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Michigander

A 21st-Century Stern Steerer

by Randy Rogoski, West Michigan Ice Yacht Club

Michigander is 40-feet long and weighs 1,400 pounds. It's in a class by itself and is one of the largest ice yachts sailing anywhere in the 21st century.

This "A"-class stern steerer carries 360 square feet of sloop-rigged sail. "That's a lot of horsepower," said skipper Eric Sawyer. *Michigander* also sports a 250-square-foot Kevlar® mainsail for better control in more wind. She'll sail in excess of 60 mph in a 10 mph wind.

plank, and runners. The components ride on a caster-mounted dolly that slides out a rear hatch. The weight of the loaded two-axle trailer is 3,500 pounds. It takes three sailors an hour to rig the boat and ready her to sail.

Sawyer's roots are on Lake Michigan's Green Bay. He has sailed ice yachts all his life and continues a family tradition by sailing this design, which dates from the 19th-century.

Cover Photo: Michigander on Lake Pewaukee, Wisconson for the 2018 Wisconsin SternSteerers Association regatta

Photo by Jay Yaeso

Michigander's fuselage being built in Yaeso's second story workshop in Green Bay

Sawyer built this monster of an iceboat in a second-story garage workshop with the efforts of a friend.

He won every race in a fleet of eight at the 2019 Northwestern Ice Yacht Association regatta January 19 and 20 in Lake City, Minnesota. The waterfront there is an expansion of the Mississippi River known as Lake Pepin.

While becalmed on a frozen Montana reservoir for five days in 2004 with fellow ice-seekers from the West Michigan Ice Yacht Club, Sawyer hatched the idea of building a new fuselage that would be half the weight of the original. With his friend, and crew member, Jay Yaeso, he drew up plans based on proven designs and began construction in Yaeso's Green Bay, Wisconsin garage. *Michigander* sailed her maiden voyage in March 2011.

It took 10 week-long trips to Green Bay, much sawing, clamping and 40 gallons of West System Epoxy for Sawyer and Yaeso to build the hull from Sitka spruce. When it was finished, they hired a crane to lift the fuselage through a second-story window to a waiting truck.

Sawyer also built a 45-foot enclosed trailer to carry *Michigander*, her 39-foot mast, 28-foot

When the Soo Locks, which connect lakes Superior and Huron, close for the winter, Sawyer devotes time to boat building and sailing. Sawyer, 54, works as the captain of Great Lakes cargo vessels. When not at sea or iceboating, he lives on White Lake in northern Muskegon County, Michigan.

And he has other projects in the works. "That's the beauty of an iceboat. They're never done."

He grew up sailing a kid-sized stern steerer, and has owned a Renegade and a Skeeter, but always wanted a big stern steerer. In 1990, he brought home a 40-foot stern steerer named *Eclipse* from Pewaukee, Wisconsin. After the mast and plank were broken in capsizes, he built replacements from lighter materials using composite construction.

For every hour of sailing an iceboat, there are many more hours of building, traveling to the ice, setting up, waiting around for wind, and repairing the boat when it breaks. To spend as much time sailing *Michigander* as he's spent working on it, Sawyer says he would have to live 200 years.

"It's that 80 mile-an-hour ride, that's why we do it," he said.

50 years

Here at Gougeon Brothers, Inc. we're celebrating our 50th anniversary in business. We've grown from a modest boat shop that began experimenting with epoxy in the late 1960s to a trusted manufacturer and supplier of epoxies worldwide. We serve the high-end composite, boatbuilding, boat repair, and board-sports industries. Our products are manufactured under rigorous ISO 9001:2015 standards to ensure consistent high quality and performance. Marine and composites educators, designers and manufacturers consider GBI epoxies—WEST SYSTEM®, PRO-SET®, and bio-based Entropy Resins®—the gold standard in their respective markets.

Since 1983 we've been an employee-owned company. "Each member of our staff is invested in client success and satisfaction. That's crucial to our business philosophy. We're enthusiastic about our customers' projects—whether they're hobbyists, boat construction or repair yards, major manufacturers, or rocket scientists," company President Alan Gurski said. "We believe in hiring people who are smart, hardworking and cooperative, and we provide our employees opportunities for growth. Our preference has always been to promote from within the company."

Employee ownership means that in addition to our salary or wages, full-time employees earn stock in our company and enjoy regular dividends and profit sharing. We also get sabbaticals every third year, and tuition coverage for employees pursuing higher education. Most who've parted ways with GBI over the years have retired after decades of service.

With a workforce of fewer than 50 individuals, GBI remains a nimble and responsive company that puts customers first. Founded by Meade, Jan, and Joel Gougeon, the family has always kept a hand in managing the company. President Alan Gurski is the son-in-law of the late Meade Gougeon.

Never content to rest on the laurels of this enterprise's early successes, we continue to take product quality, business sustainability, environmental stewardship, and market growth seriously.

In 2018, we acquired Entropy Resins, a small, bio-based epoxy brand popular in the board-

"We look forward to serving our industries and customers for the next 50 years,"

The current employee owners of Gougeon Brothers, Inc. Taken January 2019

Early employees of Gougeon Brothers, Inc. in front of HOT FLASH, a 32' half-ton monohull. Photo taken in 1976.

sports industry. We've also undertaken a joint venture with HF Industri & Marine ApS to provide affordable, accessible PRO-VAC vacuum consumables to composites manufacturers in North America.

We have a tradition of generosity toward students and educators in the marine and composites industries. A dozen accredited schools and universities with composites or boat building programs receive our annual credit for epoxy purchases and special pricing. Hundreds of students and teachers avail themselves of GBI's Educational Support Program as well. We funded a scholarship for Minnesota's Winona State University composites program in the name of GBI technical advisor and WSU program graduate Michael A. Barnard, who passed away in 2017. Two other colleges local to the Saginaw Valley also have GBI endowments that fund scholarships for students studying the sciences.

Our Gougeon Employee Foundation donates thousands of dollars annually to fund local initiatives. We donate 1% of Entropy Resins sales to environmental initiatives through 1% For The Planet (www.onepercentfortheplanet.org), a global network of businesses, nonprofits, and individuals working together for a healthy planet.

Contenders for the America's Cup have repeatedly turned to us for technical expertise and PRO-SET epoxies in developing state-of-the-art sailboats for this venerated contest. Both USA-based America's Cup challengers, the New York Yacht Club's *American Magic* and the Long Beach Yacht Club's *Stars & Stripes*, have retained PRO-SET as their official epoxy supplier. PRO-SET was also an official technical supplier to ORACLE TEAM USA, the defending champion in the 2017 series.

Brothers Meade, Joel, and Jan Gougeon founded the company in 1969 in Bay City, Michigan. They started out building sailboats and iceboats, then pioneered the use of epoxies for marine bonding and coating with their flagship WEST SYSTEM brand. The brothers innovated cold-molded construction methods, and in the late 1970s published their popular textbook, *The Gougeon Brothers on Boat Construction.*

Today, thousands of marine chandleries worldwide distribute WEST SYSTEM products. "We look forward to serving our industries and customers for the next 50 years," Gurski said.

Richard with team USA's bobsleds.

BMW World Cup training January 3rd 2018
Photo: IBSF / Viesturs Lācis

Bobsled

By Richard Laubenstein

USA Bobsled/Skeleton's Crew Chief, Richard Laubenstein, constantly works toward one main goal: to design and maintain the fastest, most aerodynamic bobsleds for Team USA's athletes. Bobsleds are high-performance machines powered by people. Athletes push the sled in a sprinting start to gain speed, then jump in to continue down the icy track at speeds exceeding 95 mph.

There are currently 16 bobsled tracks in the world. The International Bobsled and Skeleton Federation World Cup tour competes on nine of those tracks. While the tracks are all different in shape, they are approximately one mile long with straightaways and sharp, high-banked turns. One bad bump or turn can be disastrous.

Team USA's sleds were previously made of fiberglass. The latest USA sled cowlings (body) are made of carbon fiber because the material is structurally sound and lightweight. This allows the team to move their weight within the sled for a performance advantage. Hans DeBot's team at DeBotech in Mooresville, NC builds all of USA Bobsled/Skeleton team's 2-man, 4-man and skeleton cowlings.

In a sport that can take a turn for the worse

with one small mistake, the team needs to be prepared to make many repairs on the road. There is no bobsled store to run to for new parts, especially since Team USA has their own unique design that is not shared with any other countries. Laubenstein, whose background includes working on Indy cars, must make do with the limited resources that the team travels with on tour. Since they spend a great deal of time in Europe, they must be as self-sufficient as possible.

There are many challenges that come with working on the road. One is the dark, cold parking garages that become makeshift shops where the sleds are stored after training. These garages also double as a gym since the team travels with free weights. Another challenge is dealing with limited equipment and supplies on the road as well as different electrical voltages. In these less-than-ideal conditions, the repair philosophy is "whatever it takes."

The team's go-to for bobsled repairs is WEST SYSTEM 105 Resin with 205 Fast Hardener and whichever filler is best for the situation at hand, usually 404 High-Density. At a race in LaPlange, France, the temperature in the garage was below 32°F so they had to disassemble the cowling of the sled from the frame and take it into the hotel lobby to use the epoxy.

Back in Lake Placid, NY, where the US team has a complete shop, a vacuum bag system is used for optimum performance. This makes the repair as strong as new. Gearing up for the season ahead, Team USA uses WEST SYSTEM 105 Resin, but this time with 206 Slow Hardener.

WEST SYSTEM has been extremely helpful to the USA team with all of its repairs such as laminating and bonding. Because this epoxy is versatile and easy to use, it has become their go-to product on the road.

Vacuum bagging repairs on a bobsled.

Cherry Basin

This is a project I did for a bathroom in our home. I turned the 17.25-inch wide basin from black cherry. The top of the cabinet is cherry as well, with a natural edge. I applied three coats of epoxy to each, sanding the cured epoxy between coats. The final finish was three coats of polyurethane.

- Steve Alguire

Aluminum Hinge Repair

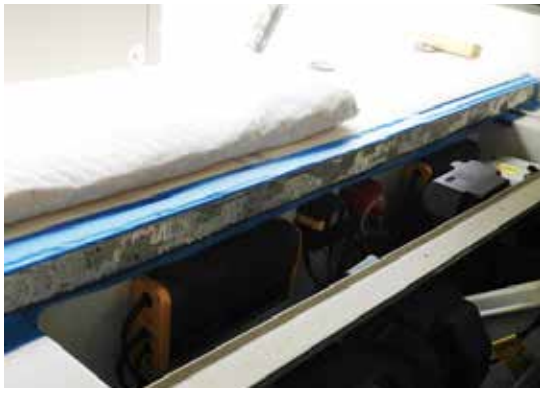
By Gary Harrison

I made a difficult rear-hatch repair on my 2007 aluminum SeaArk 1872 MVJT (modified V-jet tunnel) center console using WEST SYSTEM G/flex Epoxy.

The year before I bought it, my SeaArk center console had undergone a complete rebuild. The entire inside of the boat was sprayed with Line-X® Protective Coating, which makes clean-up super easy but prohibits any additional welding to the aluminum.

Unfortunately, whoever installed the aluminum hinges on the cargo covers, live wells, etc., positioned the hinges too low. So low that raising the 7' 1" rear cargo cover beyond a vertical (90°) forced the cover to crush the top edge of the deck. This sprung the hinge and prevented the cover from lying flat against the deck. The hinge needed to be replaced.

Before mounting a new hinge, I needed to find a way to rebuild the crushed aluminum edge so the new hinge would install correctly. I loaded my boat and took it to a big-time aluminum fabricator. He looked everything over and agreed it would be impossible to weld because of the Line-X coating. It's both difficult and expensive to remove and re-apply a Line-X coating. Eventually, he flat out told me there was nothing he could do for me. I spoke with numerous other boat repair experts, but no one knew of a good fix or offered a suitable fix at any price.



Prepped surface area on the boat side of the hinge

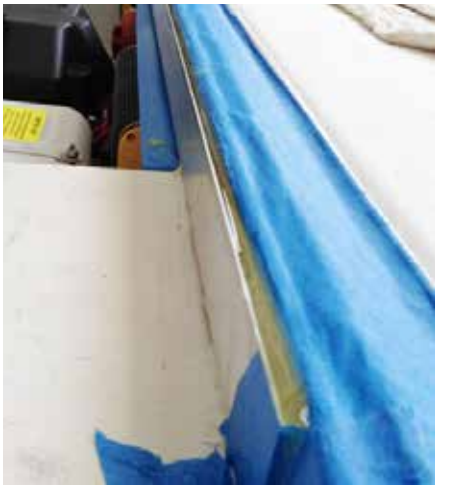
After removing the existing hinge from the rear cargo cover, I saw the biggest problem: the face of the aluminum on the boat side was crushed. Instead of the hinge side being a vertical 90°, it was now closer to 70°. I needed to straighten or square the face where the hinge attached to the boat. This would require me to position a new piece of flat aluminum stock to the boat face to provide a square surface for mounting the new hinge. But this new aluminum strip had to be mounted so that its bottom touched the bottom edge of the boat face while keeping the top almost 1/4" away, hanging out in midair.

I called WEST SYSTEM and talked with their technical advisors. They spent a lot of time educating and guiding me, helping me choose the correct products. I decided to get both G/flex 655 thickened and the G/flex 650 unthickened epoxies. Next, I ordered a 2" x 6' x 1/8" stainless steel hinge, a 2" x 6' x 1/16" piece of aluminum stock, and a bunch of rivets.

G/flex 655 Thickened Epoxy allowed me to use a putty knife to put a heavy bead of epoxy

Finished rear deck hinge

Tapered gap filled with G/flex



Just finished pouring

along the bottom and side edges where the hinge was to be positioned on the boat (approx. 1 3/4" from the top). Using a long straightedge, I slid the piece of flat 1/16" x 2" aluminum stock square against the boat face where I'd applied the bead of G/flex. I pressed the aluminum firmly, forcing the epoxy to form a bead at the bottom and side edges. I secured the aluminum strip to the boat face with painter's tape while the epoxy cured. After about two hours, the G/flex Thickened Epoxy was firm enough to trim the bead along the edges of the aluminum. With the aluminum strip mounted at the base and sides of the boat face, I needed only to fill in the remaining gap with G/flex 650. Using a throw-away syringe, I back-filled the gap with unthickened G/flex. After this cured, I had a new, square (90°), aluminum "face" into which I drilled and, using rivets, mounted the new 2" stainless steel hinge.

Because the inside of my boat was coated with Line-X and welding was off the table, I don't believe there were any other ways of replacing the rear cargo hinge that would have worked so well. Because WEST SYSTEM offers their G/flex epoxy in both unthickened 650 and thickened 655, their customers have options that haven't previously been available. I don't think I could have solved my particular problem without both G/flex 650 and 655.

The final step was painting the exposed epoxy along the top edge of the epoxied joint so it blended with the deck, and made the repair virtually invisible.

"I called WEST SYSTEM and talked with their technical advisors. They spent a lot of time educating and guiding me, helping me choose the correct products."

Author's note: I wrote this article soon after completing the hinge replacement, back in mid-2014. It's 2019 now and the hinge still functions properly. Considering this cargo cover is more than 7' long, made from 3/16 aluminum (with an extra 1/8" plus of Line-X), this is a very heavy, bulky cover. The G/flex repair has worked out perfectly.

The reinstalled hatch ready for painting.

Don in his completed Pietenpol Air Camper

PIETENPOL AIR CAMPER

A wood and fabric airplane

By Don Youngblood

Top: The completed airframe prior to installing the fabric cover

Above left: Cockpit controls and gages

Above right: Fiberglass cowling for the nose prior to painting

Left: System routing in the cockpit

I built this 1929-design Pietenpol Air Camper in my single-car garage, with the final assembly at Pickens County Airport, LQK, South Carolina. Construction over a 6-year period used about two gallons of WEST SYSTEM Epoxy. I "hammer tested" scrap wood joints after each mix had cured—wood always split, never the epoxy joint.

The photos show the complete airframe prior to installing the fabric cover, cockpit and systems routing views, and the fiberglass cowling before I painted it. I made the cowling over a cardboard and plaster of paris mold which I'd lacquered and waxed. Then I laid strips of 4-cross-ply fiberglass cloth over it. I kept the cowling wet with WEST SYSTEM Epoxy until I'd completed the fiberglassing. For the finish, I used auto primer and automotive gloss paint (for fuel durability), matching the fuselage with Rustoleum® blue aerosol paint.

The materials I used were FAA approved Sitka Spruce, 5-ply aircraft plywood, steel plate and tubing, and aluminum plate and tubing. The engine is a 75 hp Continental, with wheels and brakes from a Cessna 150. The plane's empty weight is 676 pounds and it can accommodate a pilot weight up to 225 pounds.

I have flown it 13.2 hours as of 7/28/18. It flies true, indicating 70 mph at 1,900 engine rpm. Its maximum speed is 88 mph, and the touchdown speed about 40 mph.

The covering is heat shrink fabric coated with household latex paint, Rustoleum aerosol paint on the trim, and automotive clear top coat. I now keep it at Oconee County Airport, CEU, South Carolina, about a half-hour drive from home.

The designer, Bernard H. Pietenpol, is deceased. I bought the plans from his son. For a complete history and construction details on this amateur design—which originally used the Ford Model A engine—visit pietenpols.org.

Cemetery Monument Repairs

By Ron Graham

I started working regularly at Pine Ridge Cemetery, an abandoned, historic cemetery in Bay City, Michigan in 2009. For several years, I concentrated on mowing and clearing out scrub growth (clusters of hawthorn with up to 1 ½" thorns). When I reached a point where things looked better with the grass and trees, I began working on monuments that needed to be raised, straightened, or stood up.

Toppled headstones in the cemetery in need of repair

In 2015, two things happened that changed my direction. First, I started to get help with the mowing, which allowed me more time to work on the damaged monuments. Second, I started probing the ground and found several tall obelisks (up to 81"), two of which were broken in two.

I began searching for a way to repair the breaks and found WEST SYSTEM Six10 Thickened Epoxy Adhesive. Before trying it, I talked to Gougeon Technical Service and confirmed that it would be appropriate. After my first couple of repairs, I was satisfied.

While I was working one day, a man was looking around the cemetery. I asked if he could use some help finding a grave and he said yes. As it turned out the man was one of the founders of Gougeon Brothers, Joel Gougeon, and he was looking for a Civil War veteran who was his great-great-grandfather. I showed him the gentleman's monument and asked if he'd like to see what I had accomplished with the Six10. He took some pictures of the repair I showed him and asked me to go with him to meet his brother Meade Gougeon, which I did.

The headstones repaired and reinstalled

From then to the present, Gougeon Brothers, Inc. has supplied the epoxy which I have used to repair approximately ninety headstones. I'm not finished repairing all the monuments, but I'm nearing the end of this large cemetery which was abandoned in 1931. It's looking quite good. But when I stick the probe into the ground I never know what I will discover that needs repair next.

When assembling the stone pieces, I lay them out and mark the points of contact. The next step is a good cleaning, including wire brushing to eliminate any loose or soft surface material. Next, I use acetone to clean all surfaces to be epoxied. When all is ready, I apply Six10 in a ring on one surface, then I seat the pieces together and clamp them, which squeezes the epoxy into all of the cavities. I also use Six10 to bridge gaps as needed for strength.

The cleaned pieces of headstones midway through assembly. Pulverized marble and white pigment mixed with epoxy helps the joint color match the headstone.

To finish the project, I make what I call fake marble by mixing pulverized marble with WEST SYSTEM 105 Resin and 206 Slow Hardener. This makes a thick paste which I use to fill all holes, gaps, and grooves to match the surface. To match the color, I add WEST SYSTEM 501 White Pigment.

When I started this project I was working alone, but now we have a 501 (c) 3 non-profit organization called Friends of Pine Ridge Cemetery.

Bruce Niederer doing what he loves best, sailing.

I walked with Giants

by Bruce Niederer

I thought a lot about my career here at Gougeon Brothers, Inc. as my time for retirement drew near. I've been working every day, more or less, from the time I was 16 years old. I've had a lot of different jobs. But for the last 22 years and change I've been with GBI and—without sounding too hyperbolic—it has been life-changing. Soon it will all be over and I can reap the rewards I've earned in retirement.

I couldn't be more excited… I couldn't be more apprehensive.

I went to college fairly late in life. When I graduated I was 38 with a wife and three young children. By the way, my advice for a budding collegiate is—to paraphrase Arnold Schwarzenegger—*Don't do dat!*

One beautiful afternoon in 1996, I was eating lunch with my Dad, rest his soul, down at our boat dock. Our old friend (and GBI's first Tech Advisor, now retired) J.R. Watson stopped by and said "Give me your resume. We're looking for a chemist."

I generally didn't travel about with my resume in hand, so I gave him a copy ASAP and the rest, as they say, is history. But what a history!

I finished my career at GBI in the excellent new Technical Center. It's quite a change from when I started here in 1996. Tom Pawlak and I made the move into the new digs as the only remaining Senior Tech Advisors to do so. Tom retired in May 2018, and my retirement will be September 2018. The current staff of Technical Advisors will continue transitioning forward with the company as it grows.

All the old guys who taught me the ropes are now retired. We watch from the sidelines with pride as GBI succeeds. Once GBI gets in your blood, it never goes away completely.

The Technical staff is made up of individuals younger than I am. So much younger, I barely remember what I was doing at their age. But they bring mighty skills and energy of their own to the job. It has been my pleasure to work with each of them: Don Gutzmer, now our most senior Technical Advisor by years of service, is in his early 30s; Rachael Geerts, newly hired with a recent degree in composites engineering; Terry Monville, an experienced sailor and former manager at

West Marine; and Greg Bull, another sailor who worked many years helping Jan Gougeon build his winning race boats. All are skillfully led by Jeff Wright, Vice President of Technical Services.

The role of a Technical Advisor has changed dramatically over my 22 years here, and for the better. I know the current group of smart, dedicated Technical Advisors will set a high standard for service and expertise. If I have provided even a fraction of the mentorship to these people as my old mentors provided to me, I will consider my time here well spent.

One of the best aspects of working for GBI is that the job has stayed interesting for 22 years. This may be the most important aspect. I was encouraged to develop as a person and as a professional to a point where I felt the confidence that came from being at the top of my game. I've developed relationships with customers because they value my advice and opinions. I've developed a writing style that others I work with appreciate. I've even been trusted to tackle some controversial topics in print and online as a result. A work environment like this generates the satisfaction of a job well done. This translates into a level of personal satisfaction and happiness that I think is fairly rare in the world today—but common at GBI!

J.R. Watson and I knew each other 22 years ago because we both raced sailboats. Boat building and sailboat racing played a big role in the birth of this company and in my getting that first job interview. Historically speaking, I occupy a unique place in the GBI story as I prepare to leave. I am the last Tech Advisor that began learning the ropes in the old building from a group of people I am proud to call my friends and mentors; people who will forever be giants in my mind. I am grateful to each of them for giving me the foundation and expertise to take their place as, one by one, they each retired or passed away.

If my story is to be told, let it be said that I learned from the best. If my story is to be told, let it be said that I called Meade and Jan Gougeon friends. Let it be said that I am considered a comrade by the likes of former GBI Technical Advisors J.R. Watson, Tom Pawlak, Jim Derck, and Brian Knight. I thank these gentlemen for the privilege of their friendship and company.

I won't be resting on my laurels though. I will begin building a CLC teardrop camper this winter and put it to good use traveling to see the USA. Riding my Valkyrie to Sturgis is on my bucket list. I'll be sailing my beloved '81 Pearson Flyer, *Triple Threat*, to the North Channel and Georgian Bay. I'll be showing off the 1954 Cadillac outboard runabout my brother and I are restoring. We may even end up in Mystic, Connecticut. to show it off at the WoodenBoat Show. Mostly, I plan to enjoy myself and only work when it suits me—or if I need a few extra bucks for beer!

I am a lucky man, the first in my family to retire with benefits. I humbly thank all the men and women I've worked with over my 22 years at GBI. It has been my pleasure and distinct honor.

The skillful, energetic group of coworkers I'm leaving behind (L to R):

Jeff Wright–Vice President of Technical Services
Don Gutzmer–Technical Advisor
Greg Bull–Technical Advisor
Rachael Geerts–Composite Materials Engineer
Terry Monville–Technical Advisor

Above: Daniel's grandson taking his new car and boat with trailor for a spin.

Inset: Daniel's grandson happily floating in his custom, pedal powered runabout.

Right: The street rod pedal car was built from 3/4" steel tubing.

Far Right: The seat is adjustable and covers the pedal rod assemblies that drive the rear axle.

Above left: The steering wheel and pedal assembly

Left: The pedals have a 4:1 pedal-to-shaft ratio

Above Middle: 5 blade impeller and rudder

Above Right: Drive unit assembly and drive shaft

Chris Craft Baby Runabout

Daniel Laeyendecker

I designed this project by scaling down a Chris Craft runabout from pictures I found online.

I started with five rib frames and a center beam temporarily mounted upside-down on a workbench. I glued and stapled the ¼" x ¾" bead-and-cove pine strips to the ribs. Once all the strips were installed, I removed the staples and sanded the hull smooth for the heat-activated 2" mahogany strips I'd apply later.

I cut out a section of the transom bottom to install the small drive unit I made from a 3" 90° PVC plumbing elbow. Inside the elbow I fabricated a 5-blade impeller driven by a shaft connected to a foot pedal assembly under the bow. The pedal timing gear drives a small timing gear mounted to the drive shaft. The belt is rotated 90° to allow for proper rotation of the shaft. There is about a 4:1 pedal-to-shaft ratio which seems to work.

With the drive assembly finished, I went to work on the deck. I edge glued the deck strips and stapled them to the top of the ribs, taking care not to glue the deck to the ribs at this time. After the glue was dry, I removed the deck from the hull, sanded the inside of the hull and deck, and epoxied the deck for future permanent installation.

Before mating the deck and hull, I installed the steering system. I attached the steering wheel assembly to the rudder assembly at the rear of the drive assembly. I attached a cable inside a plastic tube from the lever on the wheel and connected it to a lever on the rudder.

After sanding the exterior, I applied 2" mahogany strips with a heat iron and cut them as necessary to match the curve of the hull. With the bottom hull fully covered, I applied the deck permanently. I skinned the top of the deck with mahogany strips and applied 1/8"-wide pine strips between each strip of mahogany. I then sanded everything smooth to prepare for fiberglassing.

I used 4 oz. fiberglass cloth with two coats of WEST SYSTEM 105 Resin/207 Special Clear Hardener over the entire hull and deck, followed by two coats of polyurethane varnish.

The windshield is made from ½" aluminum channel bent in a curve and welded at the corners. I cut a piece of Plexiglas® to fit it.

The seat slides forward and backward to accommodate my four-year-old grandson and, eventually, his one-year-old sister. By luck, the boat floats at the right level so that the drive unit is fully submerged and surprisingly functional. I have as much fun watching him in it as I had building it. Maybe this will inspire a few other grandparents.

After the boat project, I thought it would be neat to build a little street rod for pulling the boat. Once again after looking online at pedal cars and chassis, I built a frame from ¾" steel tubing. As a watersports enthusiast, I thought a woody wagon would be a natural fit to pull the boat.

I built the body of the car from ¾"x1" pine, doweled and glued. After much sanding, I routed out the frame body for the ¼" plywood inserts.

Car body is made with pine and mahogany veneer. The hood and fenders are painted sheet metal.

The plywood was covered with the same kind of 2" mahogany heat-activated veneer as I'd used on the boat. After I'd sanded the whole body, I covered the exterior with the same 4 oz. fiberglass and 105/207 epoxy. I brushed the interior of the body with 105/207 to seal the wood completely.

I formed the hood and fenders from 20-gauge sheet metal and primed and painted it. The seat is adjustable and covers the pedal rod assemblies that drive the rear axle. The independent front suspension was modeled after a full-size street rod.

My grandson really likes pedaling the car and only tows the boat on occasion because it slows him down.

Specialty Epoxies

By Don Gutzmer

Why use a WEST SYSTEM specialty epoxy? I will cover the important characteristics of each of our three specialty epoxies. After reading this short article, you may see a use for one of these products in your future.

Six10 Adhesive

Six10 Thickened Epoxy Adhesive is a two-part epoxy with a consistency similar to gel toothpaste. We manufacture it under vacuum to prevent entrapped air bubbles. Our in-house chemists formulated this toughened system with 8% elongation. Conveniently, Six10 requires no hand mixing when used with a standard caulk gun and the static mixing wand that comes with each cartridge. The self-metering coaxial cartridge dispenses a gap-filling, structural adhesive that bonds tenaciously to wood, metals, fiberglass, and concrete.

To apply this adhesive to areas smaller than the tip of the static mixer, tape a small drinking straw to the end of the static mixer. Six10 has a working time of over 40 minutes until the mixing wand becomes unusable. This adhesive has shear thinning properties, which means it moves more like a liquid when you work the material. This allows its use in cooler temperatures. You can also use it to wet out lightweight fiberglass cloth. It will cure in temperatures as low as 50°F (10°C).

Six10 is an excellent choice for bonding in fasteners. With the ease of point-and-shoot application, Six10 Adhesive is hard to beat. Many boat owners realize that the convenience of not needing to hand-mix epoxy or add fillers outweighs the additional cost of Six10's special packaging.

G/flex Epoxy

G/flex is a two-part, toughened epoxy that can make structural bonds which absorb the stress of

expansion, contraction, shock, and vibration. We formulated this system for high elongation with an ultimate elongation of around 30%. The increase in elongation and lower modulus (stiffness) that it provides equates to better adhesion to substrates. This helps it resist a peel or delamination from starting.

G/flex has a 1:1 mix ratio by volume for easy measuring. It's also ideal for bonding together dissimilar materials. We offer it in two versions. The liquid version, G/flex 650, has a consistency similar to honey. You can thicken it with 406 Colloidal Silica to reach the same viscosity as the 655. The pre-thickened version, G/flex 655, has a consistency like gel toothpaste. With proper application techniques it will bond to wet/damp substrates and dense or oily woods like teak and oak.

The lowest cure temperature for G/flex Epoxy is 40°F (4°C). These products provide about 45 minutes of working time at 72°F (22°C). G/flex will adhere to most plastics with proper surface preparation (see "Gluing to Plastic with G/flex" in *Epoxyworks 26*).

When you need to bond to a difficult substrate like teak or stainless steel, we recommend G/flex. Many boat owners see the benefits of using G/flex for repairs such as "Catalina Smile" hull-to-keel joint separations.

G/5 Five-Minute Adhesive

G/5 Five-Minute Adhesive is a two-part adhesive that will cure to a gel state within minutes. It has a 1:1 mix ratio by volume. You can wet sand it about 30 minutes after application. It is ideal for a temporary, quick cure that's convenient for some applications like fabricating a quick custom sanding block with some scrap fiberglass cloth and a piece of foam.

G/5 should not be used where high loads are expected or if it will be continually immersed in water. A batch of mixed G/5 can be blended at different loadings with a WEST SYSTEM formulation to reduce cure time. It will speed the cure of 105 Resin and 205 Fast Hardener. Keep in mind that blending formulations will reduce physical properties and we don't recommend it for certain applications. Thoroughly blend 105/205 at the proper mix ratio before adding blended G/5 resin and hardener to the mix.

Overall, these specialty epoxies have their advantages and expand the versatility of the WEST SYSTEM product line. The specialty epoxies are sold in larger volumes including gallon sizes, and are also sold in small repair kits.

Composite Snowshoes

By Mark Minter

Looking for an entry-level composite project? One that needs a minimum amount of materials and construction space, costs less than a boat, but still lets you travel on water? If you live in snow country, why not build a pair of snowshoes?

These snowshoes are made from a rigid foam core between two layers of carbon-fiber cloth, edged with 1" Kevlar tape. A carbon-fiber wrapped wood spar runs across each snowshoe under the ball of your foot. This provides a solid mounting point for a couple of stainless steel eye-bolts to attach a simple toe-and-heel strap for a binding. Fiberglass tape reinforces the top and bottom edges, and the upper surface of the snowshoes where your winter boots contact them. A light Kevlar scrim helps protect the bottom of the snowshoes from rocks, roots, ice, and other insults. This makes for a slick surface, so a piece of plastic netting glued to the bottom helps with traction on hard-packed snow. (For greater grip on icy trails, bolt an aluminum cleat to the bottom of the spar.) Two coats of marine topside paint give the snowshoes a durable finish.

Editor's note: Though it is not likely to cause an issue for this project, galvanic corrosion does occur between carbon-fiber and metals. Insulating the materials from each other with epoxy, will prevent corrosion.

The Joy of Six10

For teak gunwales on prototype *Clam Girl*

By Hugh Horton

Meade Gougeon was excited in 2008. "I'm using Six10 for everything!" he said. He was working on his sailing canoe in Florida. In every phone conversation we had he seemed to find a new use for Six10, "… even for composite layups because of its 'shear thinning'," a phrase new to me.

In May of 2018, a perfect application came along for Six10—the teak gunwales capping the plywood endgrain on my prototype *Clam Girl*.

Why teak? After sanding it as smooth as you want, it requires no finish coating. No varnish, paint, lacquer, epoxy—nothing. You're done. You'll have a non-slip surface that's a tactile pleasure. It's as dimensionally stable as Honduran Mahogany "pattern" lumber, and is uniquely aromatic when worked.

Marking the bottom edge of the gunwales with a scribe

36-grit sandpaper helps create a lot of tooth for the epoxy to grab onto.

But teak is heavy and costly. It's said to quickly dull tools, and has a reputation for resisting glue.

When I epoxy it, I am cognizant of its oiliness and reputation. So far, though, going back to 1980, careful preparation has done well for me. With rasps or 36-grit paper across the grain, I

roughen both surfaces. I want plenty of "tooth" for the epoxy to grab. Next, I thoroughly wipe it and scrub it with a solvent, usually alcohol, before applying glue to both pieces. All the teak in the photos had this preparation.

The stern pieces came first—following tradition—overlapped by the sides, then the bow piece overlapped them. *Clam Girl's* rails were to be continuous with no jogs or interruptions around her hull's upper edge of the transom, gunwales, and blunt bow.

Less traditional was putting the gunwales on the outside of her planking. A sailor can comfortably lean back on the inside edge of the hull, while gaining the most sailing stability from their weight.

The transom is complicated because it's curved in plan and body plan views. I cut the four ¾"-thick pieces below the transom's cap to the body plan curve on a bandsaw, and clamped them to bend around the transom's plan form.

The first full-length parts, covering the plywood endgrain, were the inner wales, a rabbeted "L" shaped section, ⅝" by 1½". The rabbet covers the end grain of the plywood sides. The small side of the "L" is flush with the inside of the plywood. Epoxying these pieces was the real test.

Preparation is key. Although Six10 is simpler to use, I gather my usual gear of spreaders, putty knives, disposable brushes, 804 Reusable Mixing Sticks, rags and paper towels, vinegar and alcohol. I find all the clamps and clamping blocks I'll need, and check them for old epoxy on the bars.

A practice dry run, clamping everything without epoxy, is wise. To ensure the sheer didn't get whacked in plan view, or lose symmetry, I clamped pieces to both sides for the dry and wet sequences, although epoxying one side at a time.

Many clamps were needed for even clamping pressure when epoxying the gunwales.

To squeeze the rabbeted, compound-bent teak down to the sheer, a 12"-reach bar clamp on each side did it, catching an athwartship clamping board for even pressure.

Yes, Six10's 600 Static Mixer fascinated me, the swirling resin and hardener coming from the nozzle ready to use.

In spite of the heat, there was no problem with Six10 hardening too quickly. I was not rushed. After those two days, I felt like tap dancing. The joy of Six10 had struck me. The job had been done alone, relatively easily, one side per day, at 90°F with mid 70s dew points.

The only fly in the goop was that I should've gotten extra static mixers, because it seemed there would often be part of a tube left. But, Bruce Niederer reminded me that, after a static mixer is used, Six10 still comes out of the tube correctly proportioned, so it can be easily mixed by hand.

After the long rabbeted pieces were glued to the hull, capping the plywood endgrain, the next layer was ¾"-thick. The last long pieces were the

Left: Dry fitting the rabbeted teak gunwales

Right: The teak gunwales epoxied together on the transom with Six10

½"-thick outer wales, epoxied after fairing the inner layer.

Only the bow piece's mating surfaces with the hull were shaped for epoxying. Its outer form remained a block of 8/4 teak, for better clamping and eventual shaping, which is often easier after a piece is firmly on the boat. This follows the dictum, too, of trimming flush when you can, rather than attempting to glue an exact, finished shape or dimension.

With the boat upside down, I cut the bevel on the underside of the rails with a small circular saw.

Fairing and shaping is all fun. The evocative teak fragrance, the variety of hand tools, the feeling of completion.

I'd written to Tom Pawlak, "Just stuck the last tricky piece of teak on Clam Girl's gunwale. Six10 to the rescue. I've begun to love that stuff." ~HH

Clam Girl's purpose is an adult's learn-to-sail skiff. I drew and modeled her in 2013.

"Like a big Optimist Dinghy," I'd written, "but, for one or two large adults. Easy rig, and leeboards for Cedar Keys' shallows."

She's utilitarian, too, a low-impact boat for fishing, birding, and sailing with friends or family. Her old cousin is the traditional Gulf coast, "net skiff," which was often powered by a small "kicker" engine on either end. Now, a brushless electric motor might be a good choice.

Meade Gougeon met naval architect JF Bedard in November of 2016. Meade suggested Bedard could help digitize Clam Girl's plans. I asked mechanical engineer Simon Lewandowski to build Jan Gougeon's cone clutch notion of leeboard mounts. Clam Girl is the result of the collaboration of Bedard, Lewandowski, and me.

Adults can learn to sail almost as quickly as children if they're learning in boats which fit them as well as kids fit in eight foot prams. Adults, too, need the same comfort with the effects of their mass on a boat's trim and balance. And, like a rig for kids, an adult's learning rig should be simple and efficient. The boat must have room for a passenger, and be stable enough to stand and reef. She should be light enough for one to pull ashore.

She is meant to be user friendly, certainly not harder than driving a rental car from an airport. And, I've tried to eliminate impediments to non-sailing, older boaters.

Clam Girl's rig is modern, powerful, and controllable with three reefs. The big sail must slide up and down easily, with the sail at nearly any angle to the wind. Thus, her mast has hoops instead of a groove or track. Except for the hoops and sail cloth, the form of her rig would not look out of place on a modern racer.

The lightweight, red sail cloth is Contender's Stormlite. The sailcloth's "hand," is relatively soft, more like cotton in jeans, rather than crinkly high tech, racing sails. Stormlite is often mistaken for rip-stop nylon but it is polyester, common in cruising sails because it is relatively non-stretch.

~HH

Sailmaker: Tom Barry, Sail Tech, 1354 20th St N., St Petersburg FL 33713 727-823-1968

Winona State University

Composite Materials Engineering Program

By Rachael Geerts

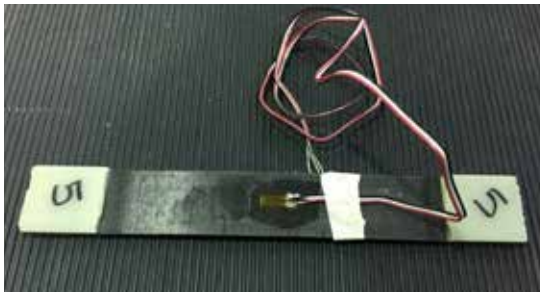
Here is an inside snapshot of how the composites world is growing at my alma mater, Winona State University. Located in Winona, Minnesota, this university has the only accredited four-year undergraduate program for composite materials engineering in the US. Through this program, students learn the fundamentals of engineering while investigating different materials. This program challenges students both academically and creatively. Students are encouraged to ask questions and strive for a deeper understanding of why things are done the way they are done. From this, they can explore how things can be improved.

Starting freshman year, students learn about what a composite material is and where composites can be found in the world around us. They go on to learn about the properties of materials and recognize when to use different types of reinforcements. Students engage early on with the composites industry as they tour local composite businesses in Winona, listen to experienced speakers, and get engineering internships. Students intern in many different areas of the composites industry. They do anything from working year-round at a local material supply plant conducting different types of material testing to a summer internship in another state, working on renewable energy technology. Winona offers a wide expanse of opportunities for students to apply what they've learned in classes, increase their knowledge, and figure out which part of the industry they're passionate about and would like to work in after graduation.

Carbon fiber landing net that was done as a senior design project

During junior and senior year, students get more opportunities to work with composites in a shop setting. In addition to typical engineering topics such as Statistics, Thermodynamics, and Fluid Mechanics, course topics unique to the program include Mechanics of Composites, Polymer Science and Characterization, and Engineering Seminar. They make reinforced panels and test them in the beginning of their junior year. The academic and hands-on experience culminates with the senior design project. Students engineer and produce a product that they believe there could be a market for. They explore the different aspects of manufacturing from material selection, to researching the potential market, to assessing production costs.

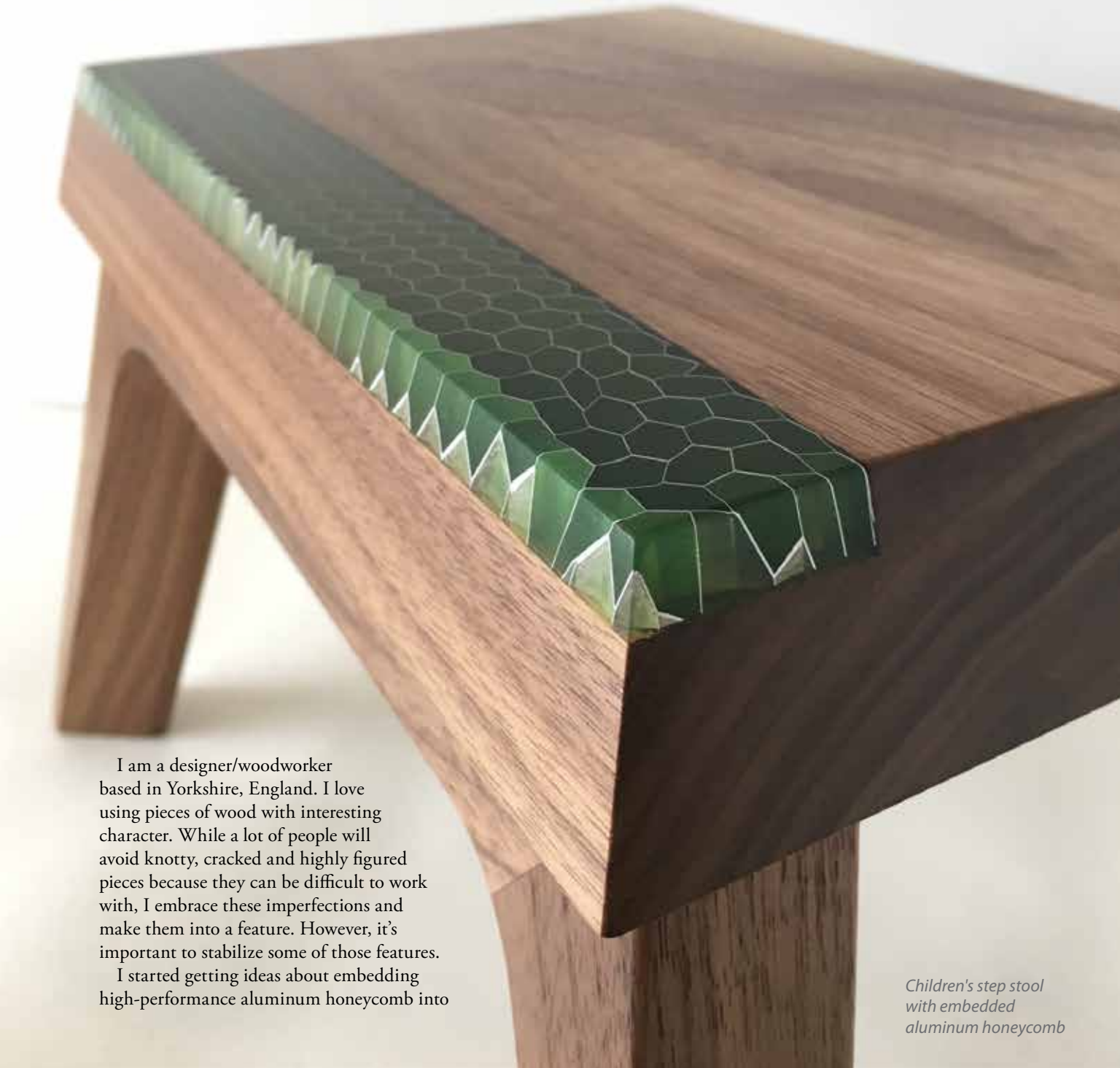
Gougeon Brothers Inc. has supported Winona State University's preparation of students for jobs in the growing composites industry through material discounts and by employing graduates of Winona State. Students become familiar with epoxies in the lab thanks to Gougeon's support. The company also started a scholarship program for students at Winona State in the engineering program in memory of Mike Barnard. He was both a Winona graduate and a Gougeon employee. This scholarship helps students to pursue their goal of making an impact on the composites industry, as Mike did here. As a current employee of Gougeon Brothers and as a Winona State alumnus, I am grateful for Winona State's preparation and Gougeon's support of education in the composites field of study.



A unidirectional carbon tensile test specimen

Honeycomb-Embedded Furniture

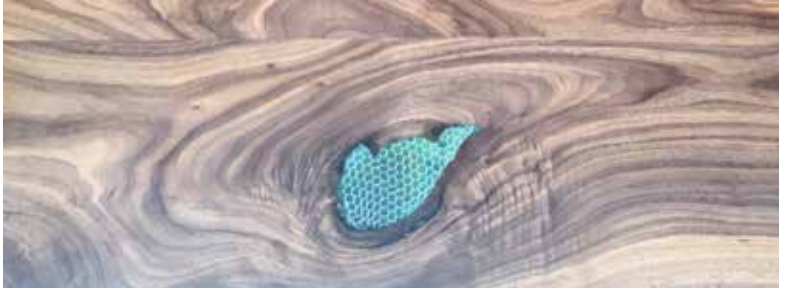
By Anthony Elliot



I am a designer/woodworker based in Yorkshire, England. I love using pieces of wood with interesting character. While a lot of people will avoid knotty, cracked and highly figured pieces because they can be difficult to work with, I embrace these imperfections and make them into a feature. However, it's important to stabilize some of those features.

I started getting ideas about embedding high-performance aluminum honeycomb into

Children's step stool with embedded aluminum honeycomb



Left: Three legged side table with aluminum honeycomb embedded

Above Top: Knot hole filled with aluminum honeycomb and pigmented epoxy

Above Bottom: The table created with the filled knot hole

epoxy to make more of a feature of the larger holes in timber that often need to be filled. Aluminum honeycomb is the same product that is supplied to the world's top composites engineering, aerospace, and motorsport manufacturers.

My initial experiments with resin actually used another brand's water-clear polyester resin. I found it incredibly difficult to sand without melting it, and it left an odor on the piece of furniture for around eight months.

I switched to a premium epoxy. In the woodworking community, WEST SYSTEM 105 Resin/207 Special Clear Hardener is the go-to resin for filling cracks and knots. Usually, the idea is to choose pigments to match the color of the existing timber and hide the epoxy. I wanted to make a feature of it, so I used complementing but contrasting colors to draw attention to the honeycomb.

The 300 Mini Pumps make WEST SYSTEM Epoxy easy to use. The results immediately improved, although not without a few mistakes. In my first attempt, I made the disastrous mistake of using 205 Fast Hardener for a big pour. This ended up causing a massive exothermic reaction which led to cracking, foaming and smoking.

I posted my results on Instagram and received a lot of advice from various sources including WEST SYSTEM. They suggested I use either the 206 Slow or 207 Special Clear Hardener, make my pours no thicker than ¼" thick, and wait for a full cure between pours. This has worked extremely well for me. I had great results filling knot holes in a couple of coffee tables and embedding the aluminum honeycomb.

While filling these holes, I started thinking it would be interesting to expose the side of the epoxy as the aluminum behind the pigmented epoxy would reflect light in different ways at different depths. One of the products I produce is a small children's stool, so I used this technique to incorporate decorative inlay into the top of one of these stools. The results are incredibly interesting, creating a slightly irregular pattern with the honeycomb. I was so pleased with these results. The cured epoxy can be sanded easily along with the rest of the surrounding timber. I apply my finish (osmo polyx) right over the top of it.

Since posting images of the stool on Instagram, I have had a number of people asking me how to achieve this look. I am really looking forward to experimenting more with WEST SYSTEM Special Clear 207 Hardener and finding more uses for this technique.

Coat rack with embedded honeycomb.

Boys Scout Composite Klondike Derby Sled

By Tom Dragone, PhD

The finished sled weighs only 12 pounds.

In Epoxyworks 43 we published "Merit Badge," an article describing a composite hiking staff project for Boy Scouts from Tom Dragone's local Troop to fulfill the requirements of the Composite Materials Merit Badge. In that project, the Scouts not only learned about the constituent fibers, matrix materials and processing methods for advanced composites, but also made a hiking staff by applying a braided graphite sleeve over a wooden mandrel, coating it with two-part epoxy and curing it in a low-temperature oven. This resulted in a strong, stiff and lightweight hiking staff that they could take on the trail.

The Klondike Derby is an annual winter camping trip held in our district (and many others across the country) for Scouts to hone their scouting skills in a winter environment. During the weekend event, Scout patrols go from station to station around our local Scout Camp, facing challenges that require them to demonstrate their skills in making a fire, navigating with a map and compass, cooking, knot-tying, and applying first aid. The Scouts must bring all their gear with them as they trek from station to station, including ropes, stoves, kindling, and hiking staves. Hence, each patrol is required to have a sled for their gear which they, as a patrol, must haul. The sled must be strong and stiff to hold the patrol gear, yet lightweight because at the end of the weekend there is a race between patrols, and the fastest sled wins.

The classic Alaskan dogsled consists of bentwood runners, upright stanchions, cross-braces, and a flat bed of slats or stretched canvas. Many of

the structural components of the classic dogsled are made from slender wooden components, so I could envision these components being made in composite using braided overwrapped. A&P Technology offers braided fibers in a variety of sizes and material choices. I chose graphite fiber to provide a classic black look and a thick braid of these meant more graphite fibers for strength and stiffness in a single layer. The 1" diameter braided layer was applied to a ¾" wooden dowel, resulting in a fiber angle slightly less than the nominal 45° to provide more axial stiffness in the components. The wooden core adds to the strength and stiffness of the graphite braid, and the graphite allows a much smaller wooden core than if it were un-reinforced.

"In a race that is usually won by less than a sled length, our swift composite racing sled won by at least six sled lengths..."

Composite rails and stanchions were lashed together with wet rawhide, which, when dry, results in tight but flexible joints. The hardwood blocks help provide support for the rawhide lashings.

Since I did not have access to an autoclave, the choices for resin materials were limited compared with what I typically use to create aerospace parts in my day job. WEST SYSTEM Epoxies offered ease of use, room temperature curing, and a strong durable finish. Experts at WEST SYSTEM technical support recommended their 105 Epoxy Resin with 207 Special Clear Hardener to create a smooth, clear surface that would not yellow over time. The Scouts used brushes to apply the epoxy while the stanchion and brace components were hung vertically, thus preventing epoxy from pooling on one side of the cylinder. The only disadvantage with using 105/207 for this application is it's slow to cure. To accelerate the cure reaction, I created a simple oven from ½" insulation board and duct tape, heated with four 100W halogen lights. The oven reached about 120°F, reducing the typical 8-hour cure time to 2 hours.

The side rails of the sled presented a particular challenge for this fabrication process because, while they could have been made from straight dowels like the other components, they are typically curved and add significantly to the visual appeal of the design. The solution: a PVC pipe flexible enough to achieve the desired curve. After placing the braid over the PVC, we threaded paracord down the center of the tube and tied back into a loop on itself. Adjusting the tension in the looped cord (with a taut line hitch, as any Boy Scout can attest) held the braided PVC in the desired shape while the epoxy was applied and during cure. Once the epoxy cured, we removed the cord and the braided PVC retained its curved shape.

Unlike the hiking staff, which was a single piece, the Klondike sled required multiple pieces to be joined together. Joining composite parts is

The winning team holding up their 12lb sled.

short out-and-back race because our sled easily slid around the pylon in the turn while the other, heavier sleds were more difficult to maneuver. In a race that is usually won by less than a sled length, our swift composite racing sled won by at least six sled lengths, demonstrating that a superior sled can be achieved by combining traditional assembly techniques with 21st century materials.

Dr. Tom Dragone is a Senior Scientist at OrbitalATK, specializing in the application of composite materials in advanced spacecraft and launch vehicle structures. He is also a Merit Badge Counselor and Committee Member for Troop 7369 in Chantilly, Virginia.

Special thanks to A&P Technology for graciously donating the graphite braided tube used in this project.

the most challenging aspect of designing with composites. It can be difficult to get enough bond area in the joints, given the limited size of the components' cylindrical shape. Therefore, we adapted traditional sled construction techniques, using rawhide strips wrapped through and around the joints. This technique employed the lashing skill the Scouts already knew. We lashed the rawhide while it was wet, and as it dried, it pulled the joint together making it quite a tight fit. The result, as native Americans, fur trappers, and pioneers discovered long ago, is a strong yet flexible joint that can stand up to backcountry abuse.

Composite runners were not in the scope of this project (for this year anyway), so we made them from hardwood 1x3s sliced lengthwise from one end, bent, and re-laminated. Small hardwood blocks fit into the joints and provided the support for the rawhide lashings. Last, we lashed a canvas bed to the composite bed frame, providing an extremely light support surface for gear.

In the end, our troop was quite pleased with the new sled. Typical Scout sleds are made from 2x4s and other scrap wood, and are built like tanks, weighing as much as 40-50 pounds. Our racing sled weighed in at under 12 pounds. This turned out to be a significant advantage in the

The sled and crew ready to race

For information about WEST SYSTEM® products or technical information for a building or repair project, Gougeon Brothers offers a range of detailed publications that can help you get started. These publications are available at your local WEST SYSTEM dealer or by contacting Gougeon Brothers. They are also available as **free downloadable PDFs at westsystem.com.**

How-to Publications

002 **The Gougeon Brothers on Boat Construction**—A must for anyone building a wooden boat or working with wood and WEST SYSTEM Epoxy. Fully illustrated composite construction techniques, materials, lofting, safety and tools. 5th Edition, revised in 2005.

002-970 **Wooden Boat Restoration & Repair**—Illustrated guide to restore the structure, improve the appearance, reduce the maintenance and prolong the life of wooden boats with WEST SYSTEM Epoxy. Includes dry rot repair, structural framework repair, hull and deck planking repair, and hardware installation with epoxy.

002-550 **Fiberglass Boat Repair & Maintenance**—Illustrated guide to repair fiberglass boats with WEST SYSTEM Epoxy. Procedures for structural reinforcement, deck and hull repair, hardware installation, keel repair and teak deck installation. Also, procedures for gelcoat blister diagnosis, prevention and repair and final fairing and finishing.

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

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Readers' projects

This group of students built a costume for a child in a wheel chair for the non-profit organization Magic Wheelchair. The design was inspired by his favorite book, The Adventures of Beekle.

PT Skiff by Bill Cavanagh

WHILE AWEIGH is an 18' PT Skiff built by Bill Cavanagh from a kit supplied by Port Townsend Watercraft. Built in the shop of DMC Boats in Falmouth MA, with lots of 105 Resin and 207 Special Clear Hardener, she is strong, light weight and very fuel efficient. Powered by a Honda 20, she will make 22 mph with two aboard and averages less than .75 gph. At 550 lbs for boat and motor, she is easily trailered around Cape Cod and other New England waters.