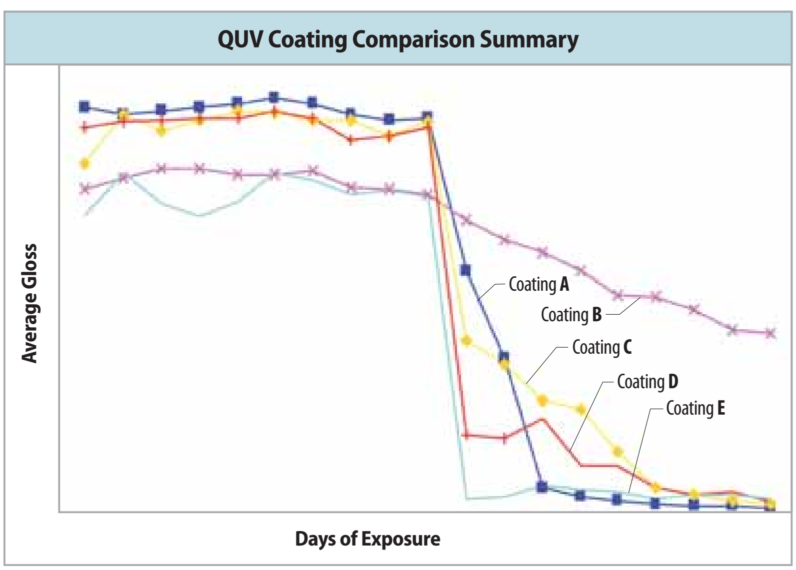
In addition to sailing, John enjoys graphic design, woodworking and making furniture.

Weather forecast: Destruction

By Julie VanMullekom

I've been with Gougeon Brothers, Inc. for 15 years, 13 of which was in the Order Entry Department where I talked to many interesting customers working on all sorts of projects. Two years ago I became a member of the Technical Department. Now, rather than giving product pricing to customers or advising them on the quantity they may need, I'm able to see how those products evolve from just a mere gleam in someone's eye to a product we are proud to call our own. For me, being a part of this process means among many other things, handling our testing data. My role ranges from filing it all the way to building data bases for the many tests we perform in house.

Julie examines a 3" × 6" coupons after a long exposure in the QUV test machine. In a matter of days, the accelerated test subjects the samples to the equivalent of months of normal weather.



The average gloss of various coatings, as measured by the BYK Micro-Gloss™ Gloss Meter, diminishes over days of exposure.

One of the tests I have taken on is related to weathering. This test is conducted in our QUV™ Accelerated Weather Test machine. This accelerated weathering chamber produces cycles of UV light, condensation and temperature change to mimic the environment—think Mother Nature on steroids. It operates aggressively, consistently and around the clock. We run these tests in accordance with ASTM Standard G154. First we create samples of 3"×6" wooden coupons, or any other substrate we deem necessary, then coat them with epoxy, polyurethane, varnish topcoats or other coatings. Along with the test samples, we include a control sample. This allows us to compare how the new materials we're studying handle the exposure compared to those we're already familiar with.

We put these coupons inside the weathering chamber with the coated side facing toward the fluorescent bulbs. I know what you're probably thinking—fluorescent bulbs? Oh no my friend, this is not your average fluorescent bulb. They are UVA 340 lamps, specially-designed to simulate sunlight, and the critical short-wave UV. Actually, for all of you sun worshipers out there, the bulbs are the same as those used in tanning beds (interesting, yet very disturbing at the same time).

Florida shows surprisingly good correlations for color shift direction and rank order for comparative testing with the UVA-340 lamp. Although UV is only 5% of sunlight it causes 95% of degradation, which makes it the primary bad-guy in weathering.

The secondary cause of degradation is moisture, specifically dew. Because of dew, the average time of wetness in many regions is 45–50%. In addition to dew of course there is rain. The reason water has such a negative effect is because it is a natural solvent. It causes chemical reactions and surface damage as well as thermal shock and erosion.

The last, but certainly not the least, factor in degradation is temperature. It can cause deterioration and thermal effects such as physical stress and deformation. A 10°C increase in temperature doubles the rate of chemical reaction. Yes, doubles! And let's not forget the whole freeze-and-thaw effect. As you can clearly see, all of these combined conditions certainly can wreak havoc after time.

Observing the effects of these elements on a test sample outdoors can take weeks, months, even years. Fortunately, the QUV machine enables us to analyze and measure the same results in a fraction of the time. With the accelerated conditions in the weathering chamber, the test samples change rapidly. For instance, it may only take a day or two for slight changes to occur to the surfaces while those same changes may take months outdoors. For this reason I take readings of each sample frequently with a Micro-Gloss Gloss Meter, in accordance with ASTM Standard D523. The Gloss Meter is a hand held device which directs a light at a specific angle to the test surface and measures the amount of reflection. The lower the number, the less surface gloss the sample has.

As important as measuring gloss is, it is only one of the many measurements we note during testing. Some other changes samples may undergo are cracking, clouding or hazing, chalking, color changes and peeling, to name a few.

An important item to note is that when testing, we always test to failure. The chart on the previous page demonstrates the importance of running a test to failure. If I'd stopped the test mid-way through, I'd have assumed test sample B was one of the worst. However, as you can see it actually turns about to be the best. It maintained a steady, slowly declining gloss throughout the test and didn't crash and burn like its competitors.

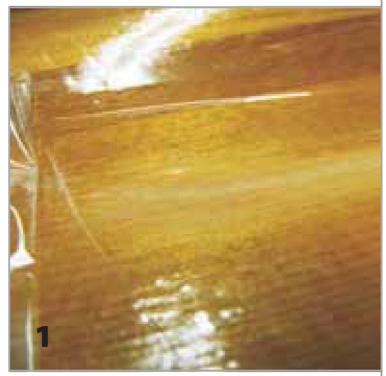
Here are some general guidelines for coatings I've observed while involved in QUV testing:

- Gloss finishes are better that satin.
- Flaws such as dirt, dust, missed areas and runs are all points where failure begins.
- Corners are bad news. Be sure to round and coat them appropriately.
- Two-part systems may cost more, but outperform one-part systems by an order of magnitude.

Weathering testing is critical to us when we are formulating new materials or improving on old. It quickly lets us know if we are headed in the right direction, if we need to go back to the drawing board or it verifies that we are still 'UV' light years ahead our competition. ■

Using G/5® as clear filler for dented varnished trim

By Tom Pawlak



1

2

3

A few years ago a customer approached me at one of the trade shows to say he loves our G/5 Five-Minute Adhesive for filling dents in wood trim prior to reapplying varnish. I thought what a great idea. It cures clear, can be wet sanded in an hour (longer if you are dry sanding) and can be varnished over without a problem. It looks much better than filling with wood putty because it is clear. It can be difficult matching the surrounding wood color when filling with wood putty.

I used his tip the last time I prepared my wood strip canoe for a fresh coat of varnish. It had picked up a few dents over the previous 15 years. The best time to identify dents is after sanding the hull with a palm sander. The dents remained shiny because the sander wouldn't dip into low spots. I abraded the dings with a 3M Scotch Bright™ abrasive pad to dull the shine (**1**) prior to applying the G/5. Filling the dents with G/5 took about thirty minutes. On the sides of the boat where the epoxy was prone to running away, I covered the epoxy with clear packaging tape until it cured (**2**). The repairs are absolutely transparent and difficult to detect once a coat of varnish is applied (**3**).

How will these repairs hold up over time?

To be sure we weren't recommending something that would lose clarity over time, we dented several varnished wood samples and repaired them with G/5. After it cured, we sanded them smooth and varnished over them with Captain's 1015 Varnish™, my favorite single-part varnish.

After drying for several days, I handed them off to Julie so she could torment them in the QUV Weathering Machine. After months in the machine, the varnish eventually went dull but the G/5 repairs below the surface remained nice and clear. ■

Camper panel repair

By Tom Pawlak

Todd Lynch, one of our valued employees, brought in a damaged plastic panel from the back end of an 11-year-old pop-up camper and asked if it was worth fixing. It came from his hunting camper which had been rear-ended. He just wanted it to be functional. The impact had made cracks at nearly every screw hole for holding the panel in place, making it doubtful it would last another trip down the highway.

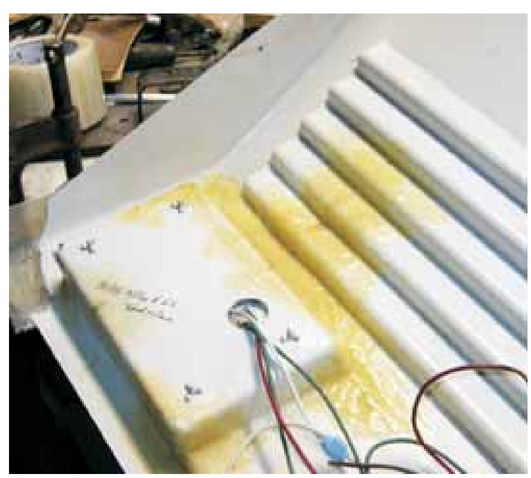
Opinions within our tech staff varied as to whether it was worth fixing. I thought it would be easier to repair than build a new one out of plywood. Others on the staff weren't so sure.

The panel was made with thermal formed plastic and was likely built using a vacuum-formed sheet-molding process. Plastic sheet roughly $\frac{1}{16}$" thick is heated to the point of softening, placed over a mold and drawn into the form under vacuum. The reshaped plastic is then allowed to cool before it is removed from the mold and trimmed to final size. This process is still in use today to make simple molded shapes like inside panels for refrigerator doors. I was pretty sure the plastic was ABS or PVC, which our epoxy adheres to if it is sanded or exposed briefly to the flame of a propane torch.

We made fiberglass laminates using similar shaped, undamaged sections of the panel as a mold. When cured, these laminates were trimmed to the shape of the missing piece and glued in place with G/flex 655 epoxy.

To be sure the epoxy would stick, I performed a quick adhesion test with G/5 Five-Minute Adhesive®. If G/5 worked, I knew G/flex® would stick even better but I would get my answer the same day instead of waiting overnight for G/flex to cure. First, I sanded the portion of the surface, then sanded plus flame treated (with a propane torch) another portion. Next, I glued fiberglass laminate strips ($\frac{1}{16}$"-thick × ¾"-wide × 2"-long) in place. I glued only half of each fiberglass tab to the plastic, leaving the other end free so I would have a short handle to pull up on to cause something to break. As I had hoped for, the break occurred in the G/5-to-fiberglass bond and not in the bond to the camper panel. The sanded surface achieved the same result as the sanded and flamed surface.

To minimize cosmetic work later, we did the repairs mostly on the back side of the panel so they would be out of view when the panel was reinstalled on the camper. However, there were missing pieces of plastic in the corners of the panel requiring attention from both sides.



Left—Spacers and weights were used to force the grill into its original shape while the glue cured.

Right—Completed repairs were reinforced on the backside with G/flex 655 and 4 oz fiberglass cloth.

Left—The grill is held against plastic covered plywood with clamps and weights so repairs will be flat and smooth.

Right—Missing parts and cracks were filled with G/flex 655 and covered with 4 oz cloth.

Crack repairs

Many of the holes around the perimeter were cracked and split. To repair these, we ground into and beveled the cracks about ½" back with a 2" diameter sanding disk mounted on a drill motor. We filled these dished-out areas with G/flex 655 and before it cured, set in a 1" diameter patch of 4 oz fiberglass cloth.

Missing sections

Repairing the missing sections required a backer mold to support the epoxy while it cured. Cellophane tape applied to flat plywood panels made an excellent mold and release surface for repairing flat sections of the panel.

The panel had warped slightly, so we weighed it down flat to make good contact with the mold. If we hadn't forced tight contact the cured repair would have required lots of sanding before it could be painted.

To repair missing sections involving the rounded corners, we made very lightweight fiberglass laminates off of similar shaped and undamaged sections along the edges of the panel. We covered with shiny plastic packaging tape the undamaged part of the panel that we needed to recreate. Next, we brushed G/flex 655 onto the surface and set a couple layers of 4 oz fiberglass cloth into it. Then we applied more epoxy before setting in the second layer. When cured, these appropriately shaped laminates were removed from the grill, trimmed to the shape of the missing piece, sanded and glued in place with G/flex 655.

Todd spray painted the repaired panel with white textured Krylon Fusion™ plastic-compatible paint. He reinstalled it and says it now looks brand new. ■

The grill is clamped to remove twist while the repairs are made and the epoxy cures.

The repaired panel is back in place on the camper. A coat of Krylon Fusion™ textured, plastic-compatible paint completed the repair.

Small Craft Builders' Rendezvous

By Tom Pawlak

In July 2008 I attended the Small Craft Builders' Rendezvous in Peterborough, Ontario at the invitation of Ted Moores and Joan Barrett of Bear Mountain Boats (bearmountainboats.com). Their company was one of the sponsors of the gathering which included modern wood and epoxy constructed boats as well as traditionally built wooden canoes. Those attending ranged from professional builders to serious amateurs.

A great gathering of small craft took place at Trent University in Peterborough, Ontario in July, 2008. Both wood/epoxy and traditionally built canoes and kayaks were on display.

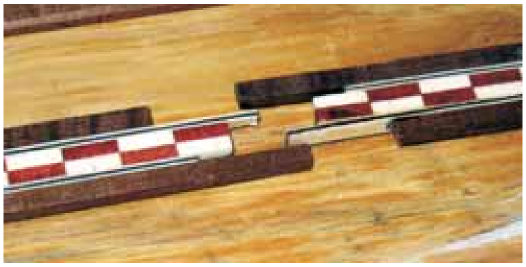
Approximately 75% of the boats displayed were traditionally constructed with steam bent oak ribs and wide flat cedar planks that were canvas covered. This was expected because many who attended were members of the Wooden Canoe Heritage Association who scheduled their annual gathering the same week as the Small Craft Builders' Rendezvous. Trent University is ideal for the events. It's located on the Otonabee River which is part of the Trent Severn Canal that travels from Lake Huron's Georgian Bay to Lake Ontario via a series of locks. Another benefit of scheduling the events at the university was the availability of inexpensive dorm room accommodations which many of us took advantage of.

Throughout the event a number of demonstrations, seminars and paddling excursions took place. The demonstrations included building a traditional canvas covered wood canoe, paddle carving, deck inlay techniques (*see Al Whitham's article on page 14*), seat caning, and rib and stem repairs to traditional craft.

On Saturday Skip Izon, builder of wood/epoxy canoes and kayaks from Shadow River Boatworks, gave a presentation on canoe hull design and performance parameters.

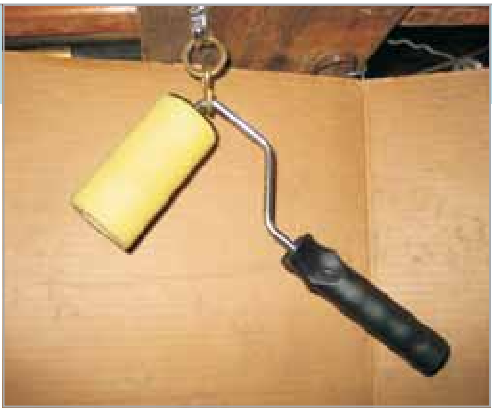
Ron Frenette, owner of Canadian Canoes, Bob Arthur and Brian Heaslip demonstrated an alternative strip building technique without the use of staples (*right, below right*) and incorporated fancy inlay accent strips in their demonstration. Bob Arthur makes the accent strips from hundreds of pieces of various colorful woods that he glues together with 105 Resin and 207 Hardener. He makes these strips about 3' long each and the ends are machined to interlock allowing you to make them to any length (*below*). The staple free construction kits and fancy inlay strips are available from Canadian Canoes at www.canadiancanoes.com. ■

See more Canadian Canoes on the back cover.



Below—Sections of clear polycarbonate tubing embedded in some accent strips available from Canadian Canoes glow as light shines through from the backside.

Saving your 801 Roller Frame



When you've completed a coating task using a 801 Roller Frame and 800 Roller Cover, what next? The roller frame is reusable but if you leave it resting in the pan while the residual epoxy cures, you'll probably ruin both the reusable pan and the roller frame. If you lay the roller and frame on a workbench, it will be stuck there the next day.

Setting the roller on a piece of plastic will bring you closer to success but in any instance where the roller frame rests on a surface while the epoxy cures, the cover will accumulate epoxy where it touches the surface. This accumulated epoxy forms about the plastic roller ends and cures. Attempts to remove epoxied roller covers may break the frame. Cutting the cover off with a saw is tedious and may damage both the frame and your saw.

Removing the cover before the epoxy cures is one answer, but is difficult because wet epoxy is slippery.

After 30 years of confronting this issue I've found the best solution: remove excess epoxy from the cover by rolling it on cardboard or scrap wood, then hang the frame and cover from an S hook. The hook should be connected at the turn in the frame (as shown in photo) and allow to cure that way. With the frame hung this way excess epoxy runs to the 'open' end of the cover. Once the epoxy is cured, remove the cover from the frame simply by pulling on the cover.

With this approach, I've been able to reuse the same roller frame many times.— *J.R. Watson*

Bates Technical College builds boatbuilders

Boatbuilding instructor Chuck Graydon of Bates Technical College sent these photos of some projects that his students have been working on using WEST SYSTEM® epoxy.

Bates Technical College is located in Tacoma, Washington. They offer several boatbuilding and repair programs designed to prepare students for apprentice-level employment in the boat building industry and ultimately fill positions in shipyards, marinas, and private boat building companies.

Their students obtain experience through extensive hands-on training in the construction of wood and fiberglass boats and are prepared for employment as aluminum fabricators, fiberglass laminators, wood and fiberglass tool makers, joiners, and marine carpenters. The program also provides extended learning opportunities for persons previously or currently employed in the industry.

They offer an Associate of Technology Degree and Certificates of Competency that cover basic boat building design and construction, and either fiberglass boat building and repair or wood/composite boat building.

Shorter programs are available that target the specific training areas of basic boat building design and construction, fiberglass boat building and repair or wood/composite boat building. And, they offer continuing education classes, providing individual evening courses to cover specific topics related to boat building.

Graydon says students enjoy the versatility of being able to use appropriate hardeners for different situations, and various fillers and thickening agents mixed to customize to the project. "Our students have come to rely on the predictability and consistency of results they get for any number of applications on a daily basis."

Visit www.bates.ctc.edu/boatbuilding for more details. —*MB*

Instructor Chuck Graydon tells us the finest looking recently completed project using WEST SYSTEM epoxies must be the 9' hollow, strip-built surfboard that student James Hibray crafted. He did a first-class job on the glassing and finishing.

Aaron Gnirk show off the stitch and glue kayaks he's built . It's the students own design, using 3 mm and 6 mm plywood encapsulated with WEST SYSTEM epoxy and 6 oz fiberglass cloth.

One of the students is building a plywood hulled hydrofoil, with high density foam and WEST SYSTEM epoxy and fiberglass composite struts and wings.

Their vacuum–infusion project is still in the tooling stages. Shawn Hanna fairs the hull plug—a labor intensive job and a tough one to get the students to focus on.

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.

Free literature (US and Canada only)

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

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

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

Also included are the current price list, stocking dealer directory, and the *Fiberglass Boat Repair* brochure.

Publications for sale at WEST SYSTEM dealers

Also available from the WEST SYSTEM Info Store at www.westsystem.info, 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.

002-650 ***Gelcoat Blisters-Diagnosis, Repair & Prevention***—A guide for repairing and preventing gelcoat blisters in fiberglass boats with WEST SYSTEM epoxy.

002-150 ***Vacuum Bagging Techniques***—Step-by-step guide to vacuum bag laminating, a technique for clamping wood, core materials and synthetic composites bonded with WEST SYSTEM epoxy.

002-740 ***Final Fairing & Finishing***—Techniques for fairing wood, fiberglass and metal surfaces. Includes fairing tools, materials and a general guide to finish coatings.

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

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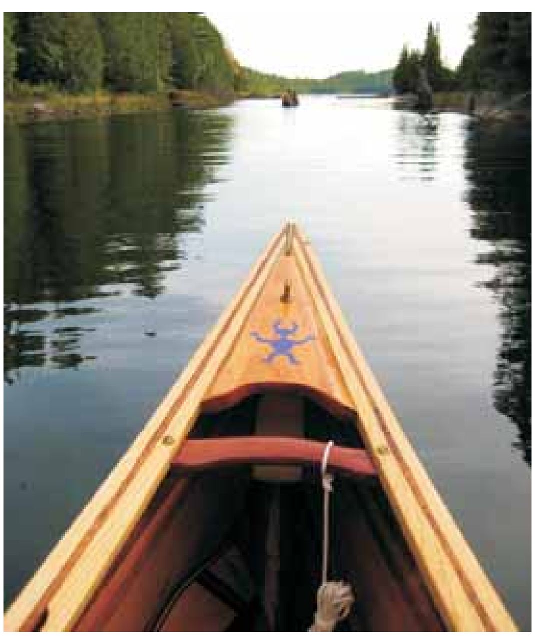
Why people build boats

A rest break after crossing a big open stretch into a facing wind—day 2 of a 7-day trip. Closest is a 16′ Prospector, in the middle is Ron Frenette and his wife in their 17′ Nomad and on the outside is a traditional wood canvas canoe built in the 1950's.



The 16′ Prospector, late in a day that saw rain and more rain. The deck is a piece of cherry, nicely sculpted, with an image of a mystical creature often seen in petroglyphs in northern Ontario.

Paddlers in a 16′ Prospector check out an amazing faulted rock formation in northwestern Quebec, September 2008.

Photos courtesy of Ron Frenette of Canadian Canoes. See also page 23 and visit www.canadiancanoes.com

Somewhere in the Fox Islands chain in Georgian Bay. Submerged rocks below crystal clear water make a great backdrop for this 17′ Endeavour kayak.