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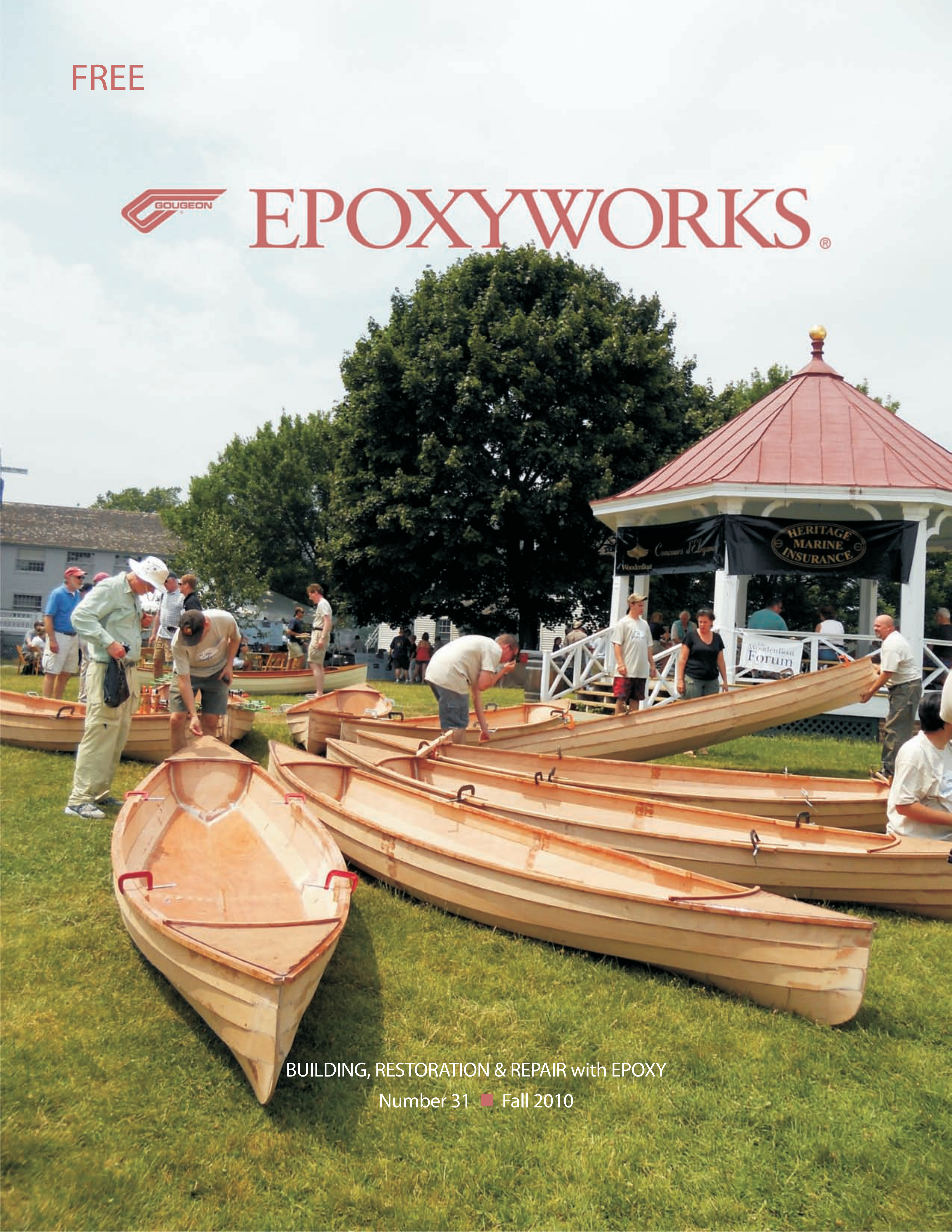
# EPOXYWORKS®




BUILDING, RESTORATION & REPAIR with EPOXY

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## In this issue




## EPOXYWORKS®

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# Sassafras 16
# Family Build Weekend

*By Grace Ombry*

Cover story

WEST SYSTEM®, Chesapeake Light Craft (CLC) and nine family groups joined forces at the 2010 WoodenBoat Show at Mystic Seaport in Connecticut this June to build nine Sassafras 16 kit canoes.

With only a blue and white striped rental tent to shield them from the unseasonably hot weather in Mystic that weekend, everyone labored hard to get their boats a long way toward completion in just three short days.

The Family Build event drew a lot of attention from boat show visitors, and many were excited to realize that building a boat of their own was not outside the realm of possibility. The nine Sassafras 16s were not the only boats being built at the show, but they were by far the most popular choice of the Family Build Weekend participants.

On the eve of the Woodenboat Show, WEST SYSTEM technical advisors Bruce Niederer and Tom Pawlak worked with CLC's president John Harris and his colleague Matt to set up sawhorses and tables, and glue together a total of 72 puzzle jointed planks and 36 scarf jointed inwales and outwales with Six10® Thickened Epoxy Adhesive. This preparation work set the stage for the family builders to make serious progress on their canoes over the long weekend of the show.

CLC's well-planned and expertly cut kits feature their LapStitch™ construction set up. Neatly pre-drilled holes allow for easy stitching with copper wire, quickly resulting in a round-bottomed, traditional-looking lapstrake boat that is strong, stiff and beautiful.

By the end of the first day the Sassafras 16 hulls and bulkheads were stitched into place and the laps were glued together with Six10. On day two, fiberglass cloth was applied to the interior boat bottoms with WEST SYSTEM 105 Resin® and 207 Special Clear Hardener®, and the inwales and outwales were glued into place and clamped. Everyone installed their decks and seat hangars on the third day, and sanded the boat bottoms.

Participants car-topped their nearly completed canoes home. WEST SYSTEM sent each group enough resin, hardener and filler to finish the job by glassing the exterior bottom of the hull, sealing the rest of the hull in three coats of 105/207, installing the cane seats and painting or varnishing their finished canoes. ■

**Semi-finished Sassafras 16 canoes on display at the 2010 WoodenBoat Show at Mystic Seaport.**

**Nine families begin the building process by stitching the first strakes together with copper wire.**

**Tents provided much needed shade for the families, and the CLC and Gougeon advisors as the canoes begin to take shape.**

**Temporary and permanent bulkheads are wired in place. By the end of day one, all of the strakes were stitched in place and the laps were glued with Six10 Adhesive.**

**On day two the bottoms of the interiors were fiberglassed. The now rigid hulls were rolled over and the copper stitching was removed .**

**The very practical, puzzle joints make it easy to turn short planks into long planks.**


**With the copper stitching removed and the outer lap joints filleted, the hulls are ready to be rolled upright again to install the inwales and outwales before the end of day two.**

**All of the inwales and outwales are glued, clamped and left to cure overnight. As the saying goes, "you can't have too many clamps."**

**On day three the decks were installed. At the end of the show, the weary families headed home to install the thwarts and seats and get started on the big tasks, sanding and finishing.**

One family leaves the 2010 WoodenBoat Show at Mystic Seaport with a nice souvenir of the weekend.

At the end of the three-day Family Build Weekend, the nine family teams pose with their assembled Sassafras 16 canoes. After some additional sanding, coating and finishing these handsome lapstrake canoes will be ready for the water.

*Photos: Grace Ombry*

# Building a practice Sassafras 16

In preparation for the Mystic Family Build Weekend, Bruce Niederer, Julie Van Mullekom and Grace Ombry built a Sassafrass 16 in the Gougeon tech department shop. They gained some valuable hands-on experience before Bruce, Tom Pawlak and Alan Gurski went to help families at Mystic build their Sassafras.

Gougeon summer intern, Nick Wisner and Bruce Niederer take the Sassafras on her maiden voyage. Though not completely finished, a gray pigmented epoxy coating keeps it watertight.

Nick and Bruce paddle out to greet the *HMS Bounty* as it heads up the Saginaw river to the Tall Ships Festival. Twelve tall ships visited Bay City for the three day festival held July 16–18, 2010.

Kari Maples

# So Stands the Mighty Oak

The Druids waved their golden knives
and danced around the Oak
when they had sacrificed a man;
but though the learned search and scan
no single modern person can
entirely see the joke.
But though they cut the throats of men
they cut not down the tree,
and from the blood the saplings spring
of oak-woods yet to be...

*'The Song of the Oak'—G.K. Chesterton*

***By Bruce Niederer***

The **PATTI** test uses compressed air to pull an aluminum stud from the surface of the test material to which it is bonded. It records the force required to break the bond in pounds per square inch.

People have been building boats using white oak for centuries, sacrificing blood, sweat and tears to engineer wonderful and enduring vessels of all shapes and sizes.

Oak was often used because of its desirable properties and behavior. It is dense, strong, rot resistant, holds fasteners well and can be steam bent. In the days before glues and adhesives, oak planking was used because it would swell considerably which resulted in tight and sound hulls, meaning little leaking and dry interiors. Of course, time marches inexorably forward and eventually builders began using adhesives to augment or, in some cases, replace mechanical fasteners.

We've been debating the issue of gluing oak ever since.

**Tensile adhesion test results**

| Adhesive | surface prep | Average adhesion |
|---|---|---|
| 105/205 | 80-grit sanding + alcohol wipe ×2* | 1,864 psi |
| G/flex 650 | 80-grit hand sanding | 1,935 psi |
| G/flex 655 | 80-grit hand sanding | 1,780 psi |
| G/flex 655 | 80-grit sanding + alcohol wipe ×2* | 2,212 psi |

*70% isopropyl alcohol in water

There are many who argue that adhesives have little use or no place in wooden boats. Sometimes that statement is qualified to apply only to "traditional" wooden boat construction. We have over 40 years of experience, data, and history to support our argument to the contrary and I will share some recent test data here. So get ready people—it's GBI as Mythbusters.

These days white oak is used more for keel timbers and frames, less so as planking. Regardless of the application, adhesion, while certainly important, is only part of the equation necessary to success. Still, it's a good place to start.

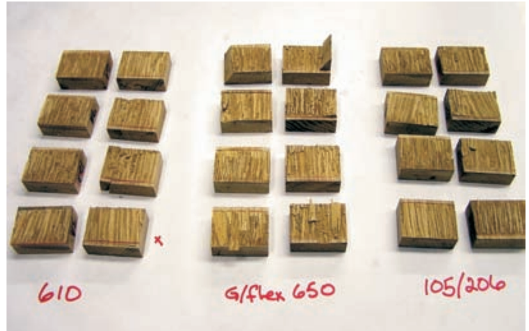
When we say adhesion what we are referring to is tensile adhesion measured with our **PATTI instrument** according to ASTM D-4541 (*results left*). There are no peel or shear forces involved.

What we learn from this data is surface prep can make a difference in adhesion as well as choice of epoxy. While G/flex® yields significantly better values, standard WEST SYSTEM® 105 Epoxy Resin®/206 Slow Hardener® did pretty well without any surface prep at all, which does lend some support to our stated position that epoxy can bond white oak. But as I said, this is only one part of the story.

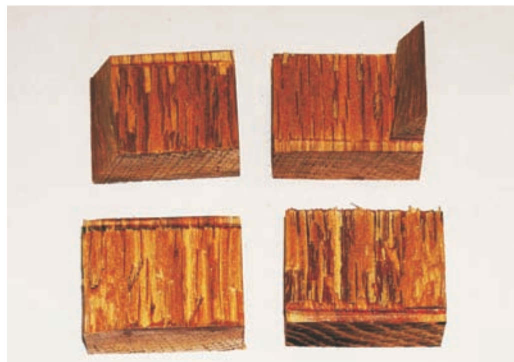
To get a more complete understanding of adhesion to white oak we recently completed short block shear testing according to ASTM D-905. We had two goals: first, to test adhesion to white oak under a shear load and second, to collect some more data on our new Six10® Adhesive. All the specimens in this sample population were hand sanded with 80-grit followed by a thorough wipe with alcohol pads. The load is applied to the sample in the direction of the grain. The results are as follows:

**White oak short-block shear test results**

| Adhesive | Average shear strength |
|---|---|
| 105/206 | 2,866 psi |
| G/flex 650 | 2,968 psi |
| Six10 | 2,834 psi |




**White oak short-block shear test samples after testing to failure. All samples resulted in 100% wood failure.**



**Close up of broken white oak short block shear test samples. Failure occurred in the wood grain rather than the glue line, indicating the glue was stronger than the grain strength of the wood.**

**Close up of broken jatoba short block shear test samples. The denser jatoba also failed in the wood grain rather than the glue line.**

Referring to the photos (*right*) of the broken samples we can see that every sample in the population, regardless of which system was used, resulted in 100% wood failure. But that doesn't mean all things are equal.

What are the practical implications we can assign to the observed results? Given that all the samples received the same prep, all of them resulted in 100% wood failure and all the values are very close, it is fair to say the glue is stronger than the shear strength of the oak. The slightly higher values achieved with G/flex can be explained by noting the extent of the wood failure. Because of the tough flexibility of G/flex, more wood got involved in resisting the applied shear force and so the value was somewhat higher.

What we learn from this test data is that, contrary to the opinions of the naysayers, with the proper surface prep white oak is quite bondable. It's instructive to understand what these numbers really mean and how they might apply to something real, like a boat. For tensile adhesion picture this: you could lift a block of aluminum weighing just under a ton by a 1" square piece of white oak glued to it.

An interesting point to make in that regard is the use of a wipe with an alcohol pad, a practice I am following more and more. Our current theory as to why this works is that the alcohol removes oils in the wood and the water in the wipe raises and opens the grain which allows for better penetration and therefore involves an increased amount of wood surface to better share the load. Regardless of the mechanism the data doesn't lie: that surface prep works well.

The results of testing we did on another dense wood from South America, jatoba, support this conclusion. The white oak we tested had a density of 10.461 g/in$^3$ (39.9 lbs/ft$^3$) while the jatoba had a density of 15.80 g/in$^3$ (60.2 lbs/ft$^3$), which is 33.7% more dense than the oak. If density plays a role in adhesion we should be able to see that here. First let's looks at the results:

**Jatoba short-block shear test results**

| Adhesive | Average shear strength |
|---|---|
| 105/206 | 3,319 psi |
| G/flex 650 | 4,031 psi |
| Six10 | 4,088 psi |

Looking at the photos of the broken samples we see very similar results. Every sample has 100% wood failure and the average shear strength values are consistently similar. Again, it's fair to say that the glue is stronger than the shear strength of the jatoba and that the higher values with the jatoba reflect the increased density and thus the increased shear strength over the oak samples.

Still not fully convinced? Good. Neither am I. As encouraging as this data is, I can't help wondering if it accurately describes what we can expect in the real world. These samples were made in the lab under ideal conditions of moisture content, humidity, temperature, etc. How often are boats built that way? Good question. To try to answer it we are conducting another series of tests where the samples will be tortured in our environmental huts to really get that oak moving. I'll report the results in the next issue of *Epoxyworks*. ■

# Wooden Bicycles,


By Grace Ombry

## Renovo Hardwood Bicycles

Meade Gougeon was intrigued by the Renovo Bikes company of Portland, Oregon after spotting their wares on display at the WoodenBoat Festival in Port Townsend, Washington last fall. Meade has long been a serious cyclist and understands better than most the value of wood as an engineering material. He saw in Renovo an opportunity to combine two of his great loves, wood and bicycles.

The remarkable, bright finished looks of Renovo bikes are secondary to what they have to offer the serious cyclist. The ride is incredibly smooth and quiet and the bikes are responsive, light weight and have excellent frame stiffness. Renovo frames are hollow wood and laminated bamboo, materials that offer excellent performance in designs that maximize their strengths.

Meade commissioned Renovo to build a bike for him of wood and WEST SYSTEM® Epoxy, and the results were beautiful. Renovo team member Ken Wheeler describes Meade's bike frame: "The center wood is curly maple outlined with a pinstripe of wenge. The outer laminate is padauk. The stays are outer layers of wenge with centers of Port Orford cedar. The front triangle is as stiff as carbon Cervelo S2 (very stiff). The rear triangle has about 80% of the stiffness of S2 to provide a smoother ride."


**Meade Gougeon shows off his lightweight Renovo Hardwood Bicycle. The custom bike is made of curly maple outlined with a pinstripe of wenge. The outer laminate is padauk. The stays' outer layers are wenge with centers of Port Orford cedar.**


Renovo Bikes started their business with a clean CAD screen and a few sticks of wood. In the three years since, they've shipped wooden bikes to countries around the world, are internationally respected for their designs and have some fresh ones nearly ready to release.

Their focus from the beginning has been quality over quantity. Some of their very early bike frames have logged over 10,000 trouble-free miles and still look as good new.

From the beginning, Renovo has worked to refine and improve their frame designs, maximizing wood as an engineering material. Having begun to reach the stage of diminishing returns, lately they've turned their attention to increasing their production rate. Renovo has been optimizing their designs and manufacturing processes; they've built new fixtures and tooling; added skilled employees to every area and increased their operations space from 5000 to 7500 square feet.

The result has been a dramatic increase in production capacity with no loss of quality.


# Seriously

## Boo Bicycles

Another maker of fine wooden bikes is Boo Bicycles of Fort Collins, Colorado (with manufacturing facilities in Vietnam). As you might have guessed, Boo Bicycles makes its bikes from bamboo. The company's founder, Nick Frey is a professional cyclist, a multiple national cycling champion and a mechanical engineer who recently graduated from Princeton. As with Renovo, these are high-performance bikes despite the seeming novelty of their chosen frame material.

Frey chose bamboo for frame construction because bamboo is similar in structure to carbon fiber reinforced plastic. Bamboo's tensile strength and stiffness offer excellent rigidity. The dense longitudinal fibers in bamboo tubes give it a strength-to-weight ratio higher than that of steel. Bamboo vibrates much less than steel, providing an extremely smooth ride.

Boo Bicycles uses a variety of bamboo known as "iron bamboo" or *dendrocalumus strictus,* which is very stiff and resilient. They grow their bamboo near their facility in Ho Chi Minh City, and harvest a year's supply when it matures. The four-month drying process calls for baking the poles in the sun then placing them in a dehumidified drying room. Their moisture content is monitored to prevent splitting, and poles are pre-stressed to determine strength before they're selected for bike building.

Boo Bicycles miters the bamboo tubes, fits them into a custom jig and tacks them together with epoxy. This part of the construction method is the same one used on steel or titanium bike frames. They then wrap the joints in carbon fiber applied with epoxy, compress the fibers to remove excess epoxy and allow all to cure in a temperature-controlled room. After they are sanded, hand signed, serial numbered and decals are in place, each frame is finished with a tough lacquer.

Boo Bikes' bamboo frames are as durable as metal or carbon and should be treated like any normal bike frame. They are sealed against water with a thin coating of WEST SYSTEM Epoxy inside the tubes, which prevents expansion and contraction of the bamboo fibers. According to Nick Frey, bamboo is better at absorbing impact than carbon fiber.

Both Renovo Bikes and Boo Bikes make competitive, highly functional, durable and beautiful bikes for the serious cyclist.

Visit www.renovobikes.com and www.boobicycles.com to learn more about these outstanding companies and their products. ■

**"The Boo Bicycles T is a boutique touring bicycle. It is specially designed for longer touring rides when comfort and stability are paramount. For shorter touring around the city, it is simply perfect—a beautiful bicycle for cruising in comfort and style."**

# A Professional Technique for **Repairing Damaged Wood Trim**

*By Tom Pawlak*

When repairing or replacing missing sections in wood molding, it helps to have a way to do it efficiently. If you're repairing historically significant architecture your method should disturb as little of the original wood as possible. Sections of wood may be missing due to rot or wood splitting and pieces falling away. Professional repairers sometimes fill these missing sections with new wood glued in place with epoxy, but more often the missing sections are replaced with epoxy thickened with low-density fillers.

If the original carved details are unique, the repairer may opt to use thickened epoxy as a sculpting putty and carve the repair to the shape of the missing section. Epoxy thickened with low-density filler like 410 Microlight® is easy to sand and carve after the epoxy cures. When thickened with 410 Microlight to a putty consistency and allowed to cure, epoxy carves as easily as basswood.

Rotted wood molding may have originally been milled on a wood shaper with special cutters. These cutters are costly to reproduce, so making replacement trim is prohibitively expensive. Localized damage to this sort of trim is easily repaired with thickened epoxy. But, if you have lots of damaged trim, you may want to repair it with a mold from an undamaged section of trim using epoxy and fiberglass, cotton or polyester fabric.

To make one of these light duty molds, begin by selecting an undamaged section of trim, sand away bumps or paint drips and fill indentations with wood putty or thickened epoxy. Cover the molding or trim with 2" wide cellophane packaging tape overlapping the tape slightly. The shiny plastic tape acts as a mold release so you can remove the mold after the epoxy cures. Be sure to let enough extend beyond the mold so you can grab onto it when it's time to pull the mold off.

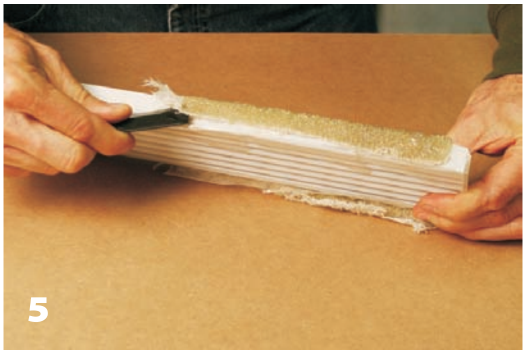
**1—Cover the area you are taking the mold from with 2" wide cellophane packaging tape. Press the tape into the recesses of the surface.**

**2—Apply epoxy thickened to a ketchup consistency with 406 Colloidal Silica or other high-density filler to fill the voids in the surface.**



**3—Apply a layer of fabric reinforcing material. In this case a piece of old terrycloth was used.**

**4—Wet out the fabric with epoxy and allow it to cure. G/5® can be used for these steps to make a mold quickly.**



**5—Remove the mold by working wood or plastic wedges under the perimeter until it releases. The 804 Mixing Stick is a good tool for this.**

**6—The mold should pop off cleanly—a perfect reflection of the taped surface.**



**7—Before using the mold, trim the excess off with a band saw and smooth ragged edges with a belt sander.**

**8—Cover the mold with a mold-release like cellophane tape (pressing the tape into the recesses in the mold) or apply an automotive paste wax.**

Apply epoxy thickened to a ketchup consistency with 406 Colloidal Silica or other high-density filler. When this reaches a soft, tacky cure apply a layer of fabric with West System® Epoxy. If you're in a hurry, try G/5 Five-Minute Adhesive for this step.

To achieve adequate stiffness, add layers of fabric wet out with epoxy. Nearly any fabric will work. It should end up around $\frac{1}{16}$" to $\frac{1}{8}$" (1.5mm–3 mm) thick. Allow it to cure.

Remove your mold by working wood or plastic wedges under the perimeter until it releases, or by pulling up on the mold release tape you've left extended beyond the mold. Before using the mold, smooth ragged edges with sandpaper to avoid bloodletting via epoxy splinters.

To use this mold, first cover it with a mold-release such as cellophane tape or apply a more typical release agent like automotive paste wax. Position the mold over the area you wish to restore, making sure that the mold fits to adjacent undamaged trim. For best results, the mold should extend beyond the damaged section and engage with the undamaged trim on either side of the repair. Sand away any paint drips or bumps to achieve a good fit.

Prepare damaged wood sections by removing any damaged wood. Use a chisel or coarse sandpaper to slightly bevel the perimeter of the area. Be sure the area is thoroughly dry.

Apply unthickened epoxy to the damaged section, allowing a few minutes for it to soak in. Reapply epoxy as it's absorbed. Fill the void with epoxy thickened with one or more of the powdered fillers, over-filling the void slightly before positioning the mold. Press into position, displacing excess epoxy.

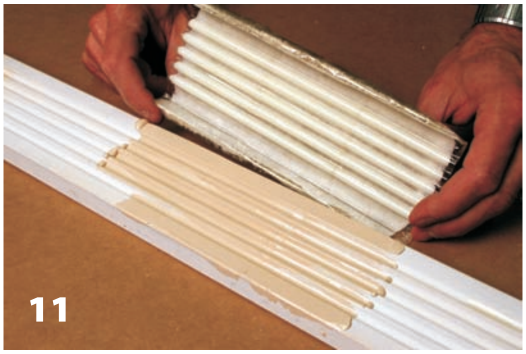


**9—After wetting out the damaged area with unthickened epoxy, fill the void with thickened epoxy. 410 Filler will be the easiest to shape and sand when cured.**

**10—Press the mold firmly into position, displacing excess epoxy. Clamp the mold in place and allow the epoxy to cure thoroughly.**

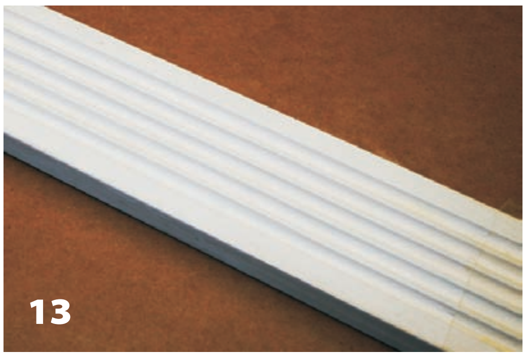
11—Pry the mold from the surface with plastic or wooden wedges inserted around the perimeter.

12—The cast epoxy can be carved with chisels or sanded to match the trim and prepare the surface for paint.





13—Apply a quality latex or fast-drying oil based primer and finish as you would any wood surface.




To keep the mold in place, clamp it or drive tacks through pre-drilled holes at the mold's ends. Leave them slightly proud of the surface to allow for easy removal later.

Filling large voids with epoxy can generate excessive heat or exotherm. You can avoid this by filling most of a large void with a wood plug glued in with epoxy. Make sure the wood plug is set a bit low so there is room for thickened epoxy to be placed over it prior to positioning the mold. If the wood plug stands proud of the surrounding area the mold will not engage correctly and the resulting casting will require a great deal of sanding and/or carving to shape.

If the void is large and you wish to fill it with epoxy, thicken it first with 404 High-Density Filler. Of all the fillers, it works best to reduce epoxy exotherm. If the void isn't deep, 410 Microlight is your best choice for thickener because it extends the epoxy considerably, more than doubling the volume of epoxy when enough is added to achieve a mayonnaise viscosity. Conversely, because Microlight is very low-density filler, it is more prone to exotherm if used in deep cavities.

You can use these trim molds over and over to efficiently reproduce missing sections of trim as long as you properly maintain them by replacing the mold release tape between each use.

After removing the mold, sand the epoxy dull and apply quality latex or fast drying oil-based paint to protect the epoxy repair from sunlight. If air bubbles are trapped on the surface of the repair, use latex caulk or epoxy putty to touch it up before painting.

Using this technique will allow you to do professional quality repairs to damaged wood trim, making it look as good as new. ■

Left—This column base is an example of the kind of woodwork that can be reproduced with a light-duty epoxy mold.

Center—A mold was taken from an undamaged column base covered with stretch wrap.

Right—The mold was made using G/5 epoxy, 406 and 407 Fillers and reinforced with fiberglass fabric.

# Repair of the Tartan Ten, *Flags*

**By Tony Sheppard, T&M Marine**

The Tartan Ten, *Flags*, sustained port side core damage in a race course collision. The original repair, a simple patch applied over the damaged skin, was improper and ineffective. Within a short time there was distortion and movement in the hull side at the repair area. Water penetrated the skin and saturated the core, which soon began to rot. A significant crack reappeared and even more water went into the balsa core. Eventually the boat was nearly unusable.

Once the work started to repair the hull, the decision was made to repair some wet core in the deck as well. The project quickly spiraled into a major undertaking.

*Flags* was totally re-built by T&M Marine. This became a personal project and was fit in between other projects. The hull side core had to be removed and replaced in the area of the original damage and in the bottom of the hull. The hull skin was repaired and faired and the entire boat was painted. While the boat was upside-down, most of the deck core was replaced. This was much easier with the boat upside-down since gravity was now a help instead of a hindrance. Structural repairs were also made to the keel boss and keel floors to reinforce that area. All core replacement and glass laminating was done with WEST SYSTEM® 105 Epoxy Resin® and 206 Slow Hardener®.

This project was a tremendous amount of work but the results were worth the effort. A project of this magnitude is not something to undertake unless there is a complete understanding of the scope of work to be performed. This project is a showcase for the suitability of WEST SYSTEM Epoxy for FRP boat repair. ■


***Flags*** **sailing after the restoration.**

**The boat is upside down and the outer skin and core have been removed with a router.**

**With new skin and core in place the repaired hull was faired before barrier coating and painting.**

**The interior floor skin and rotted balsa core were removed.**

**New balsa core and fiberglass skin were installed in the damaged areas.**

**Terry Livingston, of Lihue, Hawaii, designed and built this 16' (4.8 m) Hawaiian canoe, built with a "variety"of woods. The hull is strip-planked with redwood and some western red cedar. Gunwales are western red cedar. Water tight bulkheads are vertical grained fir and mango. Splash guard and manu are kamani. Seats are Tasmanian blue gum and the ama is redwood over a foam core. The paddle is also laminated with WEST SYSTEM® Epoxy. You can see more of Terry's work at www.customcanoepaddles.com.**

## Readers' projects

**Karl Stambaugh provided the design for this 36' (10.9 m) Cruising Sharpie. Ron Gabriel, Palm City, Florida, used WEST SYSTEM Epoxy to bond okoume plywood over straight frames and bulkheads with a healthy amount of fiberglass and epoxy to seal her up.**

**She has accommodations for four. Although designed for day sailing and weekending, the Sharpie 36 has longer range capabilities for extended cruising. A shallow keel and weighted centerboard provide stability for this sharpie to stand on her feet in good wind conditions. She has twin rudders behind twin skegs and will sit upright if left to dry out on an ebb tide.**

**Olympic sailing medallists, Pippa Wilson, Nick Rogers and Ado Jardine named, launched and took the first sail in *Xoanon* the latest creation of the XOD (X one design) class sailing boat at The Royal Lymington yacht club in July, 2009 in Lymington, England.**

**The idea to redesign the X Boat was the brainchild of Ado and Stewart Jardine. Yacht designer, David Alan-Williams, provided the lines for the templates to make the hull is as faithful as possible to the original 1911 lines. By using WEST SYSTEM Epoxy products and the technical support from Wessex Resins, the team of volunteers were able to build a Douglas Fir, tongue and groove strip plank boat, glued and coated using epoxy, with a subsequent epoxy impregnated glass fibre layer inside and out; thus, creating a boat which is considerably easier to maintain each year, reducing the annual maintenance costs and more importantly, a big reduction the initial build cost.**

**Wessex Resins & Adhesives, manufacturers of WEST SYSTEM epoxy in England, helped sponsor the project.**

**Aloha Editor of *Epoxyworks*,**

**We built this boat about eight years ago with no blueprints or plans. We started with a several pictures of lobster boats from New England and did a Hawaiian version. We had 100 sheets of 3/8" (9.5 mm) marine plywood and about 50 gallons of WEST SYSTEM Epoxy. It took three months to do the hull and get the boat into the water. The cabin was added while the boat was in the water. I am still working on the interior teak trim. Every time I go down to the harbor to work on it, I get distracted by Hawaii's beautiful weather and end up going out for a cruise and swim instead!**

**The boat is 32' (9.7 m) LOA with an 11' (3.3 m) beam and an 18"(.45 m) draft. It is designed for inshore use in Kaneohe Bay, Hawaii. We have two barbeque grills on the stern and just added a marine stereo system. The boat is named *Huialoha* after a historic church on Maui I helped restore. "Hui" in Hawaiian is a group that gets together for a common purpose. "Aloha" means love, so "Huialoha" is a group that gets together for love.**

**Jim Cook**

**Dicky Saltonstall of Rockport, Maine, sent these photos of his latest iceboat design called BlackFly. The BlackFly is an alternative for DN guys who still want to car top but also would like a bit more boat. All up this boat is about 60–70 lb (27–31 kg) (heavier than a DN but it has a much more powerful rig. The mast is 20' (6 m) and the plank is 16' (4.87). A spring board adds about 5' (1.5 m) to the fuselage.**

**"It is a front seat ride, which is a lot safer and allows the boat to be better balanced" says Saltonstall. The fuselage is the same length as a DN with a windshield and mirrors which can be folded out of the way. The design is a tortured plywood stitch and glue project. The wing mast is Core Cell foam and carbon. Saltonstall also says all he ever uses are WEST SYSTEM epoxies. For more information about the BlackFly iceboat send an email to saltonstall.richard@gmail.com.**

**The boat building class conducted by the Saginaw Bay Community Sailing Association of Bay City, Michigan, recently completed *Ellen* a 12' (3.6 m) sailing skiff. Ellen's lapstrake hull was built by instructor Bill Bauer in a class he took at the WoodenBoat school. Seats, flooring, centerboard, rudder, spars and finish work were completed by the local class. Ellen was auctioned off to raise money for the SBCSA.**

**The SBCSA class has started a second "Ellen." The strongback, hull forms, bow stem, transom and keelson were fabricated and set in place in 2009. In 2010 the second "Ellen" will be planked up, and if time permits, the class will start to finish out the hull.**

# *Bolero* Restored


By Joe Parker

"Maybe the prettiest yacht ever built." That is what some folks say about *Bolero*. Of course, beauty is in the eye of the beholder, still, very few boaters would be able to take a quick glance at this yacht and not continue to stare and measure every detail with their eyes. Any sailor would imagine themselves on board sailing for Bermuda or their destination of choice. Her proportions are just right and the construction details are elegant and refined. *Bolero's* designer Olin Stephens had this to say "*Bolero* is an example of the best in practical yacht design using top grade wood construction." Of course he this statement in the early 1950s shortly after *Bolero* was built and launched. Today, high-end wooden boat construction involves some new methods, and the lovely old girl has just emerged from the building at Rockport Marine following a thorough restoration showing off some very modern wood composite construction techniques and looking as good as ever.

*Bolero* was built in 1949 at the Henry B. Nevins shipyard in City Island, New York. She was designed by Olin Stephens of Sparkman and Stephens Yacht Design (S&S), an iconic design firm. She reflected the finest in materials and construction methods of the time and has lived a long life. The current restoration expands on the concept of the best materials and workmanship to include the latest epoxy offerings from WEST SYSTEM® as well as the superb skills of one of the busiest yards in coastal Maine.

John England, Project Manager at Rockport Marine in Rockport, Maine, headed up a crew of 20 carpenters and shipwrights over the 20 month restoration. The yacht was nearly completely reconstructed. A section of hull that was replaced in 2001–2002 is the only remaining portion of the hull or previous restoration work. The yacht also had a massive Monel welded structure supporting

**Left—The frame laminating jig. Note the adjustable stops set to create the shape of a frame.**

**Right—A frame being glued up in the jig. The glued and stacked frame laminations are wrapped in plastic to prevent bonding to the jig.**

the ballast keel, mast step, mast partners, two deck beams and the chainplates. This structure is still in great condition and was left in place while the framing members were replaced around it. You can see the deck section of the weldment in second photo at left.

The entire hull skeleton was rebuilt with laminated white oak frames. These frames were glued with WEST SYSTEM Epoxy. G/flex works exceptionally well with white oak, a notoriously difficult to bond wood. Our tech staff worked with the Rockport crew to define the best processes to machine and glue up these large frames and structural components. The white oak stock was milled to ¼" (6.3 mm) thick, then sanded with 80-grit and wiped with alcohol and a paper towel prior to assembly.

Once the skeleton was rebuilt, the hull planking was replaced. Inner planking is white cedar and the outer planking is Sipo, an Indonesian mahogany. The hull planking was glued together with WEST SYSTEM 105/206. All planking was scarfed with a locking or nibbed scarf and glued in place on the hull. This type of scarf is great in thicker stock to help align the scarf and prevent under or over matching the scarf bevels.

The deck is framed with laminated white oak glued up with G/flex for the main beams. The smaller frames are laminated spruce glued up with 105/205. The deck is a 4-layer composite to allow for a traditional looking overhead on the inside of the boat and a traditional looking planked deck on the top side. The first layer is tongue and groove Alaskan white cedar laid fore and aft and glued up with 105/206. Then two plies of ¼" (6.3 mm) Meranti plywood are laminated with 105/206 and vacuum bagged onto that. The final layer is planked fore and aft with Alaskan white cedar and left natural on the top surface for a very traditional look and feel. The deck beams were laminated on the bench and then assembled on the hull framing. The deck house was also re-worked and installed as a complete structure.

The mast, rigging and all deck hardware were all refurbished. All new mechanical and electrical systems were installed in the boat to bring her up to modern yacht standards.

*Bolero* is as stunning as ever and is still a wonderful sailing yacht. Her timeless beauty will now be admired by another generation of sailors and yachtsmen. If previous history is any indication, *Bolero* will be sailing and turning heads for another 60 years. ■

**A "nibbed scarf" joint in the outer planking being glued together in place over the inner planking.**

**Deck frames being installed with the Monel weldment visible.**

**Two layers of ¼" plywood are vacuum bagged over cedar planking. Note the staggered joints in the plies.**

**The deck house being fitted to the new deck.**

# Why You Want a Hugh Saint Boat

*By Grace Ombry*

Hugh Saint is a custom boat builder in Cape Coral, Florida who specializes in fine mahogany runabouts that remind you of those built in the 1930s and '40s. His team of skilled artisans combined their backgrounds in engineering with a finely honed understanding of nautical beauty.

A retired U.S. Air Force Colonel, Hugh Saint started his boat building business more than thirty years ago. His business partner Tom Stovalk built wooden furniture and worked as an automotive computer technologist before joining forces with Saint.

The 65' (19.8 m) Commuter is finished with 16 coats of DuPont MS1 varnish over six coats of clear epoxy. Twin C-32 Caterpillar marine diesels powering 22" (558 mm) Twin Disc jet drives give the commuter a top speed of 47 kts and a cruising speed of 35 kts.

Working with their crew of seven employees, they build up to three boats at a time in their 4,500-square-foot boat shop. Their most recent launch was a 65' custom commuter built with copious amounts of WEST SYSTEM® Epoxy. Saint says her top speed is over 50 mph (80 kph) and she turns like a runabout.

The 27' Sheerliner shown here is powered by a 510 hp V-12 BPM marine engine to achive a 60 mph top speed.

All designs come from highly qualified naval architects including Charlie Jannace, Douglas Van Patten, John Hacker and Dan McCarthy. Saint offers an impressive variety of wooden power boats ranging in size from 22' to 65' (6.7 m to19.8 m) and run anywhere from $255,000 to $6.5 million. Their designs incorporate all of today's technology, modern engines and drive systems, in styling so classic these boats are often mistaken for lovingly restored antiques.

Construction time is about 12 months for runabouts and 1½ to 2 years for larger boats.

Saint uses only the finest marine plywood and pattern grade mahogany in all of their construction. He cold molds every boat with WEST SYSTEM Epoxy for dimensional stability, strength and low maintenance. The bottoms of their bright-finished boats are sheathed in Dynel™ fabric for outstanding durability, and their painted boat hulls are sheathed entirely in Dynel. This acrylic fabric is highly abrasion resistant.

Saint works with wood because it's more weight efficient than fiberglass and offers better strength-to-weight ratios than steel. He encapsulates all of the wood with epoxy to eliminate shrinking, swelling and rot.

Despite their stunning retro looks, Saint's boats aren't particularly demanding in the maintenance department. The decks are varnished and he recommends keeping them out of the sun when not in use. He says that in tropical climates, his decks can go at least three years between varnish jobs and in northern climates the varnish lasts for a good five years.

Every Hugh Saint boat is fitted with specially designed stainless steel rudders which provide for outstanding handling at any speed. The convex sectioned underbodies provide a soft and stable ride.

Visit www.hughsaint.com for information and photographs of Hugh Saint's boats. ■

# Harken Flexible Furler Repair

*By Tami Shelton*

I have a now-discontinued Harken furler unit for my F-27GS trailerable trimaran. This furler is made of an extruded PVC foil with a braided stainless internal liner, with a rod that passes through as the actual forestay. I really like this flexible foil because of its ease of use when raising the mast as well as the fact that it can be somewhat coiled and stowed in the boat for travel.

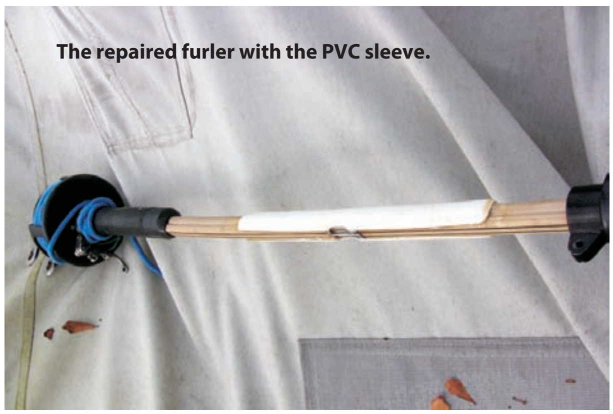
After probably 10-12 years of use, the PVC extrusion failed at the boltrope feeder. The split broke the PVC in two at the feeder, not vertically up the foil, but circumferentially. The liner, and of course the rod rigging, stayed intact. Harken, having discontinued this furler unit, had no solutions to offer.

About the same time this failure occurred, WEST SYSTEM® came out with their G/flex® epoxy formula. The descriptions suggested that plastic repairs could be effected with G/flex and so I decided to repair my flexible foil. Given that the foil is PVC, I thought that it might work to bridge the split with a piece of Schedule 40 PVC water pipe, gluing it in with the G/flex.

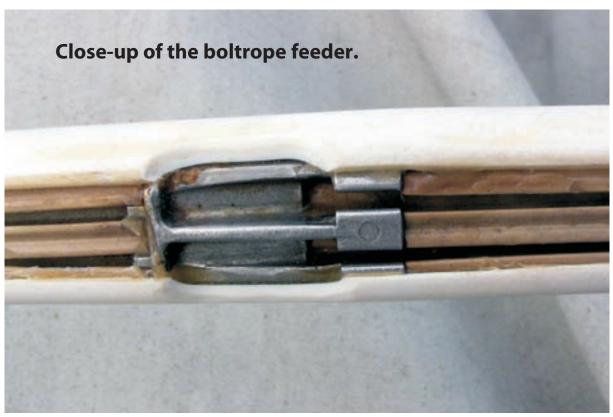
I first selected a diameter of PVC which was close to that of the foil. I cut a piece of the PVC much longer than I thought necessary to bridge the split, but I was concerned about loads from the furling drum causing another crack beyond the area of repair. With the extra long PVC bridge I hope to reduce bending of the foil around the feeder area.

With a hacksaw, I cut the PVC piece longitudinally.

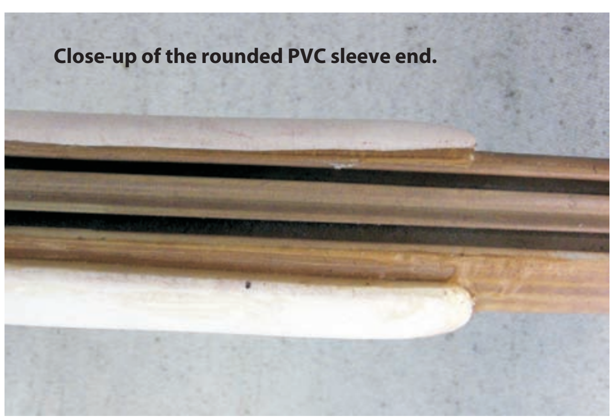
I began to slip the opened PVC piece over the foil at the masthead (top) end. This was merely for ease of shaping the PVC, one could mold the PVC anywhere along the foil, I suppose.



**The repaired furler with the PVC sleeve.**



**Close-up of the boltrope feeder.**



**Close-up of the rounded PVC sleeve end.**

Then while pushing the PVC down the foil, I heated the PVC with a heat gun to shape it to the foil's shape. Bear in mind it doesn't take a very high temperature to achieve flexibility in the PVC. I kept a rag in my hand so I could squeeze the PVC to shape on the foil. In doing so, the cut opened up enough to expose the boltrope tracks. With the PVC piece shaped and cooled I removed it from the masthead and moved it to the repair area.

I prepped the foil extrusion and the inside of the PVC sleeve with the alcohol wipe and flame treatment (*see page 18*). After this, I masked the boltrope track and pre-feeder with clear packaging tape to prevent epoxy from getting into the track.

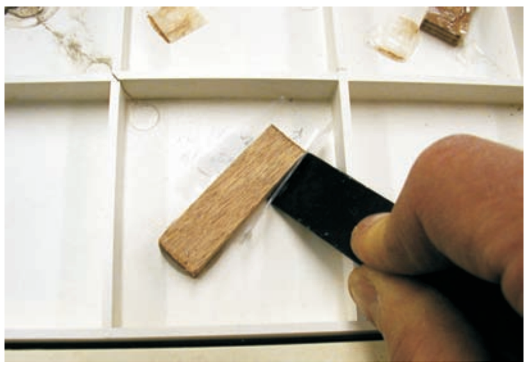
I used the pre-thickened G/flex 655 Adhesive for this repair. I mixed up enough to fill the channel in the PVC quite generously and then slipped the PVC over the foil extrusion, centering on the broken area. I allowed excess to ooze out of the gap between the foil and the PVC. I then cleaned up the excess, wrapped the whole repair with wax paper and clamped it into place with a series of spring clamps, one every 2" or so, and allowed it to kick off.

After cure, I spent a fair bit of time cleaning epoxy out of the pre-feeder. I'd had difficulty masking it. In retrospect, it would have been well worth the effort to do a more thorough job of masking things off before gluing. Once I sanded and faired the PVC to the foil extrusion, the repair was complete. The next weekend I took it sailing. ■

# Repairing a Plastic Hatch with G/flex®

*By Tom Pawlak*

A local sailor stopped by our shop with an old plastic hatch that was slightly warped and badly cracked. He hadn't been able to find a similar hatch to replace it. He wondered if we had an epoxy that could be used to repair the hatch. I said G/flex would likely work but to know for sure we needed to do a bit of adhesion testing.



**Before tackling this repair, adhesion testing revealed the method that provided the best bond with G/flex.**

The hatch was made with an injection molding process that used thermal-formed plastic, probably ABS or PVC.

Adhesion testing revealed that G/flex epoxy adhered well to surfaces that were sanded as well as to surfaces exposed briefly to the blue part of the flame from a propane torch.

The accompanying pictures tell the repair story. Briefly, here are the steps used:

**1.** Bevel the cracks to increase surface area for the repair after drilling holes at the ends of each crack to prevent the cracks from continuing.

Flame treat the repair surfaces with a propane torch.

**2.** Apply G/flex 655 (the thickened version of G/flex) to the prepared cracks, filling them flush with the surface.

**3.** Clamp the hatch lid against a stiff and flat piece of plywood covered with plastic to flatten it while the epoxy cures (This was necessary because the hatch had deformed.)

**4.** Glue low-density packaging foam (the white beady type) into the spaces between the ribs on the back side of the lid.

**To flame treat a plastic surface**, hold a propane torch so the tip of the blue part of the flame just touches the surface and move it across the surface quickly (12"–16" per second). Keep the torch moving and overlap the previous pass slightly. When done correctly, the surface will not discolor or burn in any obvious way. This technique oxidizes the surface and improves adhesion. For best adhesion, bond to the surface within 30 minutes of treatment.






**5.** Apply a layer of 6 oz fiberglass cloth over the foam and ribs to stiffen and reinforce the lid.

**6.** Scrape and sand the repaired cracks smooth.

**7.** Paint the hatch with plastic compatible Rustoleum™ Textured Paint for Plastic. Krylon™ Fusion for Plastic™ also works well. In the end the hatch looks as good as new. ■


# Norwegian Gunning Dory

A Great WEST SYSTEM® Epoxy Project

*From Paul Butler*

This plywood/epoxy Norwegian Gunning Dory is drawn with inspiration from the classic lines of Scandinavian watercraft. The ply/epoxy hull is much simplified from traditional plank-on-frame versions. The lightweight version can weigh less than 60 lb (27 kg), making it an easy car-topper. Instead of the traditional V bottom, there is a flat panel on the hull bottom to simplify construction and provide extra stability.

### Safety Features

Watertight fore and aft compartments provide additional hull support, dry storage and the safety of flotation spaces. Additional compartments are optional and open-water versions can be built to be self-bailing.

### Capacity and Functionality

Loaded with gear for camp-cruising or with a passenger and gear, the boat becomes increasingly stable for general recreation, fishing, or drifting small streams and exploring waterways. The 15' 9" (4.8 m) length and 45" (1.14 m) beam provide a stable platform. The Norwegian Gunning Dory can also be poled, or paddled like a canoe. There is room for two fixed-seat rowing stations or a single sliding seat; the lightweight hull is fast enough to make open water rowing with a sliding seat interesting.

### Easy Care

Maintenance is much reduced with epoxy sealed plywood and the slick, hard graphite covered bottom allows dragging the hull over parking lots, launch ramps and gravel beaches.

The 30-page building plans are $46 and include photos, sketches, step-by-step directions and a discussion of many options to help the amateur builder customize the boat to suit usage.

To see additional photos with two interior layouts and details, and to order plans, visit www.butlerprojects.com. ■

# Testing for Damage Tolerance

By Jeff Wright

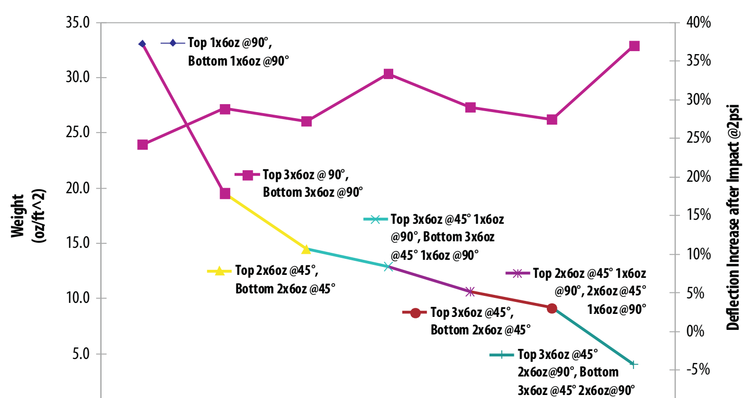
Ted Moores and his company, Bear Mountain Boats, build wood epoxy strip plank canoes, manufacture kits and publish books on building strip plank canoes and kayaks. This method of construction provides a very light yet stiff structure and also enables the hull shape to have compound curves. Moores has 30 years of experience and his designs have logged many safe miles. He understands the forces boats are subjected to when paddled on the water and during transportation.

Bear Mountain Boats expanded into a new area when they started construction of a 30' launch. This boat would be powered by a 5 kw motor and would achieve speeds of 6 knots. Moores knew that the displacement and speed of this boat meant the potential impact loads from accidental beaching and flotsam would be much more severe than with his lightweight canoes. Instead of just overbuilding the boat, Ted used composite materials to optimize its strength with only a minimal increase in weight.

**Figure 1a, right— The impact test fixture.**

**Figure 1b, left—The blunt, semi-spherical end of the 70 lb weight.**

**Figure 2—Ted Moore's Panel Impact Testing Results**




| | Panel A | Panel B | Panel C | Panel D | Panel E | Panel F | Panel G |
|---|---|---|---|---|---|---|---|
| Weight (ozs/ft^2) | 24.0 | 27.2 | 26.1 | 30.4 | 27.4 | 26.2 | 32.9 |
| % Increase | 37% | 18% | 11% | 8% | 5% | 3% | -4% |

## The Test

Since Ted Moores has been a long time WEST SYSTEM® Epoxy customer, he was well aware of our material testing capability. When he contacted us he had already decided on the wood species, White Cedar, and thickness, ¾", but had not determined the amount and orientation of the fiberglass sheathing. He knew that the amount of fiberglass would play a significant role in the boat's impact performance. We suggested using our Hydromat Test (*see Epoxyworks 14*) in combination with an impact test to evaluate the effect of damage on a variety of laminate combinations.

The stiffness of the panels would first be measured in accordance with ASTM D-6416. The panels were then damaged using our impact test fixture (*Figure 1a*) which applies the same impact force to a secured panel by dropping a blunt nosed weight (*Figure 1b*) from a fixed distance. After the panels were all struck (and damaged) by the same force, the stiffness would be measured again using the Hydromat to evaluate the effect of the damage.

## The Results

At first glance, the results seem to indicate that more layers of fiberglass help retain stiffness after an impact, but when fiber orientation is considered, the impact performance can be improved without increasing weight. In Figure 2, the increase in deflection when compared to weight is generally lower when the sheathing consists of 45° oriented fibers. Even though the panels are in the shape of a square, the fiber orientation had a significant effect due to the grain direction of the wood strips.

The pictures of Panel A, one layer of 6oz fiberglass cloth oriented at 90° on each side, show a very small area of damage on the impact side (*Figure 3A*)but the reverse side (*Figure 3B*) has a large laminate failure. Much of the laminate failure occurred in the fibers oriented across the wood grain, indicating that additional cross grain strength would be beneficial. Panel C (*Figure 4A, impact side*

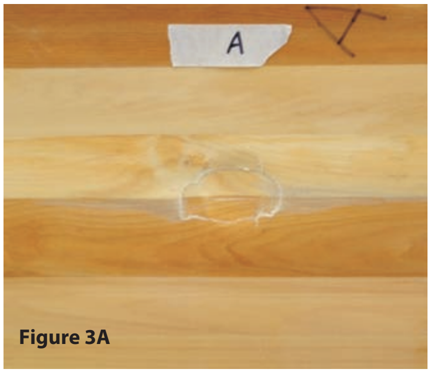



Figure 3A

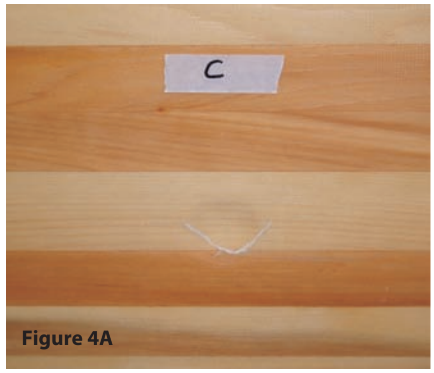



Figure 4A


Figure 5A

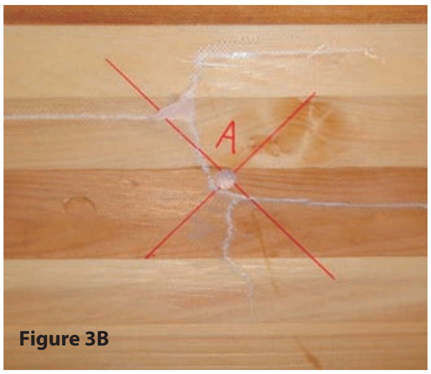



Figure 3B

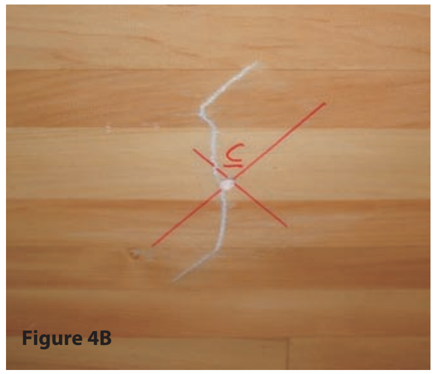



Figure 4B

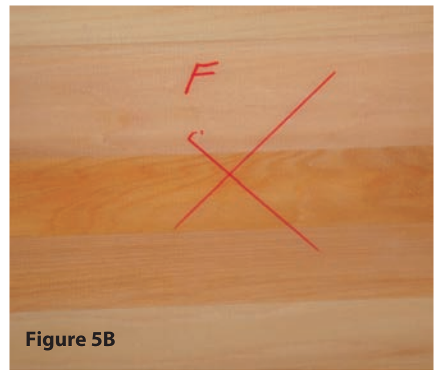



Figure 5B

*and 4B, reverse side*), which had an additional layer of 6oz cloth on each side oriented 45° to the wood grain, retained significantly more stiffness than Panel A. The other panels with fiberglass oriented at 45° to the wood grain also retained more stiffness than panels with the same amount of fabric oriented at 90° to the wood grain. The combination with the best balance between weight and damage resistance appears to be Panel F (*Figure 5a, impact side and 5B, reverse side*). It had almost the damage tolerance of Panel G, which did not lose any stiffness from the impact, but Panel F weighs much less.

It is interesting to note the amount of damage that occurred on the side opposite of the impact. If this had been an impact on an actual hull, the visible damage on the outside surface would be very misleading. As we have suggested for both wood strip construction and balsa and foam cored composites, be sure to thoroughly investigate for damage. A small divot on the outside could indicate significant damage on the opposite side. Looking at Panel A in Figure 3A, the impact certainly does not indicate the amount of damage on the opposite side that resulted in a 37% increase in deflection (*Figure 3B*).

## Conclusion

This series of panels was ideal for this test. All panels had the same wood strips, the same type of fiberglass fabric, and all were laminated in the same shop. The variables were the number of layers and fiber orientation. Thanks to Ted's excellent craftsmanship and a well-designed test, we were able to offer Bear Mountain Boats data that was helpful during the construction of this boat. Hopefully other WEST SYSTEM users will also take advantage of this information. ■

**After the test panels were struck, they show a very small area of damage on the impact side but the reverse side has a large laminate failure. Much of the laminate failure occurred in the fibers oriented across the wood grain.**

**The Bear Mountain 30 Hybrid Electric Launch was launched in June. The launch is a beautiful and efficient way to cruise the lakes and waterways around Peterborough, Ontario, home to Bear Mountain Boats. To see a video of the boat and detailed construction photos, visit www.bearmountainboats.com.**

# Of Applecores and Deadeyes

*By Bruce Niederer and Bill Bertelsen*

Gougeon Brothers, Inc. has supported our local tallships—*Appledore IV* and *Appledore V*—since they arrived at their downtown Bay City facilities on the Saginaw River. These steel-hulled, gaff-rigged schooners are typical of the type that sailed the Great Lakes and coastal waters right up to the end of the age of sail. Schooners were the primary means of transporting goods and people over long distances.

The larger *Appledore IV*, originally commissioned by Herb and Doris Smith in 1989, was the fourth in a series of schooners built for world voyaging and purchased by the non-profit organization BaySail in 1997.

Gougeon Brothers has also supported our local community sailing association which shares dock space with the *Appledore IV* for the summer. We have developed great friendships and cooperative working relationships with both organizations, and this is where this story begins.

Bill Bauer heads the Saginaw Bay Community Sailing Association Boatbuilding class located in the GBI boathouse loft. He has led the building of a Shellback dinghy (named *Applecore*, hence the title reference) and a Rangley 15 for the *Appledores*. Roger Nugent is the Executive Director of BaySail. He approached Bill with an idea for modifying the rigging blocks for easier replacement. It was a great idea, and the only catch was that because the *Appledores* are commercial vessels, they're subject to USCG inspection and requirements. Both Roger and BaySail Director Kevin Dykema (an SBCSA Boatbuilding class alumni) wanted the concept to be tested and validated to prepare Baysail with proper documentation in case the Coast Guard asked for information about the new block set up.

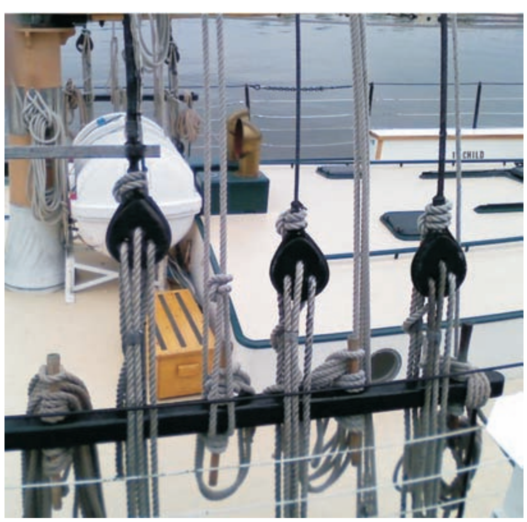


**Figure 1—Traditional black locust deadeyes on the schooner *Appledore IV*. Deadeyes are used in pairs to tension the shrouds which hold up the mast.**

Both *Appledores* utilize traditional black locust deadeye rigging blocks for the standing rigging. Traditional in this case means the blocks were carved from a single piece of wood. The ½" steel rigging cable is wrapped around the block and the wire crimped in place. Roger wanted the blocks assembled in two pieces so the main body of the block assembly could be inserted through the cable and then attached the retaining flange using epoxy. This would allow the blocks to be replaced without having to deal with disassembling the cable rigging and re-crimping the new blocks in place.

Bauer presented Roger's idea to our Chief Testing Engineer Bill Bertelsen, and asked him to quantify the load carrying capability of the two-part block assembly. (There are way too many Bill's around here!) Bertelsen said "sure" and Bauer set off to fabricate a test block using G/flex® 650 as the adhesive.

Bauer built a two-piece deadeye block and then fabricated a test sample that could be mounted into Bertelsen's trusty MTS servo-hydraulic test frame with the same rope cordage and wire rigging as used on the *Appledores*.

Figure 2 shows the test sample loaded into the MTS fixture prior to initial load testing. The "experimental" deadeye block is on top. The program started with a 100 lbf (pounds of force) pre-load on the assembly to get the parts settled in place. The load was then increased 1,000 lbf/minute to 5,000 lbf and held at that load for one minute while continuing to take data on load and actuator position every five seconds. The load was then ramped down at the same rate. Although the rope did stretch some, there was not a catastrophic failure-despite doubling the stated working load of the cable.

Good data to be sure, but a single static pull hardly represents how this assembly will perform in the real world.

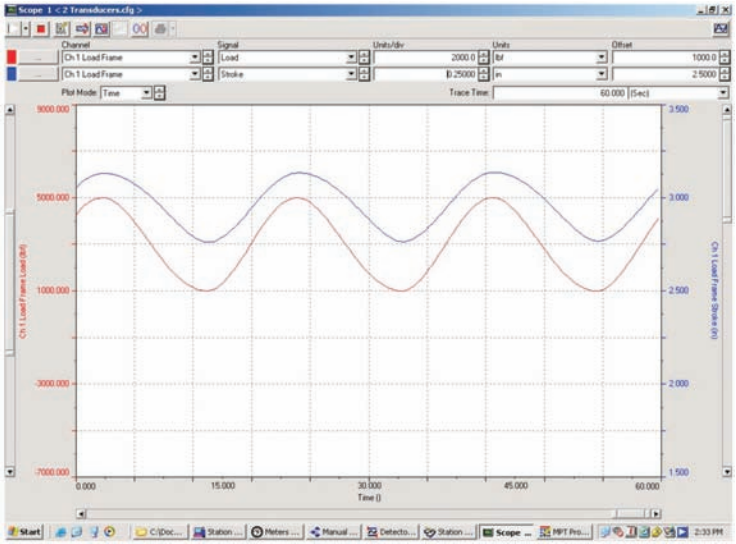



**Figure 2, left—The test assembly before testing. The "experimental" two-piece deadeye is on top.**

**Figure 3, center—A graphical display of sinusoidal tension fatigue.**

**Figure 4, right—The test assembly after the end of the fatigue cycling.**

Bertelsen called for fatigue testing to get a much better idea of what to expect in use. In an attempt to minimize rope stretch and slippage, Bauer modified the assembly by employing a knot he called a "double Mathew Walker slip knot" to the upper block fitting. The test program went as follows:

**1**. A manual ramp up to 2000 lbf in 500 lbf steps to take out the slack. The actuator was then set to 0 with a 100 lbf load applied.

**2.** An auto ramp to 2000 lbf and back. The actuator was again set to 0 with a 100 lbf load applied.

**3.** An auto ramp to 5000 lbf and back. This time the load came back to 100 lbf but the actuator position was not reset to 0 in order to indicate how much permanent stretch there was after the 5000 lbf load-a value of 0.9025".

**4.** Sinusoidal tension fatigue test, cycling at 0.05 Hz between 1000 lbf and 5000 lbf. At 0.05 Hz it takes 20 seconds to complete each load cycle.

Figure 3 is a screen shot of MTS graphical display of sinusoidal tension fatigue. The red trace is the applied tensile force in lbf; the blue trace is the actuator displacement in inches. The test ended at 401 cycles after 2 hours 13 minutes when the actuator tripped the 3.5" stroke limit Bertelsen had set.

Figure 4 shows the test assembly after the end of the fatigue cycling. It shows how the rope slipped and stretched, but the G/flex deadeye is still intact and apparently no worse for wear.

This should satisfy any Coast Guard Inspector if they should ask.

Bay City is proud to have the *Appledore* schooners to represent our city and the Great Lakes. They are owned and operated by BaySail, a private, non-profit organization dedicated to environmental education and youth development programs. BaySail funds these programs through corporate and private donations as well as public sails, private charters, group tours, and port visits.

*Appledore IV* stays berthed in Bay City for the season. *Appledore V* was commissioned in 1992 by Smith and sold to the Traverse Tall Ship Co. and sailed under the name *Westwind* in Traverse Bay. BaySail purchased her in 2002 and changed the name back to the original *Appledore V*. She now is used primarily for extended cruises visiting ports all over the Great Lakes in support of the Great Lakes ecosystems. ■

**Figure 5—The *Appledore IV*, upbound on the Saginaw river, makes way for the downbound freighter Algoway.**

# IYRS

## Student builders

*By Cynthia Goss*

If you travel to the campus of the **International Yacht Restoration School**, you might think you are walking into the past. The staff offices are inside a restored 1831 mill building. Students restore wooden boats from the 19th and 20th centuries while learning plank-on-frame construction inside a cavernous building from 1903. And hanging off the IYRS docks are majestic classics from a bygone era.

But surface appearances are deceiving. This Newport, Rhode Island school looks forward. The IYRS trains craftsmen for today's marine industry while continually developing their programs to keep up abreast of the skills needed in the modern marketplace.

To develop new programs, the IYRS canvasses industry partners to learn about their workforce needs and coordinates with organizations such as the Rhode Island Marine Trades Association and the American Boat & Yacht Council (ABYC). This has helped them to develop a family of programs, using their core two-year program in Boatbuilding & Restoration as a successful model.

Beginning in 2004, IYRS added evening and weekend professional development courses. In 2006 they added a nine-month Marine Systems program that teaches students to install, maintain, and troubleshoot onboard systems and trains them to sit for the relevant ABYC certifications.

This September, IYRS's third full-time program in Composites Technology will be open for business. The nine-month program emphasizes advanced composites. Advisors in the composites trades have lauded this curriculum for its deft mix of hands-on work and theory. "Think of a tree," explains Director of Student & Industry Relations Clark Poston. "The trunk is our core restoration program; the other programs are our branches."

The technologies taught at IYRS are diverse, but there are common threads among the programs. All students learn to master a craft while developing their skill on real-world projects. Restoration students restore 12' Beetle Cats in their first year, and move onto new challenges in their second year. These may include restoring 6-Meters, a Concordia yawl, and a series of motor launches. Composites students study with lead instructor Henry Elliot and learn their craft while building a fleet of Moths. IYRS's Susan Daly said, "We wanted a building project that would teach and test our students, while also capturing their imaginations."

▲ **An overview of Restoration Hall, originally built in 1903 as an electricity plant. A 6-Meter restored by second-year students is in the foreground. Photo: Caitlin Wood**

▼ **IYRS students splash the Herreshoff 12.5 that they restored during the school term on Launch Day.**

These diminutive single-handed hydrofoils have been clocked at 27 knots and will be more than an effective teaching tool. IYRS will partner with a Newport public sailing facility, Sail Newport, to bring these high-performance dinghies to the public. "Our sport does a great job of teaching young kids to sail, but we don't do as good a job at keeping those kids engaged in the sport as they grow into young adults," said Sail Newport Executive Director Brad Read. Once built, the dynamic Moths will join the Sail Newport fleet as the perfect magnet for young sailors who might otherwise migrate from the sport.

Each summer, IYRS has a unique graduation rite. After certificates are handed out, the graduation crowd walks to the school docks for a ceremonious launching of the boats students spent their year working on. In summer 2011, when the first Composites students graduate, traditional Beetle Cats will be splashed alongside other-worldly Moths. That scene will signal what many already know: IYRS has grown from its historic roots into an institution that trains students in the many technologies used in boatbuilding today.

For more information on IYRS, visit www.iyrs.org. ■

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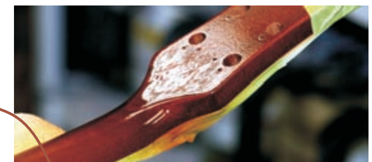
## Curt Wilson loves guitars.

And to many others who love guitars, especially classic old electric guitars, Curt Wilson is a hero. Curt combines his knowledge of epoxy and guitar anatomy with an acute attention to detail and the skills of a surgeon to bring back to life guitars that should have played their last note.

This Gretsch Billy Zoom Silver Jet is one good example. It had suffered a broken headstock. After meticulously cleaning and aligning fibers in the exposed end grain, he coated the ends with WEST SYSTEM 105/206 Slow Hardener®. By slowly adding clamping pressure he was careful not to squeeze all the glue out. He let it stay clamped for about twelve hours at 70° and then let it sit a couple of days over a heater duct before re-stringing the guitar. The Billy Zoom lives on.



# Guitar Hero

Among other repairs to this '67 Rickenbacker, the sheet inlay material on the neck was damaged and needed to be replaced. Curt used 105 Resin with 207 Special Clear Hardener™ mixed with natural mother of pearl shells. After cleaning out the cavities, he applied three layers of shells and epoxy followed with a clear coat. Curt covers many more repairs with lots of photos and videos on his website, www.midstateguitars.com. ■

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