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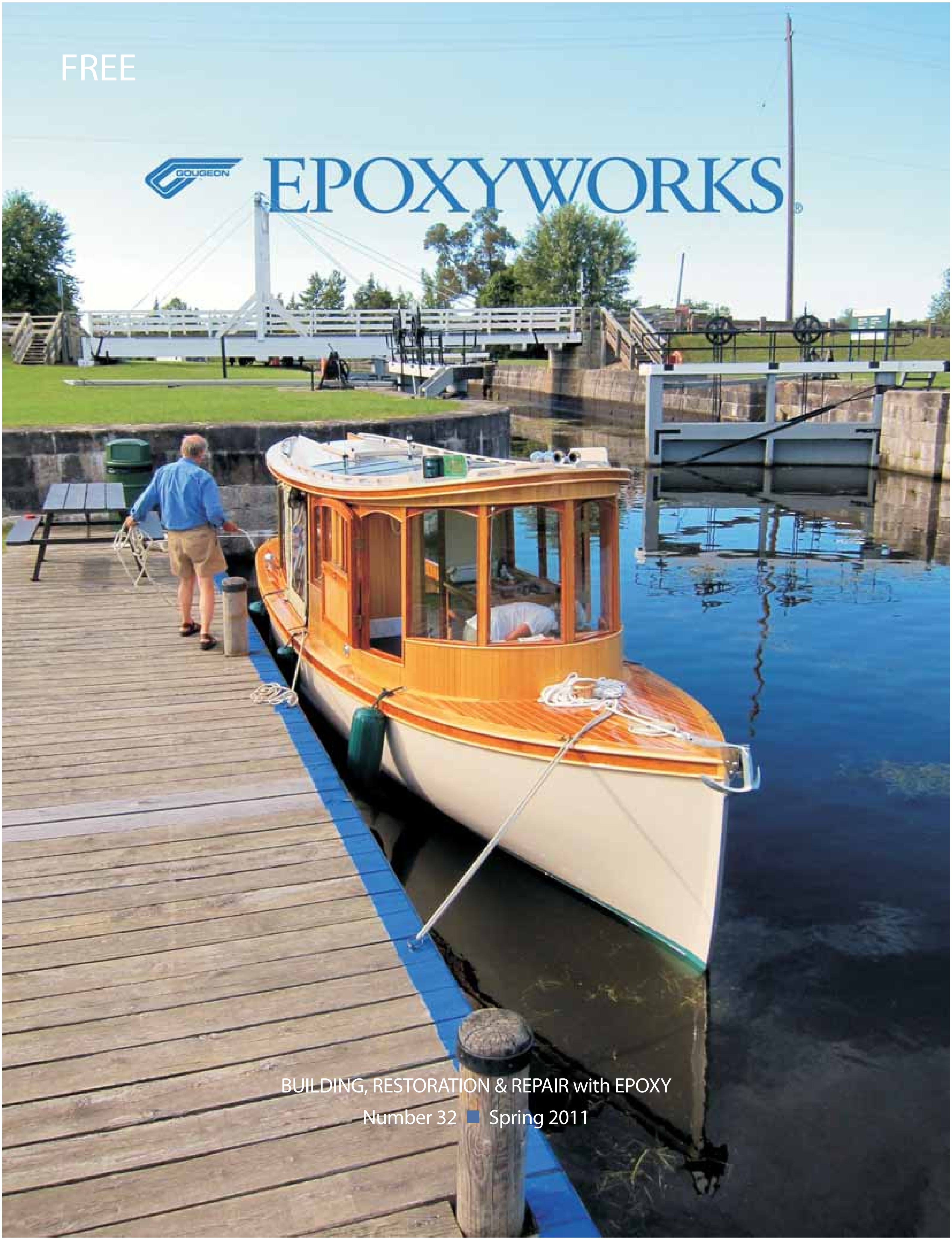

BUILDING, RESTORATION & REPAIR with EPOXY

Number 32 ■ Spring 2011

In this issue

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Ted's Jewel Box

By Michael Barker

Cover story

After three years of painstaking work and many interruptions, Ted Moores of Bear Mountain Boats completed the Bear Mountain 30 Hybrid Electric Launch *Sparks* on June 22, 2010. The boat is unlike any he had built before.

The Bear Mountain 30 Hybrid Electric Launch is designed for low-speed cruising while using the least amount of fossil fuel possible. It normally runs on batteries charged by solar panels and shore power. When necessary, a diesel generator powers its electric motor and charges its batteries.

The narrow displacement hull is more canoe-like than the average family cruiser. It was designed by Steve Killing, a master of efficient small boat design long associated with Bear Mountain Boats. The launch will comfortably accommodate a couple for several weeks of inland cruising. There is a small berth under the forward deck. The cabin, or pilot house, encloses the steering station, galley and head. The aft half of the boat is an open lounge seating area that can comfortably accommodate up to six passengers for day trips and can be enclosed with canvas panels when the weather dictates.

Following the launch, Ted and partner Joan Barrett took *Sparks* on a 12-week, 674 mile shakedown cruise from their hometown of Peterborough, Ontario, through the Trent Canal to Clayton, New York, and then north via the Rideau Canal to Ottawa.

While in Clayton they displayed *Sparks* at the Clayton Marine Museum Antique and Classic Boat Show, where it won the Best Contemporary Boat Award. It's easy to see why this 30' fantail launch is so appealing.

Ted Moores ties up *Sparks* at the blue line at the Kilmarnock Lock on the Rideau Canal.

Joan Barrett loads provisions in Smiths Falls, Ontario, for the next leg of their cruise on the Rideau Canal. The side curtains provide a good measure of protection in bad weather and are easily removed and stowed on nice days.

Joan pushes off the stern while Mary (right) and Lucie, Ted and Joan's faithful traveling companion, get comfortable in the open aft lounge.

Left—Looking forward, the cabin/pilot house contains a berth under the deck, a galley, head and the steering station.

Right—Joan and Ted check the indispensable Canal Guide to help pick the next stopping point on their way to Ottawa.

It borrows the classic lines and character of steam launches that plied these canals generations ago, but at the same time it represents everything Ted Moores has learned about modern composite boatbuilding over the last thirty-five years. I couldn't wait to see it.

While on vacation last August (2010), my wife Mary and I were fortunate to catch up with Ted and Joan in Smiths Falls, Ontario, for an afternoon cruise on the Rideau Canal. Smiths Falls is about midway between Kingston and Ottawa, lock number 29a on the canal. After dropping off a vehicle at the Kilmarnock Lock, number 24, about 20 minutes away by car, we boarded *Sparks*.

It's immediately obvious why she won a Best Contemporary Boat Award and why Joan called the launch "Ted's Jewel Box." There are few straight lines in this boat. Those classic lines require a lot of laminating, a lot of hard work. Ted is a perfectionist when it comes to brightwork and there is a lot of brightwork. The joinery and the finish are flawless. You will notice a predominance of white cedar planking and book matched curly maple veneer accented with black cherry and walnut trim. Most of the planking and veneer was vacuum bagged over plywood fiberglassed on both sides. All of the brightwork is assembled and coated with WEST SYSTEM® 105 Epoxy resin/207 Special Clear Hardener™ and varnished with Pettit Easpoxy™ Hi-build 2056.

The first leg of our afternoon cruise on the Rideau Canal was a 26' drop. Lock 29 has the largest drop on the canal. About 15 minutes after entering the lock, the tall gate at the opposite end of what was now a canyon opened. After a friendly wave to the lock keepers we were off. *Sparks* was quickly and quietly up to cruising speed. For most of the three-hour tour Ted cruised in the 5–6 knot range, right at the boats hull speed. *Spark*s seemed to move effortlessly at this speed. The absence of engine noise gives you the feeling it's being pulled along by magnets, which in a way it is.

Left—The white cedar paneling on either side of the aft stairs is trimmed with cherry.

Right—Ted also used Cherry to trim the book-matched curly maple door to the head.

Bear Mountain 30 Hybrid Electric Launch
LOA: 30'
Beam: 6' 11"
Displacement: 6,800 lb
Power: 7.5 kW Perm DC motor
Cruising speed: 5-6 knots
Designer hull: Steve Killing
Designer electric: Jonathan Killing
Builder/owner: Ted Moores

Although there is a large intimidating electrical panel, the boat's controls are quite simple: there is the traditional wheel, throttle, bow thruster control, depth gauge and a computer screen. A check of the computer showed that in the few days since they left the boat docked in Smiths Falls, the solar panels had restored the batteries to a full charge. The eight solar modules mounted on the rooftop are designed to recharge the batteries between trips and in a couple sunny days, the battery pack should fully recover from an 80% charge. On a sunny day the panels will put out enough power for the boat to run at 3 knots on solar alone. When running the boat over 3 knots or on cloudy days, the motor will draw from the batteries as needed.

The battery pack, consisting of 16 absorbed glass mat (AGM) 12 volt deep-cycle batteries, supplies 48 volts to the 7.5 kW Perm DC motor, which turns the 17" propeller directly. To preserve battery life, the computer starts the generator when battery capacity gets down to 60%. The water-cooled, one-cylinder Fischer Panda generator puts out 48 volts DC and will power the motor directly with excess power going to recharge the batteries. The batteries contribute considerable weight to the boat's 6,800 lb displacement, but do provide useful ballast for the narrow (6' 11") hull.

Jonathan Killing, son of Steve, designed the complicated electrical system, integrating three different power sources and three different storage units with all of the operating systems—propulsion, navigation, lighting, galley and a computer that monitors and records all of the systems data along with GPS data. An elegantly simple touch-screen interface shows the operator the current status of all of the components. It is easy to see which sources are supplying power, where it is going and how much is stored. While underway, the display showed how many kilowatts the motor (a spinning propeller icon) was us-

The eight Kyocera solar modules on the roof of *Sparks,* capable of producing 400 watts at 48 volts, are her primary source of power.

The Fischer Panda generator will power the motor directly when battery capacity drops below 60%. Excess power will recharge the

Moores at the helm of *Sparks*. The classic looking pilot house provides a good view of the passing landscape.

Next to a depth gauge, the computer's touch-screen interface displays all of the boat's systems. With the boat stopped, the display shows 200 kW directed to the batteries.

Ted Moores relaxes after tying up *Sparks* for the night at Kilmarnock Lock. While there is daylight, the solar panels will continue to charge the batteries for another day's travel on the Rideau Canal.

ing and how many of those were coming from the solar panels and how many from batteries. When the boat was stopped, the display showed all power going to the batteries. In addition to the 16 batteries that supply power to the motor, two additional 12 volt batteries supply power—one to the start the generator and one for the bow thruster, lights, navigation equipment, computer and other 12 volt functions.

Our cruise ended at Kilmarnock Lock, number 24. At the end of our mostly sunny trip the batteries were still at more than 80% of capacity. No fossil fuels were consumed.

Ted and Joan made it to Ottawa and into the Ottawa River then back down to Merrickville where they hauled out the first of September. *Sparks* went back in the water in Peterborough for some fall cruising until the end of October.

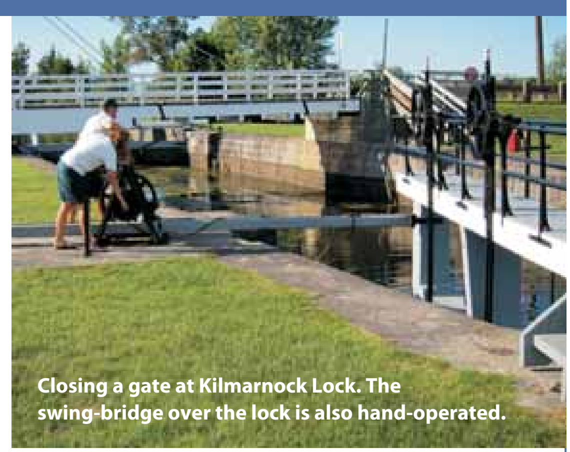
This is a different kind of power boating. It's easy to enjoy quiet conversation and the passing natural beauty of the canal interspersed with pieces of canal history. As you pass through old stone and wooden locks, hear iron pawls clanking on hand-cranked gears and a rush of water though opening valves, you experience what boaters experienced 179 years ago. Cruising on the Bear Mountain 30 Hybrid Electric Launch gives you a taste of what boating may be like in the not too distant future. ■

For more details about the building of the Bear Mountain 30 Hybrid Electric Launch and Ted and Joan's summer shakedown cruise visit www.bearmountainboats.com.

The Rideau Canal

To be honest, I had never heard of the Rideau Canal before. Fortunately, Smiths Falls, Ontario, is also home to the Rideau Canal Museum (www.rideau-info.com/museum). With a little time to spare before the cruise, we took a quick tour to find out more about the canal.

The Rideau Canal is a 125 mile long series of lakes and rivers connected by canals and locks. Completed in 1832, it is the oldest continuously operated canal in North America. It was intended as a military supply route between Kingston and Ottawa in case of another war with the US. It is a National Historic Site of Canada, a Canadian Heritage River and a UNESCO World Heritage Site. The canal was so well engineered that it operates today pretty much as it did when it opened 179 years ago.



Closing a gate at Kilmarnock Lock. The swing-bridge over the lock is also hand-operated.

Construction of the canal began in 1826 under the supervision of Lieutenant Colonel John By of the Royal Engineers. By the end of 1831, construction of the 47 masonry locks and 52 dams had essentially been completed. It was one of the greatest engineering feats of the 19th century, yet no good deed goes unpunished. By was chastised for cost overruns by the government when he returned to England. He died with his great accomplishment unrecognized. —*MB*

Ted Moores is a renowned boatbuilder, author and teacher whose name is synonymous with stripper canoes. He and his partner Joan Barrett own Bear Mountain Boats in Peterborough, Ontario. This is the first of a series of articles by Ted Moores on lessons learned from building his 30' Electric Hybrid Launch *Sparks* which incorporated the knowledge gained from 35 years of wood/epoxy boatbuilding. Pay attention kids.

Lesson 1 Strip Planking

By Ted Moores

Sparks is a science project. A professional builder working for a client has the responsibility of delivering the boat on time and budget with no surprises so we generally stick to what worked last time. But as a science project, questioning the way things are usually done, pushing the limits of the materials and then taking the responsibility becomes the objective. Because failure is anticipated with any experiment, testing is an important part of the project and has been a whole lot of fun with few surprises, mostly pleasant.

In this series, we will take a look at some of these questions and how we have used WEST SYSTEM® Epoxy to utilize less than ideal wood and look at ways of building boats with wood that will be low maintenance and age gracefully. Since working safe with epoxy has allowed me to have a long career using it, you will hear a lot about safety.

Planking *Sparks*

When we look at the future of wooden boatbuilding, the major limiting factor will be the availability of suitable wood. We won't stop building wooden boats so the challenge is to make the best of, and perhaps improve on, what we have to work with.

Strip-plank/epoxy is the ideal technique for planking *Sparks*. It adapted well to the complex fantail hull shape, could utilize local white cedar and we have been experimenting with the technique for about 35 years.

The most liberating feature of this building method is that the wood is simply a core material. The wood fibers do contribute to stiffness but the basic purpose of the core is to maintain consistent space between the two fiberglass/epoxy layers. When we look at it this way, the core can be anything as long as the glass/epoxy will bond to it and it is dense enough not to cave in under the anticipated compression load and be good in shear. Because the moisture content of the wood will not change and air is excluded, traditional planking characteristics such as rot resistance are not an issue.

Finger-joints

With this principle in mind, making long planks out of short boards did not require a structural joint; this suggested easy to machine finger-joints as an attractive option. A few simple experiments and destructive tests proved the joint to be more than satisfactory.

▲To machine the joint, we built a simple router setup that would shape the ends of two boards in one pass. One board is flipped over to fit the ends together.

▲The key to a joint that did not fail was to saturate the end grain with mixed un-thickened epoxy until it stayed shiny, followed by a thin coat of epoxy thickened with 403 Microfibers. Drawing the joint together straight and tight was also critical.

Ted 's Cheap Tricks

Working clean to get the best results with the fewest number of steps.

"In this series, we will take a look at some of these questions and how we have used WEST SYSTEM Epoxy to utilize less than ideal wood and look at ways of building boats with wood that will be low maintenance and age gracefully".

Traditionally, the accepted shape for strip planks has been square in section. I assume this began with edge-nailing dry joints on a hull that would be painted. This makes sense because it is easier to keep short nails centered in both planks and the narrow width minimized the amount each joint would expand and contract. Since our planks will be edge-glued and not move against each other, does it matter how wide the planks will be? Our choice was based on the maximum width that would handle the bends dry and yet be the best cut from the available raw wood.

Sparks planking is ¾" thick × 2 ¾" wide eastern white cedar dried slowly in a simple dehumidifier kiln to 6% moisture content then allowed to stabilized in the shop at about 8%. We finger-jointed 8'–10' long 1" × 6" planks together to make full-length planks 32' to 38' long. Then we dressed them to clean up the glue joint, split them into two planks and machined a half radii bead and cove on the edges. Planking the hull went fast using full-length planks; it was easy to stagger the joints and the lines stayed fair.

▲We planked the hull over a laminated Douglas fir stem, keelson and sheer clamp. The sheer clamp, which extends around the fantail, is covered with plastic tape to keep the planks from sticking to it. After sanding and applying the glass/epoxy to the inside of the hull, we glued the sheer clamp back in over top of the glass. This avoided all the time and complication of fitting the glass around the sheer clamp and creating a theoretical weak area in the most vulnerable part of the hull.

▲We began planking about half way between the sheer and keel where the plank would lay in the most relaxed position at both stem and fantail. This split the difference that comes with using parallel planks on a shape that is wider in the middle. This way the edge-set, or sideways bending, in the planks was not extreme at the centerline or the sheer. Once started, we proceeded to plank in both directions at the same time.

▲Most of the pressure holding the plank to the mold and edge to edge is controlled with simple jigs and wedges. The 'C' shaped plywood jig has two screws that protrude slightly through the plywood. When pressure is applied with the small clamps, the end of the screws bite into the mold to keep it from twisting when pressure is applied by the wedges. Made from scrap wood, the tooling cost is low, they apply controlled clamping pressure where it is needed and they are fast to setup and reset.

We applied mixed 105 Resin®/207 Special Clear Hardener™ thickened with 403 Microfibers to the cove with an acid brush. While there are more aggressive ways of getting the glue onto the plank, the acid brush puts just the right amount of glue in the right place. The cure speed of the 105/207 was ideal as it allowed sufficient working time to position clamps yet was fast enough to glue up two sets a day.

We make a habit of immediately using a dry cloth to remove any stray glue that gets on the gloves. This interruption controls the contamination at the source so it doesn't spread and is a constant reminder to find ways of keeping your hands clean in the first place.

On softwood and end grain, it is wise to do a pre-coat with un-thickened epoxy to reduce the danger of the thirsty wood drawing all the epoxy out of the thickened mixture. To do this in one step, we anticipated how much epoxy would be absorbed by the wood and mixed the glue to a consistency that would allow for this to happen and leave the right amount of epoxy in the joint. By anticipating the amount of glue that will be absorbed by the wood plus enough to occupy to the space in the joint, there is very little cleanup time, no glue to sand off later and you won't inadvertently sit on your bench and find yourself stuck in stray glue.

Most importantly, the time you are in potential contact with uncured epoxy is kept to a functional minimum. The bonus for me is that my helpers don't get epoxy on their gloves so my clamps stay clean.

▲We used screws and fender washers to hold the planks only if the hull started to come away from the mold. As the edge-set increased at the sheer and centerline, considerable pressure was needed to dry bend the plank into place. Our wedge planking jigs would pull the plank into position but needed the help of bar clamps between the station molds to squeeze out the excess glue; an indication that the joint was pulled up tight. In spite of the tension created, there were no glue joint failures in plank edges or finger-joints which says something about the tenacity and penetrating ability of WEST SYSTEM Epoxy.

▲Fairing the planked hull should have been straightforward because the mold was fair the full-length planks meant no hard spots between station molds and the planks were all the same thickness. Going from a series of flat planks to fluid curves should have been a good workout with sharp hand planes except for all the changes in grain direction in the narrow flat grain planks.

The wood we had to work with was one-inch rough, plain sawn which meant that all our planks were flat-grain. We experimented with the angle on the plane irons and found that with a steeper angle, there was less tear out but the cut was rougher and tear-out was not totally eliminated. While the resulting voids are effectively filled with 410 Microlight® fairing filler, it does mean one more job to take care of. Sanding with the long-board, a common but perhaps unloved fairing tool, was effective though tedious at the shaping stage. As the sander cuts the surface close to being fair, the soft part of the flat-grain cedar sands faster than the hard growth rings. The more you sand, the wavier it gets.

The routine we ended up using was to do about 80% of the shaping with an 80-grit disc on an 8" low-speed polisher. Turning at low rpm, the soft one-inch foam pad allowed the paper to take the shape of the hull and find the high spots, cutting them off clean. By keeping the paper sharp, working systematically and not over sanding, the hull was surprisingly fair at this point.

To get the remaining 20%, we used a cabinet scraper to find and take down the remaining high spots. Scrapers are not recommended for use on softwood because they do leave a little fur behind. The stiffness of the blade bending to the shape of the hull concentrates the greatest pressure on any high spot and sheers it down to the surrounding area. To remove the fuzz, we moistened the surface with water to raise the bruised grain then sanded just enough to remove it with 120-grit sandpaper on a file-board. Keeping the paper sharp helped to keep it cutting consistently. Dull paper gets into a polishing mode and eats into the soft part of the cedar, creating waves. The file-board will give you a good feel for what is happening underneath and helps to identify high places to be attended to with the scraper. This routine was repeated several times before we were convinced that it was as close as we could get to perfect. When you get this close, the glue lines and changing color of the wood confuse your eye; a good way to check is to close your eyes and let the palms of your hands tell you what they feel.

In retrospect, we could have saved significant shaping time by using imported edge-grain western red cedar, but in the interest of being as green as possible, exploring the use of locally grown wood was a good decision. We do know that it is possible to use simple techniques and epoxy to adapt to the inferior wood that will be available to boat builders in the future.

▲With the hull fair, the outside stem, keel and skeg assembly were dry fit to the hull. The stem was glued on before glassing; the keel and skeg were installed after the glass in order to have the glass fibers running across the centerline and continuously from sheer to sheer.

Before applying the glue, a 105/207 mix fortified with 403 Microfibers and sanding dust, the edges were taped off. Going from a good fit to a perfect fit on a curved piece of this size is a big step.

The tape keeps the extra glue isolated. After scraping it off level, the tape is removed leaving a clean joint. The excess glue is just the thickness of the tape at the joint, leaving very little to sand. After the glue cured, the joint was shaped with 410 Microlight to make it easy for the glass to follow the change in direction. The leading edge of the stem is rounded over to allow each layer of glass to wrap around to the leading edge to be overlapped by the next layer from the other side. After glassing, this edge will be squared up with filler to fit the stainless steel stem band.

We shamelessly skipped perfect joinery by using lots of thick glue to hide our sins. If you are filling space in a joint, it is important to over fill the joint so that glue is squeezed out. This will guarantee that the joint is full and there is no air trapped inside; it is difficult and messy to pack glue into a void without trapping air.

We are now ready to apply the fiberglass/epoxy covering to the outside of our hull. In the next article, we will look at why we chose multiple layers of glass cloth over the strip-planked hull rather than layers of veneer. Based on the testing performed by the Gougeon Test Lab, we will see how these numbers translated into our lay-up schedule and if we got it right. There are easy ways and hard ways to apply fiberglass and epoxy. We are lazy but fussy; you will see how to get excellence results with the least amount of contact with dust, chemicals and noise.

In future issues, we will look at constructing a laminated skeg that won't split, turning the hull in a custom jig, making the most of plywood, simple vacuum bagging techniques, no-sand penetrating epoxy sealer as well as endless 'cheap tricks.' ■

Visit www.bearmountainboats.com for details on the building of the Bear Mountain 30 Hybrid Electric Launch. Bear Mountain offers canoe and kayak kits, plans, books, instructions, materials and a great new DVD on stripper canoe building with TV star Nick Offerman.

A G/flex Modified Snow Shovel

By Tom Pawlak

This winter in Bay City, Michigan, we've seen a couple big snow falls and lots of small ones with 1" to 2" of accumulation. Not enough snow to bother breaking out the snow blower, so I usually shovel it by hand. About 10 years ago I fell in love with the plastic snow shovels that are lightweight and the snow slides off of them easily compared to the metal snow shovels that are heavy and snow clings to stubbornly.

My problem with plastic shovels is they wear out after one or two seasons at best because my driveway is made of fiber reinforced concrete. It is like a huge piece of 80-grit sandpaper waiting to devour my plastic shovels.

Four years ago, after another shovel had been reduced to a stub of its original self, I purchased a new plastic shovel. This time I had plans for extending its life. I planned to experiment with gluing small pieces of metal to the wear edge of the shovel with G/flex 655 to act as wear strips and extend its usable life. A few days ago (three and a half winters later) I noticed the shovel no longer had its distinctive high pitch sound while shoveling the driveway. Looking down at the tip of the shovel, the last of the original metal strips had finally worn away. These were ¼" wide strips of fairly soft steel that were about .040" thick. The shovel was still like new otherwise, so I brought the shovel back into the shop to repeat the process, but with a couple of upgrades.

The working edge of my trusty blue shovel with the wear strips worn through.

This time I decided to use harder steel in the wear strips. I located an old Starrett™ hack saw blade made with heat treated steel. I ground away all the paint and exposed freshly abraded steel then cut it into ½" long strips on a metal chop saw. I prepped the plastic surface in the shovel once again with a brief pass of the propane torch to oxidize the surface so G/flex would stick to it aggressively. Finally I glued the ½" pieces of saw blade down along the working edge of the shovel with G/flex 655 Epoxy Adhesive and let it cure. Since then I notice my wife Mary is always grabbing my improved blue shovel instead of using a new unimproved one we recently purchased. I asked her why she uses the blue shovel instead of the new one and she said "I love that old blue shovel it seems get under the snow better than the others." And it does.

The new and improved wear strips made of hardened steel.

In conclusion: It may not make sense to go out and purchase a G/flex 655 kit with the sole purpose of modifying your snow shovel, but if you do, you will have plenty left over for other minor but equally practical projects. The point in all of this is to once again demonstrate how the cured characteristics of G/flex Epoxy allow you to be creative with it on all sorts of novel uses. ■

Building My First Strip-Planked Boat

By Sean Schippers

Early last spring I was working for a talented woodworker in a quaint little wood shop in Nashville, Tennessee. He showed me a strip built canoe, something I'd never seen before. The wheels in my head started turning. I was completely captivated.

Rushing home and searching the internet, I could not believe the information and pictures that took hold of my imagination. I was in utter amazement one minute, jealous the next. In my former experience as a musician, I'd had no idea this kind of craftsmanship, experience and talent existed in today's world of "fast and now."

A good friend and I bought John R. Clark's plans for an 8' Classic Dinghy. I rented a shop space, loaded in appropriate tools, purchased the wood and started ripping strips only 30 days after seeing my first wooden boat.

The plans called for ¼" western cedar strips. I selected African mahogany with accents of Tennessee walnut and a little bit of maple in the hull, and used zebra wood for the gunwales and cocobolo for oarlock pads. I used two layers of lightweight fiberglass glass and WEST SYSTEM® 105 Epoxy Resin® with 207 Special Clear Hardener™ to seal my wooden treasure.

Schippers completes work on the oarlock of his John R. Clark designed Classic Dinghy.

The stripped dinghy hull before glassing still looks pretty good in a raw state.

This was my first time ever using epoxy on this scale to "wet out" fiberglass. I was amazed at how easy, yet strong, this boat ended up being. Building this boat was a lesson in just how much I have yet to learn. I can hardly wait to get started on my next boatbuilding project.

Sean is currently working out of his wood shop in Nashville, Tennessee, and is about to start his second boat build. ■

Left top—Bottom detail showing African mahogany with accents of Tennessee walnut and maple.

Left bottom—A detail of the transom.

Below—The finished dingy on display.

BUILDING iakos

By Joe Parker

We sailors sometimes think of ourselves as adventurers and explorers, self sufficient and capable of handling the vagaries of wind and weather. But our view of voyaging includes refrigeration to keep the food and drink cold, sail handling and navigation systems to make sailing easy and safe, and a good dry, comfortable boat so we remain content while sailing to the ends of our own personal world. When we compare that to the skills and equipment of early voyagers, it can be almost embarrassing.

The John Williams Boat Co. (JWC) on Mt. Desert Island, Maine, recently completed a project that helps put this in perspective. They constructed a set of iakos for the Polynesian voyaging canoe Hôkûle'a, built and maintained for the Polynesian Voyaging Society. The Polynesian voyagers were considered to be the best navigators of all time, finding their way around the Pacific Ocean from island to island without manmade navigational tools or equipment. No compasses, no charts, no timepieces. Their techniques have been passed down through many generations and studied by the brightest minds in science to figure out how they were able to accomplish this remarkable feat.

Hôkûle'a is a traditional twin-hulled voyaging canoe replica launched in 1975 to continue the tradition of voyaging throughout the Pacific. She will be rebuilt using traditional methods as much as possible. All structural members will be lashed together and no fasteners will be used to reassemble the craft. When complete, this restoration will allow the boat to voyage around the world. The goal is to circumnavigate the globe using only the traditional methods passed down by the Polynesian navigators. Many articles, books and TV documentaries have been produced chronicling this mission. This article is primarily about the portion of the project completed by the staff at John Williams Boat Co. in Maine that will help make the voyage a reality.

Bill Wright, Project Manager at JWC, approached us about a year ago for help with some details necessary to build the boat's iakos. The iakos are the beams that hold the twin hulls together and provide the structure for the entire sailing and living platform. The original beams were carved from single trees, but the scarcity of the appropriate timber makes replacement with one-piece beams nearly impossible.

Left—West System 875 Scarffer™ being used to machine scarf bevel and step.

Right—Dry fit of the full-length veneers on the steel mold.

Left—Stepped scarf to help align the stock while making full-length plies.

Right—Test piece being laminated. Multiple layup sessions were used in the test pieces to allow the manufacturing process methods to be developed.

Left—Application of G/flex 655. A thin coat was squeegeed onto one surface and a thicker coat was applied with a notched trowel to the other mating surface.

Right—The glued veneers are clamped over

Left—A laminated iako is being planed to final thickness.

Right—Completed iakos (beams) are getting final coatings of WEST SYSTEM 105/207.

The most appropriate solution was to build laminated beams. This presented a unique set of challenges.

The decision was made to use white oak for strength, stiffness and rot resistance. However, white oak is notoriously difficult to bond too. Sample laminates were made with WEST SYSTEM® G/flex® epoxy as well as a competitive product to compare performance and to examine the suitability of the concept. These test specimens were sent to the Advanced Engineered Wood Composite testing facility at the University of Maine for a complete evaluation.

The G/flex epoxy performed admirably in the structural testing at AWEC, providing the confidence needed to proceed with the project.

The next hurdle was to determine how to build these large beams with a fairly complex shape. A steel mold or strongback was fabricated along with some integrated clamps to allow molding each beam in just one laminating session. These beams are approximately 20' long and the cross section is 5½" × 5½".

The prep work for the glue up operation took days. This work included accurately machining all the veneers to a uniform thickness over their full length, and a dry run to ensure the sawn white oak veneers would conform to the mold shape in the full stack. The white oak stock was re-sawn, planed and sanded to ¼"-thick, so twenty four plies had to be scarfed to get the full length stock. Once that was complete, mixing the G/flex adhesive and applying it to the entire lay-up took less than an hour.

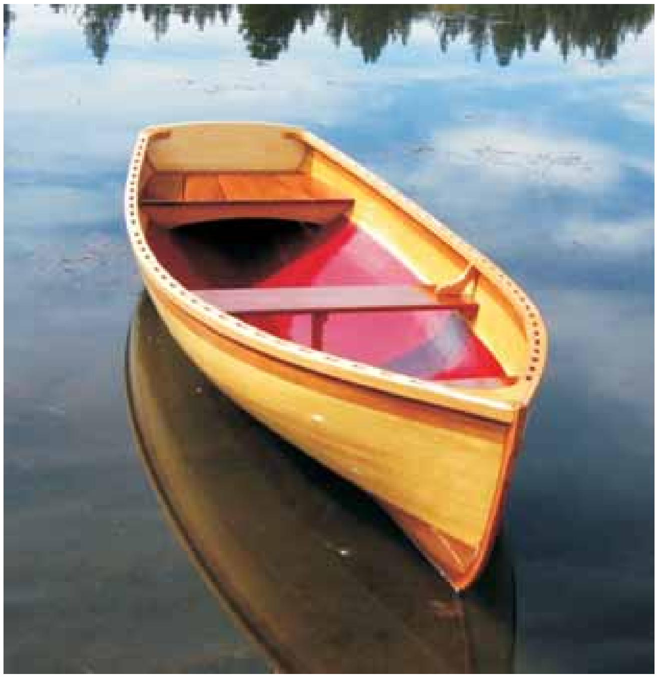
Perhaps the biggest challenge was getting sufficient clamping pressure in some areas of the beam laminate while not squeezing out too much adhesive in other areas. To prevent this from happening, the G/flex 655 was mixed and applied to all mating surfaces. A thin coat was squeegeed onto one surface and a thicker coat was applied with a notched trowel to the other mating surface. Then the plies were stacked onto the mold.

It was equally important to keep clamp pressure on as the plies were drawn down. Clamps were tightened near the center of the beam first, then pressure was progressively applied moving toward the ends of the beam. This helped eliminate dry spots that could occur if pressure was applied, released and reapplied.

The testing at AWEC indicated that the coated test sections held up to the moisture cycling ninety percent better than the un-coated sections. So, once the G/flex epoxy was cured, the surfaces were planed and sanded to prepare for the multiple coats of WEST SYSTEM 105 Resin® with 207 Special Clear Hardener™.

This is a perfect example of spending enough time preparing the stock, building an appropriate mold, arranging the clamps and tools and finally, when everything is truly ready, building the part. There is very little risk in a project like this if it's properly managed.

The result is pretty impressive. These one-piece laminated beams are very large, very rigid, and should allow Hôkûle'a to sail around the world confident her structure is solid. n



Built by David Harry of Chester, California, over four months of weekend and evening work, this 11' 2" Wherry has a 42" beam. It was launched in October, 2010. The boat was built from plans purchased from Baker Boat Works (Plan No. 76). Harry built the boat from locally available woods. The hull strips were ¼"-thick strips, ¾"-wide sugar pine, redwood and western red cedar. Douglas fir and black oak were also used. The boat was laminated inside and out with 6 oz fiberglass cloth and WEST SYSTEM Epoxy. Harry says, "It weighs 60 lb and is fast under oar, obtaining a good speed in about three strokes of the 6' 6" oars. My daughter was my clamping assistant in the construction and she named it *Rose*." Harry and his daughter enjoy rowing *Rose* around the waters of Lake Almanor, California.

Readers' projects

Scott Oldanie has found many unique uses for West System Epoxy around his Lemont, Illinois, home. These are just a few. He has built two white tail replica racks, bonded a carved, wooden bear head to the end of a beam, repaired damaged moose antlers and the rotted log ends of his log home.

Left—Oldanie builds white tail antler reproductions by first building an armature of welded pipe and ¼" steel rod. He then covers it with fiberglass cloth and builds up the antler shape with epoxy thickened with 406 Colloidal Silica Filler. He mixes in pellets from Beanie Babies for texture.

Below—Oldanie shows off the finished rack after it is stained.

This heavy, carved bear head was mounted to the end of a log beam with epoxy thickened with 406 Colloidal Silica filler.

Oldanie built this dogsled of ash and WEST SYSTEM Epoxy. The curved parts are laminated with 6-7 thin layers of ash.

The remotely operated vehicle (ROV) scoops floating debris from the water's surface and collects it for removal.

The Kell High School Robotics Team is an extracurricular activity at the Kell High School in Marietta, Georgia. Students in the program designed and built a robotic system that will be used to recover debris from lakes and rivers. The vehicle's two hulls are built of laminated Styrofoam™ covered with fiberglass cloth using West System Epoxy.

Right—Kell students prepare a laminated hull for fiberglassing (above) while other students begin to trim the excess fiberglass from a hull after the epoxy has cured (below).

Visit www.kellrobotics.org to find out more about Kell Robotics and see a video of the ROV in action.

Designed to be used for photo ops at trade shows, in the Modelo Beer booth, this massive Mayan throne was built by Saginaw, Michigan, artist Frank Smekar. Here, it has just a wet coat of primer, but the plywood, foam and West System Epoxy chair will get a crystaline sparkle texture, then be painted monochromatic gold. Smekar has been building museum exhibits, tradeshow displays and architectural details since 1982. Visit www.creativitydisplayed.com to see more of his work.

Matthew Gunning of Gunning Wooden Boats LLC, Summerville, South Carolina, sent this photo of a 15' strip boat he built for a customer in Virginia. He used 105 Resin/207 Special Clear Hardener™ with 7.5oz fiberglass cloth on the exterior and 6 oz cloth on the interior.

The Everglades Challenge

By Grace Ombry and Ben Gougeon

"…to encourage the development of boats, equipment, skills, and human athletic performance for safe and efficient coastal cruising using minimal impact human and wind powered watercraft based on kayaks, canoes, and small sailboats."

Here at the Gougeon Brother's Boat Shop Meade and Jan Gougeon are preparing for another attempt at the Everglades Challenge, a race Meade calls "a true aquatic adventure."

The expedition-style race covers about 300 nautical miles over a maximum of eight days. It's a grueling challenge; roughly 40% of starters ever make it to the finish line.

The rules are simple:

1. Racers must finish within eight days.
2. Racers must carry safety, communication and camping gear.
3. No outside assistance may be provided to any participant. This includes food, water, clothing, equipment or other material support.
4. Boats may be pushed, poled, paddled or sailed, but motors are not allowed.

Many types of boats are entered in the race. Some participants choose canoes or kayaks, others use small sailboats. Many contestants design their own crafts. There are no specific rules pertaining to which type of boat one may choose, but the race itself is a limiting factor. In order to be successful, the boat must be able to perform well in the shallow coastal waters of Florida. It must also be seaworthy and venture many miles into the Gulf of Mexico. The vessel must be small enough to pass under a 10' bridge on the way to one of the checkpoints and be carried onto land. Aside from these natural limitations, anything goes. If you can dream it, buy it, or build it, you can race it.

Meade Gougeon took *Yello Thing* for a test run on the chilly Saginaw River in preparation for the much warmer 2010 Everglades Challenge.

Meade's First Attempt

In 2010, Meade attempted The Everglades challenge. He'd built a small scow surfboard originally designed for fishing in the shallow waters in and around Tampa Bay. This "boat," affectionately known as *Yello Thing*, was designed to be propelled with a pole or a paddle. Meade was amazed at the boat's stability and efficacy and immediately recognized its potential as a sailboat. It was not long before this 16' × 3' surfboard had a reef sail, a jib, a spinnaker, a lee board, and a rudder.

After a few sea trials, Meade decided *Yello Thing* would be a good boat to enter in The Everglades Challenge. He outfitted the boat with an auto-pilot steering system and designed a bench-like structure that allowed for a seat that traversed along its width for added hiking leverage. He then added some compartments in the bow and stern to store food, gear and safety equipment.

The sea trials were performed in moderate weather with light breezes and up to three-foot waves. As all sailboat racers know, good conditions seldom remain throughout an entire race. Shortly after The Everglades Challenge began, Meade recognized some problems with *Yello Thing*. Offshore in the open Gulf, Meade found himself in unexpected 25 mph winds and eight-foot waves. The auto-pilot steering system, which worked expertly in calmer seas, simply couldn't handle these conditions. Meade was forced to hold *Yello Thing* on course manually.

"My claim to fame in sailing is that in over fifty years nobody has ever had to come rescue me, not once," Meade said. "Due to physical exhaustion, I was dangerously close to wrecking my record. At 40 years of age it would have been possible but at over 70, there was no way." After a few capsizes Meade wisely chose to head for the shore and withdraw from the race, having logged about 80 miles. At least four other boaters were not so lucky and needed rescue.

Beyond his unexpected difficulties with *Yello Thing*, Meade said the main hardships of the race were cool weather, water temperatures of only 62°F, insects, and obstacles in the shallow waters. He wanted to enter this year's race but didn't want to run it singlehanded again.

Meade is set to avoid some of the hazards of the inland routes in the 2011 Everglades Challenge with his new boat, the i550 *Hot Canary*, which has offshore sailing capabilities. *Hot Canary* is large enough to accommodate Meade and his co-captain, brother Jan Gougeon. Sleeping aboard will save them the time, trouble and equipment required of onshore camping. (See *Hot Canary* article, page 16, for details.)

Hot Canary's offshore capabilities should help Meade and Jan avoid a few of the hazards of the inland route, such as alligators. The name *Hot Canary* pays homage to a yellow DN iceboat of the same name which Meade raced in the 1960s.

Race Details

The Everglades Challenge is organized by WaterTribe, led by of Chief Steve Isaacs. The group's stated purpose is "…to encourage the development of boats, equipment, skills, and human athletic performance for safe and efficient coastal cruising using minimal impact human and wind powered watercraft based on kayaks, canoes, and small sailboats."

Only expert paddlers or sailors should consider undertaking the Everglades Challenge. The Everglades Challenge starts in Fort Desoto Park on Mullet Key in Tampa Bay, Florida and runs roughly 300 nautical miles along the coastline to Key Largo.

The first checkpoint is in Placida, Florida. Hazards on the way to Checkpoint One include rough water, a powerful tide out of Charlotte Harbor, large tarpon fishing boats, boats drifting through the pass, and boats running the pass to get in front of the drifting boats.

The second checkpoint is in Chokoloskee, in Florida's Everglades National Park. Racers must watch for strong tidal currents, especially through the mangrove channels where unpredictable currents run at 2 to 3 knots. The water levels drop and rise, exposing or covering sand and mud bars. Large boats cruise this channel, and some run at night with no lights. Although Checkpoint 2 can be difficult to approach, many kayaks, canoes, motorboats and sailboats frequent this entrance, it is do-able.

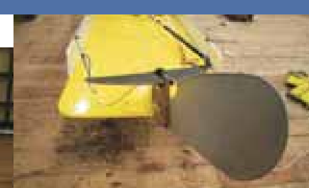
The third checkpoint is Flamingo, Everglades National Park, Florida about 60 miles up the coast from Indian Key Pass. The hard part is over, although tides will remain a challenge and racers must avoid bigger boats on these waters.

The finish line is Bay Cove Motel in Key Largo, Florida.

The 2011 Everglades Challenge takes place March 5-12. For further information about the race, visit www.watertribe.com. ■

Yello Thing, The Little Scow That Couldn't.

When the idea of paddling 300 miles in a competition arose, sails looked like a good idea. A kick-up rudder was also a added. The prospect of higher seas meant higher sides and the yellow thing, piece by piece became *Yello Thing*.



It's true *Yello Thing* didn't finish the Everglades Challenge. But transforming a simple surfing scow into a full blown screaming yellow racing machine was a challenge. One that was met head on with passion, ingenuity and West System Epoxy.

***Yello Thing* began life as a simple surfing scow that Meade could pole around the shallows for fishing.**

Soon a little box was added to the yellow thing for storage. In deeper water a paddle worked better than a pole. A lee board helped it track straight and a bow of sorts was needed to divert waves in the deeper water.

BUILDING the i550 Hot Canary

Slappy, one of the boat shop cats takes a last stroll around the deck before *Hot Canary* heads to Florida.

By Ben Gougeon

Here at the Gougeon Brothers' Boat Shop, Meade and Jan Gougeon are preparing for another attempt at The Everglades Challenge. (*See The Everglades Challenge, page 14*).

An autopilot steering failure on his sailing scow *Yello Thing* forced Meade to withdraw from the 2010 Everglades Challenge. When he reached the shore, he was already thinking about building another boat for the next race.

The next boat needed to be more substantial to handle rough seas. It needed to be trailerable and comfortable yet still meet the race's natural requirements. Meade and Jan began looking into the i550, an 18' sportboat designed by Chris Beckwith. The pair decided that with a few modifications the i550 would be perfect for the race. They ordered the plans and construction began.

The i550 Solution

The Gougeon Brothers technical staff constructed the hull in their shop with Captain JR Watson overseeing the building process. The i550 sportboat is built with plywood stitch and glue construction. We used ¼" 5-ply Okume plywood and judiciously placed 5 oz carbon fiber. The entire boat was built with WEST SYSTEM® 105 Epoxy Resin® and 207 Special Clear Hardener™.

The first task was to scarf three 4' × 8' pieces of the marine plywood together using the WEST SYSTEM 875 Scarffer™. We constructed a simple jig to enable the proper cut point on the plywood to minimize waste. After cutting the panels, we bonded them together with a mixture of 105 Resin and 207 Hardener thickened with 406 Colloidal Silica filler. Then we lightly sanded the panels with a random orbital sander to clean the scarf joints and prepare the surface for a coating of 105/207 mix. We "flow coated" the surface by applying mixed epoxy with a 10" drywall knife. This was an efficient, yet effective method to coat three 22' × 4' panels with epoxy prior to construction.

With the panels coated, we overlaid the Tyvek™ patterns (provided by Watershed Sailboats) on the panels and made reference marks to transfer the pattern shape for accurate cutting. Using a hand held jig saw, we cut the patterns from the panel, careful to leave the original reference marks intact. It's always easier to remove extra material later than it is to put it back on.

Right—A bulkhead is stitched in place with zip ties.

Left—With all of the bulkheads in place the ties were cinched tight before fillets and fiberglass tape were applied to reinforce the joints.

Left—The daggerboard trunk was fit in position after the bulkheads were in place. Gray pigment was added to the fill coat of epoxy over the fillets.

Right—Once the boat was moved to the boat shop, work on the deck began.

Captain JR Watson built an ingenious jig we used to set a scribe mark around the perimeters of the cut and trimmed panels. From this point we drilled holes at 8" intervals to allow for the HDPE zip ties to "stitch" the panels together.

We loose-fit the panels with the zip ties in place to achieve something close to the desired hull shape. With bulkheads fitted in the same manner, the i550 was starting to look like a boat.

After cinching the zip ties we added some spacer modifications to the bulkheads to alter the hull camber midship and forward of midship. We tabbed the seams with WEST SYSTEM 732 Episize 9 oz fiberglass tape. When the epoxy had thoroughly cured, we removed the zip ties.

We then completed the cockpit, deck, stem and stern using techniques detailed in the book, *The Gougeon Brothers on Boat Construction*.

After completing the hull, we moved the boat across the street to the Gougeon Brothers boat shop for Meade and Jan to finish. They made a few modifications and customized the boat to fit the needs of the race. The i550 is a one-design class that allows modifications.

The Keel

The first thing we looked at was the bulb keel called for in the plans. Because we needed a shallow draft, we built a straight keel that fully retracts into the hull. This flush keel arrangement is ideal for moving the boat over land. The Everglades Challenge requires all boats to be manually moved from the beach to the water.

We cast a NACA 12% lead foil and attached it to a board with the same section. An aluminum crane fitted with a winch lifts the keel through the daggerboard case. This arrangement provides sufficient mechanical advantage for one person to raise the keel to the desired height. The boat can be sailed with the keel up, down, or at any position in between. When portaging, the keel would be raised until flush with the bottom. The keel allows for sailing in shallow waters and for it to be easily trailered. With the keel cranked all the way down, the i550 is very seaworthy and has tremendous righting-moment.

Meade and Jan will use three heavy-duty, reinforced 10" × 48" beach rollers to move the craft over land. The rollers, stowed beneath the cockpit, serve double duty as positive flotation.

The Rig

The next thing we focused on was the rig. We bought a 25' 6" carbon fiber mast from C-Tech in New Zealand. Because the rig has to be lowered during the portage and pass beneath a ten foot high train bridge, we fitted the craft with tabernacle instead of a standard mast step. This tabernacle allows one to raise and lower the mast without assistance. No gin pole or stay guides are required. All internal halyards pass into the tabernacle and route to the cockpit.

Visit our website www.westsystem.com to view a video of the approximately 700 man-hours it took to build the i550 condensed to 3 minutes.

Meade Gougeon rolls a coat of paint on the overturned hull, while his brother Jan follows up with a tipping brush.

Left—Ben Gougeon demonstrates the blow-out safety feature of the rudder with a moveable trailing edge tensioned with shock cord.

Right—The aluminum crane fits into a slot on either side of the hull and can lift the keel for sailing in shallow water or trailering.

Left—The bowsprit is hinged at the bow and attached to a crossed line at the base of the cockpit (above) which will allow it to pivot 30°.

Below—Meade and Jan shake down the completed *Hot Canary* in Florida prior to the race.

The Rudder Assembly

Because the rudder was the major source of malfunction on *Yello Thing*, Meade knew the i550 needed a forgiving steering system. He designed a daggerboard-style adjustable draft rudder with a blowout safety feature. The rudder foil is set into a case with a non-destructive breakaway system that involves a moveable trailing edge tensioned with a shock cord. The boat can be sailed with the rudder fully extended, or in shallow water, part way up. This rudder configuration eliminates any chance of damage in grounding, while retaining a balanced helm at any depth of rudder setting, permitting shallow water control.

The Pole

Instead of a retractable pole that protrudes from one side of the bow, common to sportboats, we experimented with a pivoting pole that can be adjusted off center up to 30° for better downwind performance. The bowsprit is hinged at the bow and attached to a crossed-line at the base of the cockpit. This allows the spinnaker to be articulated from inside the cockpit.

With this final change complete, the i550 is now ready to take on The Everglades Challenge. We wish Meade and Jan, along with all the participants of The Everglades Challenge, the best of luck this year.

Anyone who is interested in building their own i550 sportboat may contact Watershed Sailboats at www.i550sportboat.com. Our WEST SYSTEM technical advisors are happy to assist anyone considering this project. Call us toll-free Monday through Friday 9-5 ET, 866-937-8797. ■

Build What You Can't Buy

By Captain James R. Watson

Do you sometimes need a replacement part for your boat, home or recreational vehicle and find out its no longer available? Discontinued. Source unknown. Can't be found. Maybe the price borders on insanity or, you need a part that simply does not exist and never did.

"Okay," you say, "I need it, can't get it, my only option is to make it."

As soon as you reach this decision, two thoughts pass through your mind. "How will I make it?" and "What materials shall I use?" You may have a third question like, "Am I the only one that has these problems?"

In answer to the third question, these are wonderful problems to have, because you do possess the ability to make stuff (I've found most readers of *Epoxyworks* have that ability). You have the power to create the non-existent part, fabricate the unavailable gizmo, fashion the unobtainium. Because you can produce "you name it," that door of opportunity is open for you. I offer the following projects I've taken on that might set you thinking about how you can make something you desperately need and can't buy.

Swim ladder bracket fairing.

My boat's swim ladder attaches to a bracket which allows you to remove the ladder and stow it when underway. The bracket is a stainless steel fabrication and on my boat it is attached to the hull's side rather than the transom.

I never would have thought a little swim ladder bracket could make so much spray. My wife sat where she thought was safe from sea spray, and got soaked.

I tried to make a shield by cutting a PVC tube, but that would have been too easy and the fit didn't even come close. This was one half of an asymmetrical cone that had to be strong enough to take wave impacts on the order of 200 lb and divert the water. I needed to fashion some kind of fairing.

738 Biaxial fabric with mat ready to be wet out with epoxy, placed between sheets of plastic and molded to shape when the epoxy gels.

Using stiff, brown paper I kept cutting it with scissors and bending it over the bracket as a fairing might until I produced something that looked right. My axiom has always been, "Trust the ol' eyeball." This paper cutout became my pattern after I thought about it and looked at it for a day. I then cut one layer of 738 Biaxial Fabric with mat fiberglass from that pattern and placed it on 4 mil plastic and wet it out with mixed WEST SYSTEM® 105 Epoxy Resin®/206 Slow Hardener®. I covered it with another piece of plastic and left it to lay flat for an hour or so, allowing it to stiffen somewhat as the epoxy began to cure.

It looked a little like a tortilla. I told myself, "I'm gonna let this tortilla cook a while, then form it to the shape of a warped, convoluted taco."

About an hour and a half later the laminate had stiffened. It was still flexible but when I formed it, it held its shape. At this point, I could form it to the shape I'd described with paper: half of an asymmetrical cone that the fairing needed to be. It stayed put and cured.

The next day I peeled off the plastic, faired the part smooth and bonded a layer of 5.8 oz woven carbon fiber to each side. With that addition, it became one tough taco, mighty enough to handle wave impacts.

The part with woven carbon fiber bonded to each side.

The edges needed a little trimming, and I scribed it to the hull's shape. By the way, the best bet for marking carbon fiber is a Sharpie metallic silver marker.

Before bonding it to the hull, I stood on it to test the part's strength. Now, spray is nicely deflected, my boat runs clean and my wife stays dry.

Time to conceive and build: 7 hours.

Limitations of this technique: Parts must have quite a bit of shape to them, be free of close tolerances and not too large. If too flat or too large, the flexible, partially-cured laminate will not support itself as it cures.

Rub rail end cap

Rub rails are made for rubbing against a dock. The end cap for the rub rail was swept off my boat when it hit a dock. I went to the chandlery for a replacement.

"No identification marks to tell who makes it," the clerk said. "How about the catalogs?" Zero. "Contact the builder?"" No such luck.

I did have the cap from the other side of the boat, so I removed it and set about to use it to make a mold to cast my own.

I troweled a thick layer of WEST SYSTEM 105 Resin/206 Slow Hardener thickened with 404 High-Density filler into a cavity in a foam packing lid (any disposable box or cup would have worked). *When pouring mixed epoxy in mass, use Slow Hardener to help prevent excessive exotherm.*

The existing cap was used to make a female mold in the thickened epoxy.

I coated the cap with a thin layer of axle grease and pushed it into the mixture to make a female mold of the outside shape of the cap.

The cap left a good impression of itself in the cured epoxy.

The next day I popped the part loose. The fastener holes in my old part created bumps in the mold and dimples in the new part which I'd use as a guide for drilling fastener holes. I cleaned the mold. There were a few flaws in the surface which I filled with toilet bowl sealing wax.

Since axle grease worked so well for casting the mold and since smoothness of finish wasn't a priority, I'd use it in the mold to make the part as well. I cut fiberglass to shape from a paper pattern I made from the mold cavity. To match the thickness I used my two coin technique—layers of glass between two coins (quarters) lightly pressed be-

Thickness dictates laminate stiffness. Matching laminate thickness will generally result in similar stiffness to the part you are replicating.

tween my forefinger and thumb. Measuring the gap between the coins I added more layers until I matched the thickness of the part I was duplicating. In this instance, a ⅛" thickness took six layers of 6 oz fabric.

I wet these out with epoxy and placed the whole stack into the mold. In this spherical shape, placing the fabric on the bias helps it conform better. I tinted the 105/206 epoxy black with 423 Graphite Powder so my part looked like the original.

The finished rail cap.

The finished rail cap installed.

While I was at it I made an extra cap. If I had an extra, I figured I'd never hit another dock.

Time to make the mold and produce two parts: 4 hours.

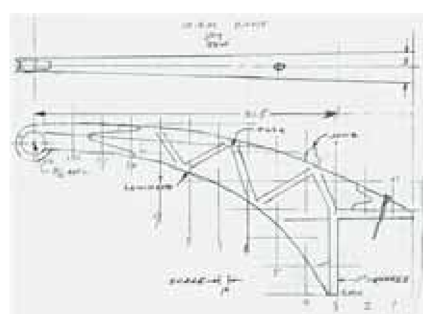
Limitations: Not too many but you're building a mold so this method is best for making multiple parts. For this particular part, I'm not sure there would have been another way to make it.

Davits for the dinghy.

A davit is a small crane fitted on a boat to hoist and lower a dinghy. Usually davits are mounted in pairs on the aft end of a larger craft. A tackle or winch is usually required to raise the load. Commercial davits are generally made of stainless steel or aluminum. Most I've seen are heavy, expensive and in my opinion ugly. For my new power catamaran I wanted davits that were lightweight, graceful looking and low cost. That meant I'd have to make them myself.

My stitch and glue 7' 10" Sabotina dinghy I built from Glen-L plans (which I was very happy with) weighs 70 lb. Two davits share the weight, but must be able to handle all the weight in case of a weight transfer situation. In addition, the davits must withstand wave shock loads which might be three times the applied load. I figured the davits should handle 200 lb with plenty of safety margin. To prevent the dinghy from filling with water, I fitted it with a bailer to help keep the weight down.

The davits needed to be about 10% longer than half the width of the dinghy's beam. There had to be a plan for attachment to the boat. These were to be manually operated davits. Using this criteria, I designed and built my davits.



The design was first sketched out on graph paper.

I sketched out my scaled design on graph paper, then transferred it to a flat plywood surface with a larger grid. This made scaling it up to the actual size easier. I built the davits on this surface. I faired it with battens and darkened the lines of the final shape. Blocks (for clamping) were screwed down to my plywood base along the line describing the davit's shape.

The top and bottom of the davits are 4 layers of ⅛"-thick spruce sandwiching 3 layers of 3" wide unidirectional carbon fiber tow resulting in a little over ½" thickness. I figured the two laminations, one-inch total thickness, would support 200 lb. The wet-out laminations were clamped together against the blocks. After they cured, I trimmed the pieces, tapering them from the root to the tip (in the top view). This would give the arms a graceful look and reduce weight on the ends.

Clamping block served as a "stuffing jig" Compression struts connected top and bottom laminate to create a truss.

Putting diagonal bracing between the tops and bottoms increased strength and stiffness further without adding much weight.

I put the trimmed pieces back against the clamping blocks and used it as a stuffing jig. I cut and fit ½" × ½" braces to serve as compression struts creating a truss that also keeps the side walls in column. I used solid stock to beef up the root ends where they would be mounted to the hull.

I fit a ¾" PVC tube under the top of each davit between the braces for the hoist line to pass through. I roughed up the PVC with 60-grit sandpaper and bonded the end where the tube passed through the top face. The tip was reinforced with a double thickness of plywood to reinforce the end for a sheave axle.

I planed and sanded the two sides flush and bonded 4mm thick plywood to each side to complete the structure. I placed weights on the plywood for clamp pressure. (Lead weights cast in a cupcake pan are handy to have around.) I rounded the corners and coated all surfaces with three coats of epoxy. No fiberglass was used.

Nearly completed davits with primer applied. Note hoist line exit from top of the davit.

The davits are attached at the boat's seat back which is a foam/fiberglass structure with reinforcement in the davit area. I made the davit base 3" wide so it would have lots of lateral stability. With the notched configuration, I'd have lots of gluing area. The davits are glued to that structure with a long stainless steel lag screw bonded in place with epoxy after passing through the root end blocking. A typical person can pull 40 lb. So all I needed was an eye that served as a dead end to yield a 2:1 purchase to ease the work. Cam cleats were fitted to the davits near the exit tube to secure the hoist line. Each davit weighed 5 lb.

To test the finished davits, I hung from each, one davit at a time.

Time to conceive, design, build and install: 30 hours.

Limitations: The lighter the dinghy the easier it is to make the davits strong enough. How the davits are attached to the mothership is crucial. In this example, the attachment arrangement was ideal.

The Euro Sink

I wanted a small sink that would conserve water, install flush with my custom countertop, and have a certain stylish look. I call my design the Euro Sink, and fashioned this item myself.

Two plywood panels are joined over a temporary form to produce the desired shape.

Plywood only bends in one plane. But if two bent panels join at an angle, you can get some interesting shapes, something like what I wanted. I cut symmetrical, temporary forms from wood and joined them together. I then bent 3mm-thick plywood around the form and bonded the two panels together with a fillet. I placed glass tape over the outside, resulting in sufficient strength to remove the forms. Then I could hold my creation in my hands, turning to view from all angles and assess its appearance.

Satisfied with what I had (actually I built two and chose the one I liked best) I put a big fillet on the inside corner like a sink should have, then applied a 5.8 oz woven carbon fiber to the inner surface yielding a metal-like, water tight structure.

The sink was bonded into the counter cutout.

The finished sink in the finished counter in the finished boat.

The sink was then bonded into the counter cutout. I used a Delran™ thru-hull fitting for a drain. The whole unit was painted with Awlgrip™. I'm pleased with the way it looks and the size is just right for the boat's head. It holds water.

Time to conceive, design, build and install: 12 hours.

Limitations: As plywood only bends in one plane, shapes are limited. Flat panels might result in a boxy look. Besides, you can buy stainless steel sinks pretty reasonably but not one shaped like this.

An instrument hood

The instrument hood on my boat houses the GPS chart plotter, VHF radio, a digital barometer and a 12-volt outlet. The existing instrument panels were the wrong size or the wrong shape—nothing existed like what the designer had drawn. It had to be built.

I wanted to build it without a mold, yet keep it lightweight. Why didn't I want to make a mold? Molds are often a great time and material commitment—especially true for one-off parts such as my instrument hood. A mold would have been as much work to produce as the part. So I set out to build this hood by combining the methods I'd used to build the sink and the swim ladder fairing.

The shape of the hood limited what materials it could be built with. Plywood wouldn't make the sharp bend needed for the corners, but a grid-scored core such as balsa or foam would. But a grid-scored core doesn't support itself without a mold. So the strategy was to create minimal support, something like a mold, until the skins were applied.

The gusset-like forms guided the tight radius. They're connected to my workbench which supports the flat section of the hood.

Curved parts are inherently more rigid because a curved surface collects loads and turns them into lateral ones. The hood would never see much force; it really only had to hold itself up with some margin of safety in case someone leaned on it. ¾" foam core with 6 oz fiberglass on each side made a surprisingly rigid panel at a mere ½ lb per square foot. I felt good about the part's strength and the projected weight.

To maintain a flat top I would use my flat shop bench surface. To control the 150mm diameter curved ends, I fashioned four wooden gussets and joined these to my bench top with fast-curing G/5 Five-Minute Adhesive. I placed 4 mil plastic between the bench and formers to prevent inadvertent adhesion to the work bench. This was an issue because I had to apply the fiberglass reinforcing on the top surface (underside of the finished hood) and was sure the epoxy would pass through the ¾"-thick, grid-scored foam.

The bench top provides a flat surface while the gussets (hidden in this photo) establish the curvature.

I wet out the 6 oz fiberglass using WEST SYSTEM 105 Resin/206 Slow Hardener. My little shop was pretty warm that day so I kept the door open to make it a little more comfortable. But after the lay up was complete I closed the door and let it get real warm inside, a little over 90°F.

Two hours later my laminate was cured to the point where I could trim the excess fiberglass along the edges with a utility knife. I then flipped the part over and placed it on a wooden male form that I'd screwed to my work surface. The shape I had struggled to envision and was not sure how to produce just a short time ago now lay before me.

The foam with reinforcement on only one side was then placed over this male form and glass was added to the outside surface.

The tighter the curve, the more the grid score opens on the outside of the curve. The gap is even greater the larger the blocks of the grid score. I filled the gaps that opened up on the outside of the curves with epoxy thickened with 410 Microlight™. When that had cured I sanded the surface smooth and applied 6 oz fiberglass to the exterior surface.

The back surface of the instrument hood is flat, so I made it out of 3mm plywood. The plywood back is joined with a fillet and fiberglass tape. I coated everything with epoxy tinted with 503 Gray Pigment. I like to get the object all one color to give it unity. It also highlights flaws that can be adjusted, in this case with fairing. Now the parts were ready for final sanding, painting and installation.

Instrument panel mounted, but without bezel in place.

The bezel portion of the instrument panel is cane rattan. I traced from a paper pattern and cut the rattan to shape with scissors. Then I bonded plywood to the back side perimeter and painted it flat black. The openness of the rattan would allow the instrument panel to stay cool, and I think looks pretty good. The bezel is attached to the instrument panel with Velcro™ tape.

Time to build and finish: 12 hours.

Limitations: size, although I did a cabin roof that was 8' × 7'. I don't know if you could produce a shape with curves in the second plane with this technique. ■

The last word

I began working at Gougeon Brothers, Inc. over four decades ago as a boat builder. Thirty years ago I became a Technical Advisor, which presented the opportunity to talk to so many creative folks building and fixing things with epoxy. This article represents one of hundreds written for our publication *Epoxyworks*. This will be my last one as I am retiring. I plan to cruise on my new boat *ION*—now in North Carolina, with her davits, instrument hood, Euro Sink and swim ladder fairing—around the Chesapeake, ICW and Bahamas. *ION* is a fuel-efficient, 10.2 meter power catamaran designed by Roger Hill of New Zealand. The boat was built for me by my long-time friend Craig Blackwell of Blackwell Boatworks in Wanchese, North Carolina.

The rub rail end cap is on my other boat kept here in Michigan. (It's a good thing I have lots of boats or I'd have nothing to write about.) It has been a pleasure communicating with all of you for all these years via email, telephone and *Epoxyworks*. Perhaps we'll cross paths on the water. That would be nice.—*JR*

A Magnesium Crankcase Repair

By Rob VanMullekom

I work here at Gougeon Brothers, Inc. as Operation Supervisor in the epoxy department where we do production mixing, assembly, packaging and quality control of the epoxy products. A lot of the guys I work with here ride motorcycles. In talking with these guys, I found out that it is not uncommon to punch a hole in the ignition housing cover. In fact, that's what happened to my bike.

The ignition cover of my off-road motorcycle is a magnesium casting. The casting is not heavily stressed but does have to hold the hot (about 140°F) oil that lubricates the engine.When I realized it cost $160 to replace the cover, I started thinking of the alternatives like, "how about using this epoxy we make for the repair and save some cash?"

After asking around a little, I came up with an approach. Now after completing the task and finding that the repair is working fine, I thought I'd share my process of how to fix a punctured metal casting.

There were too many wire and cable connections so, rather than disconnect these, I chose to do the repair with the cover in suite. After draining the oil, I cleaned all surfaces with acetone. Then I abraded the surfaces of the magnesium with a Dremmel™ Tool, to knock off the burs. Crankcases are made of other materials; aluminum and steel and I think the same strategies would work as well. I figured a rivet-like casting of epoxy would hold best. So I wanted the epoxy thick enough so it wouldn't run out.

▲The holed ignition cover is off the bike, but still connected to it.

▼The repaired cover showing the repair area from the inside.

I chose Six10® mixed with a little 420 Aluminum Powder because it will not sag and also is toughened a little so it will tolerate the vibrations that the whole motorcycle is exposed to. I didn't need enough to use the static mixer so I simply dispensed some into a small plastic container and stirred it. This material is thin when moving but thickens, or gels, when at rest. So it was easy to work into the void and flow about the inside to form my vision of a rivet. I smoothed over the outside and allowed it to cure for 24 hours before I filled the case with oil.

When I'm done riding the bike I put it in the garage with a paper towel under the repair so I can easily note if there are any leaks. Since the repair, I've ridden about 16 hours and have had no leaks. ■

Student builders

The Apprenticeshop

By Grace Ombry

The Apprenticeshop in Rockland, Maine, teaches students decision-making skills, care, patience, forethought and responsibility through traditional boatbuilding. Instructors guide each apprentice through building two to four boats during a two-year apprenticeship.

The philosophy behind The Apprenticeshop is that learning is best accomplished through direct experience. Apprentices in this program learn craftsmanship and problem solving through each step of wooden boat construction from lofting, molds, framing, planking and decking to finish work and rigging.

Traditional carvel or lapstrake are the construction methods used most often at The Apprenticeshop. But many different construction methods and types of projects are usually going on side-by-side because the shop depends on commissions. This provides the apprentice crew opportunities to learn a wide range of skills and techniques.

The shop occasionally takes on restorations as well, but only after the staff evaluates them for their educational value.

Each week, students participate in "walk-around," an exercise where they observe, ask questions and share information about every project going on in the shop.

The shop has a longstanding tradition: when an apprentice graduates, he nails his shoes to the wall, thereby leaving a piece of his soul.

During apprenticeship, each student is assigned "beagleship" or full responsibility for some aspect of the shop community. The truck beagle must keep the shop truck in good running order, while the fastener beagle inventories and reorders screws, rivets, etc. so every boat project has what it needs.

Some apprentices arrive as complete novices, while others already have extensive experience in woodworking. Most are 18 to 40 years old, and graduate from this two-year program understanding a wide array of boat construction methods and confidence in problem solving. The shop has a longstanding tradition: when an apprentice graduates, he nails his shoes to the wall, thereby leaving a piece of his soul—or sole.

The Apprenticeshop has been in operation since 1972 and is one of the oldest traditional boat building schools in the US. Originally located in Bath, Maine, the shop moved in 1982 to the old Penobscot Boatworks shop in Rockport, Maine. ■

Traditional carvel or lapstrake are the construction methods used most often at The Apprenticeshop. Students here are working on a traditional lapstrake dory.

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.

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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.

How-to publications

For sale at WEST SYSTEM dealers, 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.*

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Pouffe No. 2 **(low table), 2011—Black Chlorite and Italian White Alabaster top; taper-laminated Pink Ivory and Holly & Chechen base with Holly disk and Pink Ivory plate. The woods and the soft stone of this piece were glued with WEST SYSTEM Epoxy.**

Tables of Content

After earning a B.A. in Philosophy, David Cumming began his craft by restoring lesser furniture (often salvaged) and then trading "up" for better pieces, learning about the nature of furniture construction in the process.

For many years Cumming has specialized, when restoring and making furniture, in techniques of wood lamination, which he feels results in both greater beauty and greater strength. The bent lamination technique is particularly useful to him for making wooden forms that require a thin, graceful line and, therefore, demand a maximum of strength with a minimum of wood.

He typically uses WEST SYSTEM® 105 Epoxy Resin® and 209 Extra Slow Hardener™ with 403 Microfibers as a thickener. He laminates the legs of his tables over molds he has cut to shape. Cumming is shown below clamping coated laminations to a mold.

Amboyna Burl Top Stand**, 2007—Amboyna top with Cumaru and Black Locust Laminated legs with Pau Amarillo "claw" feet.**

Symmetry No. 1**, 2007—The White Oak legs of this stand are bent-laminated, utilizing WEST SYSTEM Epoxy. The drawer fronts (dovetailed) are Box Elder from Cambridge, Ontario. The drawer backs, sides and bottoms are Red Gum from California. The handles are Pink Ivory, from Southern Africa.**

Cumming lives in Toronto, Ontario. Most of the woods used in these pieces came from Exotic Woods in Burlington, Ontario (also a WEST SYSTEM Dealer) and the stone was purchased at Sculpture Supply in Toronto.

Contact David Cumming at 416-654-5941 or dwcumming@gmail.com. View more of his work at www.craft.on.ca/portfolio/DavidCumming. ■

Photos: Sally Cumming.

Stand No. 1**, 2010—The Holly and Ebony legs to this piece were glued with WEST SYSTEM Epoxy. The Black Chlorite and Holly top was also glued with WEST SYSTEM Epoxy. The base is Italian White Alabaster.**