EPOXY WORKS®

BUILDING, RESTORATION, & REPAIR WITH EPOXY

ISSUE NO.59 | FALL 2024

EPOXYWORKS.COM

FREE

In This Issue

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CONTRIBUTE TO EPOXYWORKS

If you have completed an interesting project, or developed a useful technique or found a practical or unusual use for epoxy, tell us and your fellow epoxy users about it.

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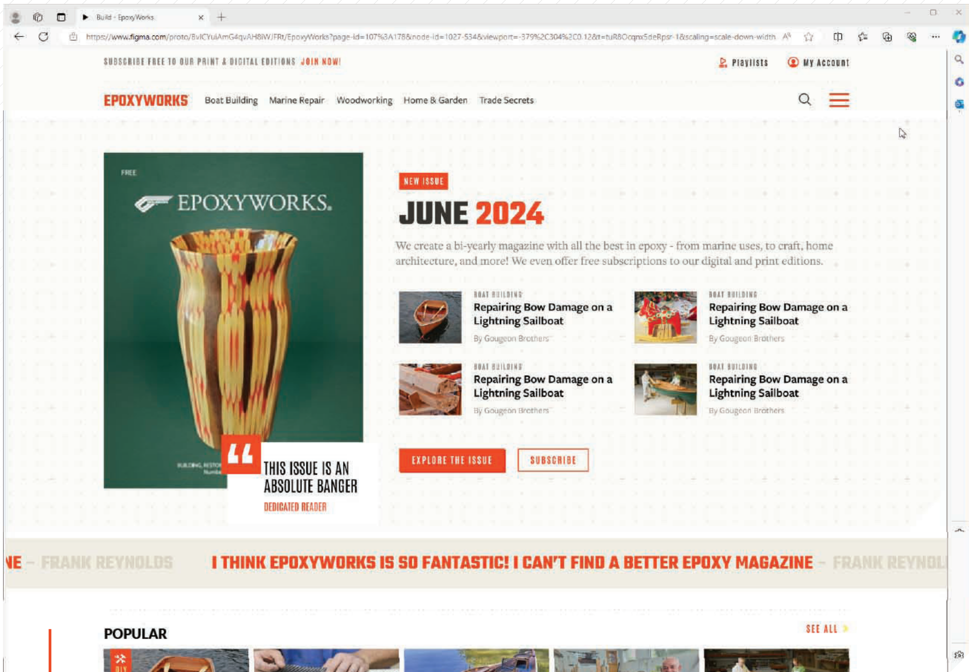
FROM THE EDITOR

Introducing the All-New *Epoxyworks* Website: Elevating Your Epoxy Experience



LEFT: We are excited to unveil the new look of Epoxyworks.com.

Epoxyworks, the ultimate resource hub for epoxy enthusiasts, is proud to unveil our revamped website! We've been hard at work behind the scenes, listening to your feedback, and brainstorming ways to enhance your online experience reading *Epoxyworks*. Our updated website is designed to offer you a seamless, personalized journey into the world of epoxy.

A Fresh Look, A New Feel

We've given *Epoxyworks* a sleek, modern makeover that reflects our commitment to innovation and excellence. Our updated branding not only brings a fresh look, we've also made it easier to find the projects that are most interesting to you. Delve deeper into the fascinating world of epoxy.

Enhanced Search Functionality

Finding the information you need is now easier than ever, thanks to our improved search functionality. Whether you're looking for step-by-step tutorials, project inspiration, or expert tips, our website's enhanced search feature ensures that you can locate relevant content quickly and effortlessly. Dive into our vast archive of articles with confidence, knowing that the answers are just a few clicks away.

Custom Reader Accounts: Tailored to You

Experience personalized browsing with our new custom reader accounts. By creating an account on *Epoxyworks.com*, you unlock a world of possibilities tailored to your preferences. Save your favorite articles, bookmark projects for later, and curate playlists of content that inspires you. Your *Epoxyworks* account is your gateway to pursuing your epoxy interests and passions.

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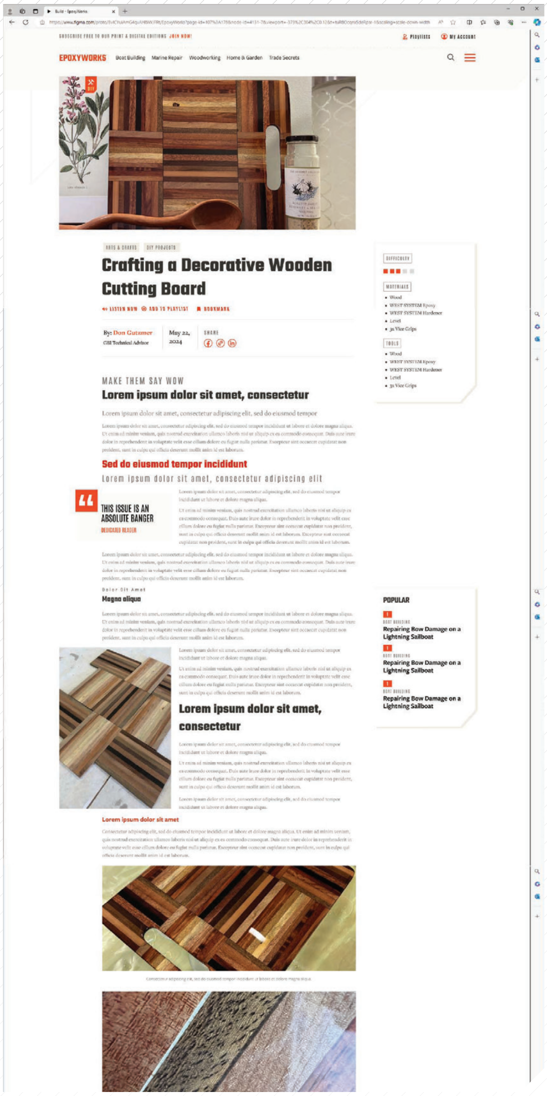


Personalized Recommendations: Discover More

Get ready to discover a wealth of new content tailored specifically to your interests. With our advanced recommendation system, we'll serve up articles, tutorials, and projects that align with your preferences, allowing you to explore new facets of epoxy craftsmanship with ease. Whether you're a seasoned pro or a curious beginner, our personalized recommendations will guide you on a journey of discovery, sparking your creativity and fueling your passion for epoxy.

Interactive Engagement: Your Voice Matters

At *Epoxyworks*, we value your input and strive to foster a vibrant community of epoxy enthusiasts. With our updated website, we're putting the power in your hands to engage with us like never before. Submit your questions, share your suggestions for future content, and connect with our dedicated team of epoxy experts. Together, we'll shape the future of *Epoxyworks*, ensuring that our platform continues to evolve in response to your needs and desires.

Share Your Story: Submit Projects and Articles Effortlessly

We champion the creativity of our community. We've streamlined the ability for you to share your projects and expertise with us by having a submission form directly on our site. You can effortlessly upload photos, videos, and narratives, sharing your techniques, documenting challenges, or spotlighting your latest creations. By contributing, you inspire others while gaining exposure to our diverse audience of epoxy enthusiasts, professionals, and learners worldwide. Your submissions not only enrich our community but also shape the future of epoxy craftsmanship and push the boundaries of creativity.

Join Us on the Next Chapter of Your Epoxy Journey

The launch of our updated website marks a significant milestone in the evolution of *Epoxyworks*. We're committed to providing you with the tools, resources, and inspiration you need to unlock your full potential. Whether you're a hobbyist, a professional craftsman, or simply a curious explorer, we invite you to join us on the next chapter of your epoxy journey.

VISIT THE NEW SITE

Explore the All-New Epoxyworks Website Today!

From informative articles to stunning project showcases, there's something for everyone in our vibrant community. Create your custom reader account, engage with us, and embark on a journey of creativity, innovation, and discovery. Welcome to the future of epoxy—welcome to Epoxyworks.

 BY DAN PAUL

SKILL LEVEL

North Carolina Sport Fishing Boat Build

Designed and built to reflect the look of a North Carolina sport fishing boat, I built this boat in my own small shop. I always loved the bow flare, transom tumblehome, and broken sheer line of these works of art. I call this model a mid-rider SFX as it has a significant deck area forward of the bench seating for four. There is a split helm with ladder back chairs and an armed ladder-back chair on the aft centerline which can be reversed for fishing. I cruise with it on Spring Lake and Lake Michigan.

The construction has two layers of 4 mm sapele marine plywood installed at opposing diagonals over white oak framing. This is joined by WEST SYSTEM® Epoxy and silicone/bronze screws. It is sheathed inside and out with 6 oz. fiberglass cloth set in 105 Epoxy Resin® and 206 Slow Hardener®. 105 Epoxy Resin and 207 Special Clear Hardener® was used on all natural finish wood areas. The paint and bright work are of Awl-Grip® marine products. The *Gougeon Brothers on Boat Construction* and WEST SYSTEM *User Manual & Product Guide* were irreplaceable references.

SPECIFICATIONS

- → LOA: 19' 3"
- → Beam: 6" 6"
- → Engine: 115 Evinrude E-Tec
- → Tank: 19 gal below deck
- → Speed: up to mid-40's
- → Build Time: 3,000+ Hours

BELOW WATERLINE LAYUP (FROM BOTTOM):

- → 10 oz Fiberglass Cloth
- → 4 mm Sapele
- → 6 oz Fiberglass Cloth
- → 4 mm Sapele
- → 6 oz Fiberglass Cloth

Differences Between Polyester and Epoxy

WEST SYSTEM® Epoxy is—as the name states—an epoxy resin system. Epoxy is easy to use, has excellent properties, and is the go-to choice for repairs, high-performance composites, and wooden boat building. However, mass-production boats are primarily built with polyester. Let's take a look at WEST SYSTEM Epoxy compared to polyester resin to understand why.

Production Process

Many production boat builders can produce a high-quality boat using polyester resins because polyester is well suited for use in a controlled manufacturing environment. These builders can control their shop temperature, have equipment to measure mix ratios with incredible accuracy, and follow a carefully engineered process the same way every time. Since mass-produced recreational boats require large volumes of resin, the slightly lower cost of polyester becomes an important factor.

The conditions for boat repair, wooden boat construction, and other DIY applications are often different. In these cases, controlling the shop environment is not always possible. Repairs and construction projects are often unique and more than just a matter of repeating the same process. For these types of projects, WEST SYSTEM Epoxy is an excellent choice. It offers accurate metering with pumps and is supported by a superior technical support team, providing unbeatable value.

Molecular Structure

The differences between WEST SYSTEM Epoxy and polyester resin begin with how the molecules react with each other during the curing process. The epoxy resin used in our products is made from a molecule that has a very strong backbone. The resin molecules then react with the hardener molecules in a process that creates a high degree of crosslinking between the resin and hardener molecules. This results in a strong 3-dimensional matrix.

Polyester resins consist of many long molecules with reactive sites at their ends. The catalyst, often MEKP, creates a chain reaction, causing these polyester molecules to begin linking to one another. This chain reaction enables polyester resins to cure quickly, but they will not have a molecular structure crosslinked in the same way as epoxy, and therefore, they are not as strong.

Curing Process

The different reaction mechanisms require different considerations when being used for laminating composites. The chain reaction in polyester requires a specific amount of catalyst, often measured in fractions of a percentage, and good temperature control. Many polyester boat manufacturers have dispensing equipment that precisely controls the amount of catalyst added to the resin to adjust cure speed. Like epoxy, temperature impacts the speed of the curing process. However, polyester has a much narrower temperature range. Builders have to control the shop temperature, particularly in the winter.

WEST SYSTEM Epoxy has a broader 5:1 or 3:1 mix ratio, allowing you to easily use the 300 Mini Pump set to dispense at the correct ratio. To adjust for temperature fluctuations, select the hardener speed most appropriate for the anticipated usage temperature.

Shelf Life

Polyester resins often require a promoter, which can be hazardous to use separately, so most manufacturers pre-blend it into the resin. Promoted polyester resin has a shelf life measured in months whereas WEST SYSTEM Epoxy Resin has a minimum 3-year shelf life. In addition, polyester resin often contains fillers to modify the viscosity whereas WEST SYSTEM Epoxy does not have any materials that will settle during storage, further improving shelf life.

Strength

The stronger backbone of epoxy resin provides high strength and fatigue resistance. This is why aerospace applications, high-performance sports equipment, and the highest levels of motorsports use epoxy resin. They can reduce weight by building thinner laminates with higher properties.

Epoxy resin is also a better adhesive. Our experience at Gougeon Brothers, Inc. is that adhesion is critical for a successful fiberglass repair. Using epoxy resin will provide a patch with a stronger bond than the original laminate, ensuring the patch will remain securely in place. The excellent adhesion of epoxy can also bond dissimilar materials, including wood, plastics, metals, and composites.

Cured Surface

Most polyester resins will not cure in the presence of air (air-inhibited). This characteristic results in a surface that often feels sticky because of the thin layer of unreacted polyester resin that remains on the surface. In a production setting, this is not a significant issue because when the next layer of fiberglass is applied, it inhibits the air, allowing the reaction to continue, forming a solid bond. This can become problematic when applying final finishes over a repair.

WEST SYSTEM Epoxy is not air inhibited and, provides a solid fully cured surface, even in thin films. This thorough cure also improves the adhesion to wood. Since there are small air pockets in wood, polyester resin does not completely cure at the wood interface, reducing the adhesion. WEST SYSTEM Epoxy's legacy in wooden boat construction is partially due to its excellent adhesion to many different species of wood.

Moisture Resistance

Polyester resins can have an issue with osmotic blisters. Osmotic blisters can form on the bottom of boats built with polyester resin after they sit in the water for long periods, typically below the waterline. This issue results from water migrating through the gelcoat into the resin. The moisture will cause the polyester resin to break down in very small voids where the polyester did not completely react when catalyzed. This forms an acidic liquid that can continue to break down the polyester resin. This liquid contains compounds of the dissolved resin and is unable to pass through the semipermeable gelcoat. A blister is formed by pressure created during this osmotic process. WEST SYSTEM Epoxy will not break down from contact with water and has a very high resistance to absorbing water. These properties enable it to be used as a moisture barrier coat to prevent polyester hulls from developing osmotic blisters. See our *Fiberglass Boat Repair & Maintenance manual*.

V.O.C. and Shrink

Polyester resin often has a strong odor typically caused by the styrene included in the formulation. Polyester resin normally has up to 30% volatile organic compounds (V.O.C.). WEST SYSTEM Epoxy has extremely low V.O.C. content (less than 1%) and a very low order. This high amount of V.O.C. in polyester resin also results in significant shrinkage when it cures. It is common for polyester resin to shrink over 5% when it cures. This can create stress in bond lines and cause cosmetic issues in large laminations.

WEST SYSTEM Epoxy's nearly 100% solids content results in extremely low shrink values during curing. Boat manufacturers make substantial efforts to manage the shrinkage of polyester resin when building boats, often by using additional layers of materials on the outside of the hull to mask the cosmetic issues resulting from resin shrinkage. When using WEST SYSTEM Epoxy, the resin will not change dimension during the curing process or after it has cured, providing a more stable surface and stronger bond lines.

When to use WEST SYSTEM

When repairing a mass-produced production boat, WEST SYSTEM Epoxy is a better choice than the polyester resin used when it was manufactured. The increased strength, adhesion, and moisture resistance will provide a better repair, and the simple mix ratio and low V.O.C. make it easy and more pleasant to use.

LEARN MORE

Fast Blister Repair with Six10®

Polyester resins can have an issue with osmotic blisters. Osmotic blisters can form on the bottom of boats built with polyester resin after they sit in the water for long periods. Read more about repairing blisters using Six10.

One Rotted Antique Door

FOUR COMMON REPAIRS

A friend of mine was looking to add a little character to his home. While in an antique shop, he came across an intricate door which happened to have all the features he was looking for. It was a beautiful door at one time, and worth keeping around, but needed a little TLC before painting and installing.

Right away, I noticed five areas that needed repair. The original hardware for the doorknob and lock were missing. The voids needed repairing to install modern hardware. The top hinge plate was loose due to stripped wood around the screw threads. Part of the window ledge had been broken off and needed rebuilding. Finally, like most seasoned exterior wooden doors, this door suffered from rot deterioration along the bottom edge.

REPAIR 1: Doorknob

The door originally had a mortise lockset installed. Moisture had gotten in around the mortise lockset, and rot had eaten away a good amount of the surrounding wood. The holes remaining needed to be filled to accommodate modern, cylindrical lockset hardware.

To begin, I removed the paint that was on the surface and any loose or deteriorated wood to see how much area I would need to fill. Once the bad wood was removed, there was a decent-sized cavity.

ABOVE: The rot caused the wood to deteriorate around the lockset.

There are two approaches I could have taken to fill this space. One approach is to fill the cavity full of layers of epoxy. Because epoxy generates heat when it cures, you have to be careful with how deep you pour epoxy. "Deep" varies based on the epoxy system you use and the working temperature. A good rule of thumb for our 105 Epoxy Resin® and 206 Slow Hardener® combination is, at 72°F, you can pour a ¼" maximum depth every 2.5-3 hours. With the size of this hole it would take multiple pours, a lot of time, and use a lot of epoxy. The second method, which I opted for, involved filling most of the volume with a wood plug, bonded in place with thickened WEST SYSTEM Epoxy. This allowed me to fill the hole in one step, which was much more efficient use of time and materials.

I squared off the cavity, so fitting a wood plug to fill the volume would be easier. I measured the space, found a piece of scrap wood of proper thickness, then cut it roughly to shape.

To prepare for epoxying, I taped off the back side of the door with clear plastic packing tape so thickened epoxy would be contained in the door handle opening. The 105 System does not bond to plastic packing tape, which made for an easy removal.

I broke out the 105 Epoxy Resin with 205 Fast Hardener®, mixed up a batch of epoxy, coated the inside of the void in the door, then the surface of the wooden plug. This initial coat of neat (unthickened) epoxy penetrates the wood surfaces. I mixed up a second batch, adding 410 Microlight® Filler until the epoxy was between a mayonnaise and peanut butter consistency. The 410 Microlight Filler is strong enough to bond in the wood plug while still being easy to sand, so it was a perfect choice for this application.

I generously applied the thickened epoxy into the void and then coated the wooden plug before inserting it. I spread the squeeze-out, leveling it slightly proud of the surrounding door surfaces. I had to apply a little extra epoxy in a few low areas. Then, I left the epoxy to cure.

The first fill was not perfect. I sanded the epoxy flush with the height of the surrounding surfaces on the face and edge of the door. I scuffed the few remaining low spots and applied another coat of 105 / 205 / 410. Again, this was allowed to cure and sanded flush.

I flipped the door over, removed my backer tape, and sanded flush. There were a few small voids where the tape was wavy or trapped a couple air bubbles. Again, I scuffed up the low areas and reapplied thickened epoxy. After curing, I sanded flush.

The surface now needed to be sealed. I applied two coats of 105 Epoxy Resin mixed with 205 Fast Hardener. I waited about 90 minutes between coats. The surface was ready to be prepped for paint.

REPAIR 2: Vertical Deadbolt

Above the mortise lockset area, there appears to have been a vertical deadbolt lock. This area was not nearly as badly damaged as around the door handle, but nonetheless, it needed to be repaired. There was a hole that ran completely through the door and on one side, the surface had been recessed by about ¼" to mount the lock.

I started with the same approach as the doorknob. I sanded the surrounding surface and inside the hole down to bare wood. In our scrap pile, I found a dowel almost the perfect diameter to fill the lock hole. Using this as my wood plug, I trimmed it to the approximate thickness of the door.

For epoxying this part of the door, I used a hybrid approach of the two processes I considered for the doorknob area. I filled the thru hole with a wooden plug and the recessed area with a layer of thickened epoxy. Again, I applied my tape backer to help hold the plug and epoxy in place. I also applied tape to the edge of the door to prevent the epoxy from running or sagging out of the recessed area. Then it was time to mix the epoxy.

ABOVE:
The voids were filled with a wood plug and mix of 105/205/410.

Using 105 Epoxy Resin and 205 Fast Hardener, I wet out the hole and my plug with neat epoxy. I then added 410 Microlight Filler until the mixture reached a mayonnaise/peanut butter consistency. I liberally coated the inside of the hole and the plug with the thickened mixture. I spread the squeeze out from the plug around the surrounding area to ensure the plug and epoxy were proud of the surface. After curing, I sanded it flush.

Before applying my epoxy filler coat to the recessed area, I wanted the plug to cure so I had a solid surface to push against. I wasn't in a hurry, and this prevented the plug from moving as I worked (which could have potentially created more voids).

The recessed area was only about ¼" deep, so I was comfortable my epoxy mixture would not overheat once applied. I mixed a batch of 105 /205 and brushed the neat epoxy onto the recessed area. Then, I thickened the rest of the batch to a mayonnaise consistency with 410 Microlight. I started at the back edge of the recess and slowly worked my way towards the edge of the door and my tape barricade. This way I minimized the likelihood of trapping air pockets under the thickened epoxy.

Once this cured, I sanded it flush to inspect. Some touch ups were needed to fully square off the edge and fill a couple low spots. I mixed one more batch to apply; that was subsequently sanded flush. Then, I applied a coat of neat 105 / 205 to the entire area to seal the epoxy.

REPAIR 3: Door Hinge

Over many years of use, one of the screws in the door that held the top hinge plate had come loose. The screw had partially stripped the wood, so there was no longer any wood for the screws to hold onto.

I removed the screw and wiped it with a clean paper towel to remove any loose rust or debris. Then, to prepare the screw for epoxy, I sprayed it with cooking spray. The spray prevents the epoxy from sticking to the screw, so you could back the screw out if you needed to later.

For this repair, I chose our G/5® Five-Minute Adhesive. G/5 cures quickly, so you must work quickly, but it has excellent adhesion to wood. I added a little 406 Colloidal Silica, thickening the mix to a peanut butter consistency so that the epoxy did not drain out of the screw hole while curing.

ABOVE:
The loose rotted wood was removed. A mixture of G/5 and 406 was applied to the screw threads and worked into the hole.

I applied the mixture to the threads of the screw to ensure the epoxy didn't trap air between the grooves. Using a mixing stick, I forced the epoxy from the mix into the screw hole. Then I took my screw and ran it in and out of the hole a few times to work the epoxy down the length of the hole. Sometimes, you can get an air pocket stuck in the bottom of the hole, which helps disrupt that, allowing the epoxy to work its way to the bottom. Alternatively, I could have used a syringe to inject the epoxy from the bottom of the hole outward.

Once satisfied the hole was sufficiently coated, I applied a little more epoxy to the threads and inserted the screw back into the hole. I made sure the head was flush with the hinge plate. Then I removed the excess squeeze out, so I could back our screw out later if I wanted.

Repair 4: Door Window Ledge

The window ledge, with its detail work, is one of the main character elements of the door, but it was in rough shape. One end of the ledge had been broken off and the top plate had split halfway across. Removing the ledge would be detrimental to the character of the door, so I needed to repair it. My approach was to make a splash mold on the good end of the ledge to rebuild the missing end.

I removed the paint from a section of the ledge with the least amount of damage. I covered the area where I would build my mold using clear plastic packing tape. I made the mold as big as I could in my undamaged area. I had to keep the tape smooth and tuck it tightly into all my corners to get the most accurate shape possible. Since the tape was thin and flexible, it easily conformed to the surface's contours. The smooth plastic surface makes a great release surface.

Once the undamaged area was taped, I mixed a batch of 105 Epoxy Resin and 205 Fast Hardener with 406 Colloidal Silica until it reached a peanut butter consistency. I used the 406 Colloidal Silica because I wanted the mold surface to be fairly hard and dent-resistant. This way, I could ensure the mold maintained its shape throughout the project while rebuilding the opposite end of the ledge.

I applied the thickened epoxy to my packing tape, paying special attention to working the epoxy into the corners of the profile, removing all the air pockets. I applied enough epoxy to fill all the lows in the profile, which left a nice flat angle to apply my fiberglass reinforcement. The fiberglass stiffened the mold, making it much easier to work with and helping maintain the proper shape.

ABOVE:
The missing section of the ledge was rebuilt using a splash mold and a mixture of 105/205/406.

Using some scraps of 6 oz. fiberglass, I laid the first piece dry on top of my thickened epoxy. It was time to mix up a batch of neat 105 / 205. I brushed this on the fiberglass until it turned transparent, signifying it had been thoroughly wet out. Repeating this process, I ended up with three layers of 6 oz. fiberglass.

Since I had a little epoxy left over, I used it to bond the split part of the ledge back together. I brushed the neat epoxy onto the mating surfaces, then used masking tape to hold the split together snugly while it cured.

After an overnight cure, the splash mold easily popped off the surface. I did a quick trim on the mold to get nice, clean edges. Then I removed any paint and bad wood from the rest of the ledge to prepare the surface for rebuilding.

Since our mold was made with epoxy, and epoxy bonds to epoxy, I also needed to prepare my mold surface. Using the packing tape again, I taped the mold surface so I could keep the smooth surface and it would release easily. Another option would have been to wax the surface, but since the packing tape is so simple (and works perfectly for the shape of this mold), I decided to stick with it.

I applied a coat of 105 Epoxy Resin with 205 Fast Hardener to saturate the exposed wood surface where I would begin my build up. Then, I added 410 Microlight to my epoxy mixture until it reached a peanut butter consistency. I built up the surface by dabbing the thickened epoxy onto it. Then, by placing the splash mold over the thickened epoxy, I could mold the details of the ledge into the epoxy. I started from the end overlapping the existing profile and gently pressed the mold down snugly as I worked toward the missing section. The excess epoxy that squeezed out was spread to fill any voids under the mold.

Once the epoxy cured, I removed the splash mold. The surface needed a little sanding to square up the edges and remove any little imperfections. Since my mold was too short to do the entire section with just one casting, I needed to be sure the mold would reseat snugly into the profile for the second round of filling. I repeated the process a second time to extend the profile to the end of the ledge.

Then, it was on to the final shaping. Almost all of the edges outside of the mold were flat and square. A sanding block and a file made cleaning the remaining edges easy. The ledge was now ready for primer and paint application.

Finishing

I sanded and scraped the peeling paint from the rest of the door and inspected it for any significant damage I had missed. I didn't fill every ding and dent but instead left them for the character of being a 100+ year old door. The last step for me was to prime the door. I chose a white primer for a clean, even base. I applied two coats of primer to the door. From here, the rest is up to my friend. His sad beat-up antique store find, is now a functional piece of character he can proudly add to his home.

This project ran the gambit filling voids, making molds, crafting missing parts, sealing against moisture, and consolidating/bonding wood. The versatility of the WEST SYSTEM product line enabled me to tackle these diverse repairs and give this antique door a new life.

WATCH THE VIDEO

Repair 5: Sealing the Bottom of the Door

Check out our video to see how Greg approached sealing the bottom of the door.

BY JENESSA HILGER – GBI MARKETING

Our Technical Department is Growing

MEET THE NEW TEAM OF INDIVIDUALS HELPING SHAPE THE FUTURE OF GOUGEON BROTHERS.

For over 55 years, Gougeon Brothers Inc. has been leading the way in epoxy development for the marine industry. From our own firsthand experiences, we developed epoxies that could fulfill the needs of any marine building and repair application. We backed these products with extensive scientific data, recommended practices, and an excellent support team to ensure optimal performance for any epoxy user.

Over the years, the success and notoriety of the WEST SYSTEM brand within the marine industry, have lead it to be used in other high-performance industries that require specialized processes. Today, GBI brands not only include WEST SYSTEM® Epoxy but also the Entropy Resins® and PRO-SET® epoxy lines. The popularity of these brands amongst high-end composite builders drives us to continuously develop new formulations tailored to meet the unique needs of our customers. We are committed to building on this momentum as we look to the future.

Meet our New Team Members

Since breaking ground on our state-of-the-art Technical facility in 2013, our Technical Department has only continued growing. We've increased the services offered to our customers, increased custom formulation development, and increased the number of epoxy batches we produce annually.

This growth has necessitated the expansion of our Technical Team, especially for those who work in our chemistry lab. Each new team member plays a vital role in our epoxy production:

Eric Pitt

QC Laboratory Technician

Eric inspects every single batch of epoxy before it leaves our building. He works closely with our operations team, running a battery of tests to ensure every resin and hardener performs within specification before giving it his stamp of approval to be shipped out the door.

Hunter Moreau

Chemist

Supporting new formulation development, Hunter extensively researches, tests, and vets new raw materials and formulations. He works to develop the perfect formulation to solve our customers' specific challenges.

Nicole Murley

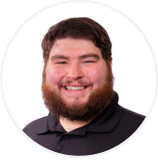
Chemist

Nicole is one of the most recent additions to our team. Utilizing her experience in the polymer industry, she is working jointly with Hunter to aid in the formulation development process. Her expertise is already proving to be of great value to the team.

Jonathan Lillo

Laboratory & Instrument Technician

The laboratory functions smoothly due to Jonny's persistence in maintaining the precise lab equipment and the lab itself. He establishes our testing protocols in the lab and calibrates our instruments to maintain our ISO 9001 requirements. Additionally, he performs tests analyzing customer samples.



Avery Jorgensen

Composite Materials Engineer

Avery recently joined as our second on-site Composite Materials Engineer. He performs mechanical testing on customer samples and maintains our Technical Data Sheets, which provide information about each system's properties. Avery will also become a regular contributor to *Epoxyworks*. Look for his articles in future issues.

The growth of our Technical Team presents exciting new opportunities for GBI. Our expanded R&D capabilities will shorten our formulation development times while still following the highest standards of quality you have come to expect from GBI. This enables us to conduct more comprehensive testing, leading to innovative solutions that set us apart from the competition. With a larger team, we are able to provide enhanced customer service and support for our expanding customer base.

These are exciting times for our company, and we are confident that adding new team members will propel us to even greater heights. We look forward to a bright future of innovation, growth, and success.

West System Fillers

THERE ARE SO MANY. HOW DO I CHOOSE?

West System offers six different fillers—why so many? When is it critical to use a specific one? What are the differences? Let's explore the details of West System Fillers and discuss how they function. Understanding these products will enable you to take advantage of the versatility inherent in the West System 105 System.

The primary purpose of all our fillers is to modify the viscosity of the liquid epoxy mixture. Still, other properties, such as strength, density, and surface texture, are affected when fillers are added. Having six fillers allows us to create a mixture with ideal properties for your application.

First, we will discuss the four fillers used for structural bonding and then the two fillers for fairing. Structural fillers provide a strong mixture after they are cured, and it is important to note they are hard and difficult to sand. We do not recommend them for surface fairing and finishing. Fairing fillers, conversely, are much easier to sand and shape to a smooth finish but should not be used for highly loaded structural bonds.

Adhesive Fillers

All West System Fillers, except for 406 Colloidal Silica, are blends. These blends have been developed to create products that are easy to use and provide predictable properties. Custom manufacturing equipment is used to produce them, and the raw materials are not easily blended using hand tools, so we encourage our customers to take advantage of these time-tested filler formulations.

406 Colloidal Silica

We will start with one of our most versatile fillers, 406 Colloidal Silica. It is our only filler that is not a blend—it is 100% fumed silica. It is very difficult to buy in small quantities and obtain a grade suitable for use in epoxy. We add value by providing the ideal product for use in West System Epoxy and providing it in convenient packaging.

The product has a very low density when in the container due to the particle's unique nature. The particles are somewhat "cloudlike," creating a significant surface area that enables the particle to efficiently saturate a mixture of liquid epoxy. The particle's shape allows it to stay suspended in the epoxy and become entangled with other particles. This makes it the most effective at modifying the viscosity to the desired consistency and providing very smooth fillets. The resulting cured mixture is of high strength with the intent to be used as a structural adhesive.

403 Microfibers

Another filler that is well-suited for structural bonding is 403 Microfibers. 403 is a blend of different fillers, the majority of which is cotton flock fiber. These fibers blend in quickly and increase the viscosity with a relatively small amount of filler. Because the filler consists of actual fibers that reinforce the epoxy, the cured mixture will have strength that is suitable for use as a structural adhesive. However, it does cure with a smooth surface. We often describe it as having an oatmeal texture. 403 Microfibers is ideal for applications that require the epoxy to be spread thickly over a large bonding area, such as laminating two sheets of plywood. Because of its rougher texture, we do not recommend 403 for filleting.

405 Filleting Blend

When fillets are used to stitch and glue plywood boats and other applications where the epoxy will be visible on wood, we recommend 405 Filleting Blend. This filler is a recipe of wood flour and other fillers that give a wood tone color and create very smooth fillets. Wood flour is not sawdust. It is processed and filtered to ensure the particles stay consistent and suspended in the epoxy. We also add specific amounts of other fillers to create a color similar to mahogany and other common boatbuilding woods.

404 High-Density

The last of our structural fillers is 404 High-Density. This product is a mineral filler that, as the name describes, contains a very high-density particle. The particles are shaped like long needles made of a hard mineral. This provides strength to the thickened epoxy. We developed it for potting the mounting studs of wind turbine blades. It provides the highest strength out of all our fillers but it is not dramatically stronger. It requires more filler to increase viscosity than the other adhesive fillers, so it is ideal for highly stressed joints that are common in fastener bonding. It has the unique property of absorbing heat when the epoxy cures, reducing the chance of excessive temperatures in thick applications.

Low-Density Fillers

407 Low-Density Filler

407 is a blend of phenolic microspheres with other fillers. The blending is essential because if you attempt to use 100% microspheres as epoxy filler, the light filler particles will float to the surface and will not blend into the liquid. Our blending solves this issue and makes using a low-density filler very easy. Blending of multiple fillers allows this filler to be used as an adhesive for lightly loaded bond lines. For example, 407 Low-Density Filler may be well-suited for a small stitch glue boat if the fillet radius is increased, possibly providing a weight reduction. Using 407 Low-Density Filler in this application is discussed in the *Gougeon Brothers on Boat Construction*, pages 102-103.

410 Microlight®

Finally, we have 410 Microlight. This highly formulated filler that takes advantage of multiple particle types and unique liquids to make an extremely low-density filler that can be easily dispensed and stirred into neat epoxy. It is lightly packed in the container which, makes it easy to scoop out with little mess, and it will not float out of the liquid epoxy. The ease of sanding comes from the use of thermoplastic micro balloons. Using these micro balloons requires caution when using the filler under a dark-colored surface that will get direct sunlight exposure. 407 Low-Density Filler has better temperature resistance for these applications. For other fairing applications, it is very easy to apply and sand, which is an important consideration. 105 Epoxy Resin and corresponding hardeners cure to very strong and durable materials that are difficult to sand without adding a low-density filler.

Safety

None of our fillers are carcinogenic. It is important to note that we do not sell crystalline silica, which requires special handling for safe use. It has a very different particle shape than 406 Colloidal Silica. A dust mask, safety glasses, and gloves will provide exposure protection when utilizing any WEST SYSTEM Filler.

WEST SYSTEM Fillers have an indefinite shelf life when stored properly. Store fillers in a dry environment because they absorb moisture and may become clumpy. If this occurs, run the filler through a flower sifter to break up the clumps and mix thoroughly to break up any remaining clumps.

Final Notes

We offer multiple fillers so our customers can have the ideal product for their application, but these products do overlap each other in where they can be used. If you keep 406 Colloidal Silica and 407 Low-Density Filler in your workshop, you will be well-equipped for most common applications. If the specific properties of another filler are required, the versatility of the 105 System enables you to purchase that filler and use it in the same resin and hardener.

403 Microfibers

404 High-Density

405 Filleting Blend

406 Colloidal Silica

407 Low-Density

410 Microlight

 BY JIM ENSMINGER

SKILL LEVEL

The Strip Canoe That You Can Do

In January 2020, I sent for plans for a 14-foot cedar strip canoe. This looked like a challenge I was up to. I had spent most of my working career as a project manager for a construction company and consider myself relatively handy.

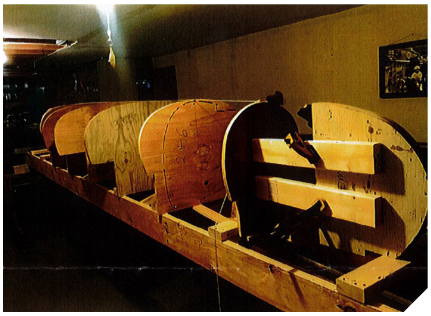
I purchased the material to build the strong back (the frame for building the cedar strips around). Building the strong back was much more involved and time-consuming than I expected. I chose ⅞" by 12' cedar for the hull itself. I could not buy anything locally, and the directions stated that splices were common and not a problem. My first step was to plane the boards down to ¾". The next step was to rip all strips to ¼". I don't know how many strips it was, but many had to be discarded because of knots.

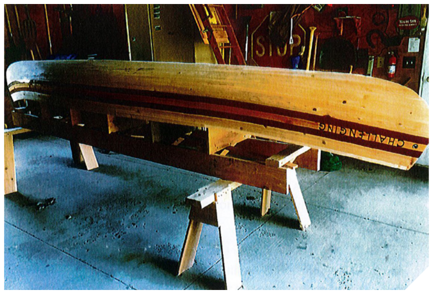
Adding a 2° bevel on one edge to every strip was the most tedious job. This was needed to prevent gapping as the strips rounded towards the top of the canoe. I cut the ends of the ¾" strips at a 45° and epoxied them together for a finished length of about 16'. These would be cut to length later. It would have been much easier if I could have bought 16' boards to begin with. No question—next time I will.

Then, it was on to the stems. I applied tape on the top of the mold for the stems so the epoxy would not stick to them. Then, I could epoxy, clamp, and staple the cedar strips to the stem mold.

For the hull, the first strip is stapled in place. Every strip after must be epoxied, clamped, and then stapled. I can only epoxy, clamp, and staple about four strips on each side every day. It is very difficult to bend many of the strips in two directions at the same time. Once all the strips were in place, it was time for many hours of hand sanding.

Time for epoxy. I chose the WEST SYSTEM 105 Epoxy Resin® and 207 Special Clear Hardener®. My only other epoxy experience was in 2016 when I built an 8' Portuguese-style dinghy fishing boat for my grandson's 12th





FAR LEFT:
Jim rolling a coat of 105/207 on the hull of his 14' cedar strip canoe.

TOP LEFT:
The frame built, though more time-consuming than expected.

TOP RIGHT:
I was able to apply about four strips per side in a day.

BOTTOM LEFT:
With all the strips in place, it was time for many hours of hand sanding.

BOTTOM RIGHT:
Challenging is a fitting name for this canoe.

birthday. Though it turned out very well, my epoxy work was not the most professional-looking. This time, I was much more careful. I did the inside, let it set for a day, then lightly sanded it with 220-grit sandpaper. Then, I applied the second coat, saturating the fiberglass. A third coat became necessary because I had to cut out and sand away some bubbles.

With the boat turned over, it was time to tackle the outside. Every boat and canoe must have a name. It didn't take much thought to come up with the name Challenging. I got out my wood-burning kit, and Challenging appeared on the bow.

I could not purchase fiberglass cloth large enough to cover the entire canoe at that time, so I had to apply it in three pieces. I knew I needed help with this and had a friend give me a hand. We rolled on one coat of 105/207. To avoid sanding, two hours later, we applied the saturated fiberglass. All went well. I can see where the three pieces butt together, but I don't know if anyone else can.

Building the frame for the seats was easy, but they needed caning—something I've never done. Following directions, with only a few take aparts, it was successfully completed in about 8 hours. My 19-year-old granddaughter volunteered to assist me with the second seat, which also turned out well.

With both seats completed, and installed, it was time for my wife and me to get it wet. We put it in at a boat launch. It floated exactly how it was supposed to. The total building time was 510 hours.

Harbour Quay Eagle Soars Again

The Eagle soaring at Harbour Quay has seen better days. A group of volunteers restored it to it's original grandeur.

The Port Alberni Harbour Quay is located on the west side of Vancouver Island—on the wet west coast of Canada. With an annual rainfall of about 6 ½'(1.88 M) and summertime temperatures reaching nearly 100°F (37°C), it's a tough environment for wood. The Harbour Quay Eagle carving, an almost 8' (2.4 M), has been perched on top of a 20' (6 M) tower overlooking the Harbour for the past 36 years. Local artist Bill Maxon originally carved the piece in partnership with Fred Graham, a Māori carver from New Zealand. The carving was commissioned for the World Expo 1986, hosted in nearby Vancouver, British Columbia. The years have taken their toll on the carving. In 2010, some repairs were undertaken by city staff, but now the Eagle needs a major restoration.

Volunteers undertook the project to restore the carving to its original condition. They worked with the Port Alberni City Parks Crew, who arranged transportation to and from the sculpture and the city to cover the material costs. The materials comprised WEST SYSTEM Epoxy, carving-grade Western Red Cedar, an epoxy primer coat, and Epifanes® two-part polyurethane in various colors. Great Central Milling provided the kiln-dried cedar at a reduced cost.

Once the Eagle arrived for restoration, it quickly became apparent that the project was much more involved than expected. Even though the Eagle was on top of a tower, with adequate air movement, the wood became waterlogged. The larger concern was the abysmal condition of the bird. Although the damage seemed minimal based on what we could see while it was 20' in the air, upon closer inspection, there was significant rot throughout the piece. The rot was especially severe within the body of the Eagle. Several pieces of the sculpture had fallen off, including the wing tip, and the head and tail of the salmon.

We realized work could only begin after the wood was under 10% moisture content. We moved the bird indoors for a more controlled environment. The drying process had to take place slowly to avoid unwanted cracking. Fans and direct heat were not initially used. After about six months, the core of the body remained stubbornly wet. To remedy this, we drilled several ¾" (19 mm) holes vertically through the body and installed fans with gentle heat to reduce moisture. After about one year, the Eagle was ready for restoration to begin.

The Eagle was moved into the shop and placed upside down on an automotive hoist. This strategy turned out to be exceptionally good, as the Eagle could be raised or lowered to create the ideal work height.

Initially, our plan to repair the body was to solidify compromised wood with a wash of 105 Epoxy Resin® and 206 Slow Hardener®. Then, we would fill any voids with 105 / 206 mixed with 404 High-Density Filler. After considerable assessment, it became apparent that the voids were too large to simply fill with epoxy. Instead, the better method was to fill the voids with new wood, which would reduce epoxy use. This would decrease costs and reduce unwanted heat buildup during curing.

The plan was to rebuild the sculpture from the base up, paying meticulous attention to every detail. A new wood base was laminated together and cut to size. The final fitting was a daylong endeavor to carefully carve and chisel the base to fit the original bird. Once the base was completed, it was set aside to allow access to the main body of the sculpture.

We began by removing rotten wood. Rotten areas, mainly within the body, were chiseled out into random cubic-shaped voids. These voids were filled with new wood blocks. We noted the grain direction of the surrounding wood and oriented the blocks to match. The body repairs consisted of about 25 individually shaped blocks that filled the voids—similar to a 3D Tetris puzzle. After the epoxy was applied to the walls of the void, each wood cube was epoxied in place with a mixture of WEST SYSTEM 105/206 and 404 High-Density Filler. For the large repairs on the wings and body, we mixed 18 pumps of both resin and hardener. Gradually, we mixed in 3 ½ cups of the 404 High-Density Filler.

Throughout the restoration process, careful attention was paid to following the original details of the sculpture. Construction of a new fish head required making a proportionate grid from a historical picture, then scaling it up and transferring it to wood for carving.

G/Flex was used on the top side of the wings because of its flexibility and better adhesion to the stainless-steel structural plate. We abraded the stainless plate with a 40-grit resin disc to ensure adhesion. We used 105/206 with 404 High-Density Filler to rebuild the basic shape of the sculpture and anywhere strength was required. For areas that had surface details and didn't require a lot of strength, we used 407 Fairing Filler, which has a red coloration and is easier to sand. Generally, we found the WEST SYSTEM products were easily sanded, faired, and more forgiving than polyester products.

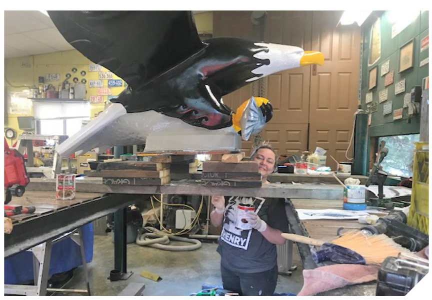
With the shape restored, we needed to coat the Eagle with epoxy to protect it from future damage. We stripped the original paint finishes from the sculpture so the epoxy coating could bond to the wood surface. This took considerable time and care while keeping the original detail intact. All surfaces that did not require repairs were coated at least once with 105 Epoxy Resin and 206 Slow Hardener.

All the repaired surfaces received a layer of protective fiberglass and epoxy. This included the underside of the wings, the body, and the top of the wings. Rather than draping cloth over complex surfaces, which could cause the original carved surface to become rounded and softer, we cut the cloth into smaller pieces. Using the patterns we made of all the surfaces to be fiberglassed, we carefully trimmed the cloth to fit around the sculpture details before applying epoxy. This precision took longer, but we endeavored to maintain the original carved surface.

Epoxy resins require protection from ultraviolet light. To solve this, the Eagle would get a fresh coat of paint. We carefully washed all the epoxy surfaces to remove the amine blush. When the blush was removed, it was easy to tell as a clean, non-slippery surface replaced the waxy film. Then, we used Interlux® 202 Fiberglass Solvent Wash to remove any potential contaminants. Care was taken to maintain a clean edge on the cotton wipes. Then, we lightly sanded it to improve adhesion and lightly cleaned it with the fiberglass solvent wash.

With the surface prepared, we applied two coats of Interlux Epoxy Primekote with a brush and a small roller. This was followed by two coats of epiphanies and two-part polyurethane. We did the second coat within 24 hours of the first, so no sanding was required. Brush thinner was added to allow the finish to flow out. The final touch was to epoxy in the new glass Eagle eyes.

The end result was beyond expectations. The Eagle now has an estimated life of 10 to 12 years before repainting is required. Once again, the Harbour Quay Eagle is soaring over the picturesque Port Alberni Harbour Quay.



TOP LEFT: There was significant rot throughout the sculpture. It required a year to fully dry.

TOP RIGHT: The rotted wood was removed and epoxy was used to help consolidate the remaining wood.

BOTTOM LEFT: Blocks were used to take up volume within the sculpture. Some sections, like these tail feathers, needed to be patterned and recreated.

BOTTOM RIGHT: The Eagle was sealed with epoxy and fiberglass to prevent future damage. Then it was painted to match the original color scheme.

 BY LORRAINE DUCKWORTH – ATL COMPOSITES

Upholding TRADITION

LEFT:
Close up of undercoat.

Suspended in a cradle at the former Creese's yard, Battery Point, a 40-year-old 40" timber yacht is being returned to its original form to compete in the 80th Rolex Sydney Hobart.

The yacht is owned by an experienced sailor, Rob Gough, who, with John Saul aboard the Akilaria RC2 *"Sidewinder,"* etched their place in Race History by winning the inaugural 2-Handed Line Honours in the 2021 Sydney Hobart race.

Fittingly called *Tradition*, it has a suitably sentimental story.

"It was our family boat," explains Rob. "It was the last boat to leave Creese's shipyard at Battery Point in 1984. We sailed down the channel every weekend, around Bruny, swimming and setting off in little dinghies.

"Then my dad traded it in and bought a new Buizen yacht. The Gourlay family in Launceston bought it then and owned it for over 20 years. I often walked past it at the same marina."

In another twist, Rob ended up selling his yacht, a Moody 54, to the Gourlays and buying *Tradition*.

"I was very fond of it – it's a beautiful boat. Huon Pine such a special timber," he continues.

"I remember it being built, watching the boat builders gluing planks together. I used to marvel at it as they mixed resin and hardener from two 44-gallon drums. In those temperatures, it would have been hard to get the mix right. It took phenomenal skill.

"40' was enormous in those days and, it's a really good size for what we're after."

Rob aims to compete in the 80th Rolex Sydney Hobart Yacht Race in 2025, ideally with his two kids, a son, 17, and a daughter, 21. He has competed in four editions of the epic bluewater race—three of them two-handed.

According to Rob, who sailed aboard the 10-meter *Jeanneau Kraken III* with John Saul in 2023, "the 2023 edition was a long, arduous race." The ordeal influenced his decisions about which features to retain and which materials to use in restoring *Tradition*.

"Being two-handed, we each had to hand steer with the tiller for an enormous amount of time. We were sailing in 5-meter seas, 40 to 50-knot wind and hail. In 2021, I broke five ribs. Around the bottom of Tasmania, I really changed my thinking about *Tradition*. I decided to leave the wheel in and thought it would be great if *Tradition* could handle a Sydney-Hobart.

"Initially, it was only to be a Sydney Harbour day racer and for family cruising. But it would be nice to have the ability to cruise more extensively in *Tradition* and compete in a Hobart."

Rob's vision is to crew *Tradition* with a six-person team, including his kids, John Saul, and a couple of close mates.

"There's a huge amount of preparation required, especially on the physical side. I've only just recovered from last year's race. I don't want to rush the restoration. I want to savor it, and do it right.

"I'd rather have an achievable deadline. We want to be back in the water in September, then carry out the fit-out and rigging over next summer, train on board, and get it ready for the 2025 Sydney Hobart. The kids have done a lot of sailing. We did a lap of the Pacific, so they know what they're getting themselves into."

A friend recommended Nathan O'Neill for the refit project, as Rob explains. "A really good friend of mine, Michael Vaughan, did the course at The Wooden Boat Centre [Tasmania], so I asked him who he would recommend that would be able to accommodate my quirks and the way I operate, and he recommended Nathan."

Nathan, Jonathan Minnebo, and Matt Stevens lead the talented team at Tasmanian Shipwrights & Co., all under 35, each with a different and complementary skill set. Jonathan (with 17 years of experience in the boat-building industry) and Matt (formerly lead shipwright at Denman Marine) bring a wealth of boat-building and restoration experience to the job. In addition to Nathan's diverse and creative background, the three partners have a full work calendar under the new enterprise established in October 2023.

"There was some rot and a major crack in the hull," explains Nathan. "We have replaced those damaged planks with Huon Pine."

Working to the deadline of September to have the yacht back in the water, Nathan, Jon and Matthew are relying on WEST SYSTEM's range of epoxy products, as well as Epifanes PP Varnish Extra, Rapid Clear and standard Clear Varnishes.

"We exclusively use WEST SYSTEM for its quality and reliability," Jon says. "And we're getting great results with EPIFANES, single pack for interiors and 2-pack for exteriors."

Tradition's owner, Rob, unsure whether or not to finish the hull in fiberglass laminated with epoxy or with only an epoxy resin coating. After experiencing extremely challenging conditions in the 2023 Sydney-Hobart, he decided to go with fiberglass.

"He chose the extra strength for peace of mind and insurance purposes," Jon explains. "We will liaise with maritime architect Andy Dovell before we proceed, but we're planning to use 450 gm double bias E-fiberglass from ATL, WEST SYSTEM Epoxy to bond it to the hull, and multiple coats of WEST SYSTEM resin before applying a 2-pack paint system."

So far, Rob is thrilled with the way *Tradition* is shaping up.

"It's come full circle," he says. "It really is a family heirloom. The whole family loves the idea of the project. They all said they'd lend a hand, although we're yet to see that!"

LEFT:
Stern with name.

ABOVE:
Laminating the hull.

RIGHT:
Tasmanian shipwrights.

The trio from Tasmanian Shipwrights & Co are dedicated to the preservation and restoration of wooden boats which have a unique allure. "It's what nature gave us and it's sustainable," says Nathan of the raw material.

"The majority of the constructed world is built on top of what is naturally there, but boating is inherently about being in and working with the natural environment. So, building with an organic material makes sense in that context. Wood is still the best material to capture both elements of boat building: function and beauty.

"A boat is not just a means to an end to get a job done, it's also art and emotion. Wood still captures that better than steel or composite."

Matthew too is just as passionate about wooden boats, saying "The allure of working on wooden boats is learning a craft that has been in place for hundreds of years.

"The knowledge that with a handful of tools, unchanged for the past century, and a selection of trees that can be regrown for future generations, you can build something aesthetically pleasing and practical that could carry you around the world using nothing but the wind. It is surely one of the most romantic trades."

For his part, Jon enjoys the technical challenge. "Whether it's boat building or restoration, each job is different, bringing its own set of challenges.

"Though no two jobs are alike, they all require thinking, planning, and problem-solving. It's a mentally stimulating job that offers a big chance for learning and growth. With a basic foundation in using hand tools and machinery, passed down from earlier generations of boat builders, you gain the confidence and skills to take on new jobs. The satisfaction comes from challenging yourself, solving problems, and creating something to the best of your ability while picking up new skills.

"Looking back at your work and feeling proud of what you've accomplished is really rewarding. I'm always learning, not just from taking on new jobs, but also from Matthew and Nathan, as well as other boat builders who are always willing to share their knowledge and experience."

TOP:
The painted topside of the hull.

BOTTOM LEFT:
Interior refurb.

BOTTOM RIGHT:
Structural framing planks.

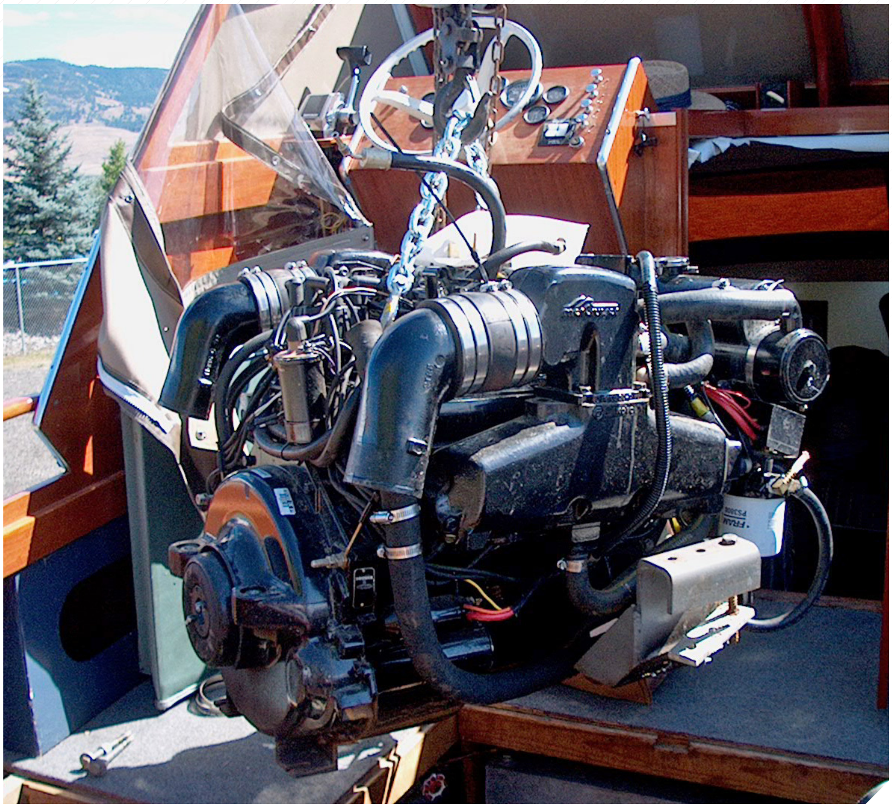
Caduceus Transom Rebuild

After burning out my engine coupler and being towed home to Kelowna Yacht Club (KYC) (by a sailboat, no less), I knew my boat was going to need some work. We hauled the boat out of the water and removed the engine to determine the extent of repairs required.

I have an Enos custom built fiberglass hull cruiser that my dad commissioned in Vancouver, British Columbia, back in 1964. Now, nearly 60 years later, we continue to enjoy the boat, spending much of our time on Lake Okanagan.

With the engine (a 5.7-liter Mercruiser Bravo II) removed, I could tell there was more damage than just the burned-out coupler. The last ten feet of the stringers supporting the motor were rotted and would need to be replaced. Also, the oil pan was rubbing on the inside of the keel, indicating the transom didn't have enough angle to properly accommodate the motor.

I made prototype engine bearing stringers to use as an engine stand in my garage so I could work on the engine over the winter. Then I installed a new engine coupler, new water pump impeller, and power steering cooler hose.



TOP: After burning out the engine coupler, we hauled the boat out of the water and removed the engine.

BOTTOM: The model from the outside.

Developing a Plan

With spring not quite here yet, it was time to research the best approach for repairing the stringers and adjusting the transom's pitch. I consulted the WEST SYSTEM® manuals and *The Gougeon Brothers on Boat Construction* book to develop my approach. Additionally, I consulted the book Fibreglass Boats by Hugo Du Plessis and, of course, the internet. Armed with my knowledge, I formulated my plan.

I built a model of my plan. Instead of the transom section protruding at the top, like it was currently doing, I wanted to have the top flush with the rest of the transom and tip the bottom section in to accommodate the angle the motor needed. I adjusted the model until I was happy with the angle. This plan would also require moving the first bulkhead forward to accommodate the engine.

Cleaning and Demolition

It's time to get to work. Cleaning forty years of oil and bilge water took forever. After scrubbing with grease removers and soap, I power-washed, then used solvents and acetone. I allowed the fiberglass to dry over the fall, winter, and spring before giving it a final sanding and acetone wash.

With ski season over, the transom and stringer work could start. I had to remove the existing, protruding angled section around the motor opening. I ground a channel through the outer fiberglass skin to make cutting easier. This project was a big commitment, so I bought several new tools, including a 12-amp reciprocating saw. My Thule® box made a perfect overnight storage area for my tools and supplies.

The stringers inside the boat were cut down leaving, 4" of fiberglass tabbing protruding from the hull. All the rotten wood core material was removed.

Plans Change—The Hole Gets Bigger

The wood core of the transom around the removed area was pretty solid, but not everywhere. The rot got worse towards the ends of the stringers. I suspect water was collecting between the stringers, and due to a lack of limber holes, it had nowhere to go, filling up the cavities. Over time, the water worked its way into the stringers and traveled through the wood all the way back into the transom.

The rot needed to be removed before rebuilding could begin. I had to cut a larger opening in the transom to get to the edge of the rot. The rot was worse near the stringers, especially on the port side. The stringer core needed to be removed from the transom to the first bulkhead forward of the engine. This big job was undertaken with a chisel, hammer, saws and lots of patience.

At this point in the project, I changed my mind and did not want to move the bulkhead. That meant I would have lost storage space forward of the bulkhead and would have to do a lot more work. Therefore, the transom section must remain flush at the bottom and tip out at the top.

New Stringer Core

I spent many hours cleaning and fairing the bilge area to prepare for the new core and, eventually, more layers of fiberglass. This included thoroughly preparing the 4" fiberglass tabbing left from the previous stringers and the hull surface between them.

The new stringer core was made from two pieces of ¾" marine grade plywood epoxied together. All of the wood was first warmed and then encapsulated with unthickened (neat) epoxy using WEST SYSTEM® 105 Epoxy Resin® and 206 Slow Hardener®. Special attention was given to all end grain to ensure it was sealed with epoxy. The stern ends were cut at an angle, ready for attaching to the new transom piece.

Thickened epoxy was applied to the inside surfaces of the stringer tabbing and the hull. The laminated core was then inserted. Lots of plastic sheeting was used around the bond area to prevent epoxying the clamps to the stringers. I used many clamps, tightening them until they were secure, but not so much that I squeezed out all the epoxy.

New Transom Core

With the stringer core installed, it was time to rebuild the transom. The transom has a concave (looking

TOP:
The rot got worse towards the sides of the hull.

TOP:
The rot was worse near the stringers, especially on the port side.

TOP:
Clamps and poly around the glue area to prevent gluing the clamps to the stringers.

from the inside) curve, making it very strong. To keep the curve, I epoxied the first layer of ¾" plywood in sections. I needed to be sure there was good contact, without any voids, across the surface of the fiberglass transom. To have ample working time, I used 206 Slow Hardener and only installed one section per side per day.

I braced the plywood against the bulkhead with long scraps of wood. Along the opening in the transom, I used lots of clamps. I tightened the clamps to avoid epoxy-starved joints to a pressure similar to a firm handshake. I used plastic sheeting everywhere to avoid gluing my clamps to the boat.

With the temperature starting to drop as we got closer to fall, I found it helpful to use a radiant heater to warm the substrates before epoxying and fiberglassing.

Once the planking was done on both sides of the transom opening, it was time to add my plywood reinforcement above the transom opening. I made a special effort to use one piece of plywood across the top of the transom opening for extra strength. I used several layers of 5⁄16" plywood because it was easier to work with than the ¾". I first bent the plywood, then epoxied the pieces in, one at a time, to fit the curve of the transom. It worked very well. No voids and good adhesion. I used braces and lots of clamps to hold the plywood in place while the epoxy cured.

Limber Holes

I rebuilt the stringers with limber holes so water can't collect behind them and cause rot again.

I used a 1" PVC pipe wrapped in fiberglass to create the tubing for my limber holes. I started with a section of pipe long enough to use for all my limber holes. I wiped the tube with acetone and roughed it up with coarse sandpaper to prepare the surface. I wrapped the tube with fiberglass cloth tape and unidirectional fiberglass. I wound a length of string around the assembly to hold the cloth tight to the tube. Once cured, I cut the tube into the lengths I needed for each of the limber holes.

This method of fiberglass wrapping the PVC will ensure good adhesion of the PVC to the stringer. If the PVC were to break loose from the stringer, water could penetrate the stringer core again.

To install the PVC/fiberglass limber hole, I drilled an oversized hole through the stringer for the limber hole tube. I also drilled a much smaller hole above this, angling downward—exiting through the tube hole in the middle of the stringer. I then inserted the limber hole tube and laid up strips of fiberglass mat in the gap between the oversized hole and the tube. This sealed the opening on both sides of the stringer. Once that had cured, I injected neat epoxy through the small top hole into the space around the pipe. This should ensure a good bond and seal out water if that bond should ever fail.

Reinforcing the existing transom was almost finished. I then covered it with four layers of biaxial fiberglass and three coats of epoxy. The natural wood looked so good I was tempted to leave it, but I finished it off with three coats of white epoxy paint.

Checking the Bilge Keel Cap

Since I had everything torn apart and discovered the extensive stringer and transom rot, I cut off the bilge keel cap. I wanted to expose the wood keel and check that for rot too. Luckily, there was none. I dried the keel for six months (over the winter), then coated the warmed keel with neat epoxy to prevent future rot. I replaced the cap pieces and filled the gaps with thickened epoxy. I covered the area back up with a layer of fiberglass CSM, unidirectional fiberglass, bi-directional fiberglass, and a layer of CSM again.

Stringers and Transom Knees

I wanted to strengthen the stringers that were located either side of the motor and add transom knees to help

TOP:
The first layer of ¾" plywood glued in sections to make good contact with the fiberglass transom.

TOP:
After preparing with acetone and roughing up 1" PVC pipe with coarse sandpaper, I covered it with cloth tape and unidirectional.

TOP:
The starboard stringer filled with dense polyurethane foam and covered with mat.

transfer the load from the transom to the stringers. I increased the width of the stringers by sistering them with a total of three pieces of ¾" plywood.

The plywood was double-coated with epoxy to form a waterproof barrier. Then, it was bonded in place. The ends of the plywood were intentionally left staggard. This allowed the knees to be aligned more easily during installation, and the staggered joints ensured a smoother load transition from the transom into the stringer.

I applied fiberglass to the stringers, leaving the ends exposed for later. Two layers of unidirectional fiberglass cloth were followed by three layers of bidirectional fiberglass, and the top of the stringer received extra layers of fiberglass.

The knees were built from three layers of ¾" marine grade plywood, epoxy coated and bonded together.

Transom Extension

In the spring of 2007, with the snow melting and ski season done, it was time to break back out the epoxy. I needed to extend the hull bottom for the new transom to sit on to keep everything in perfect alignment.

I started by building a supporting plywood platform that extended the lines of the hull aft. I covered the platform with a plastic drop cloth so the epoxy would easily release later. My first layer was carbon fiber. I laid it on the plywood platform and wrapped it a couple of inches onto the existing transom. Next, I applied two layers of "S" biaxial fiberglass cloth and another layer of carbon fiber. I allowed that to cure, removed the platform, and then trimmed the new extension to size.

With the platform removed, I now had access to reinforce the bottom of the fabric/transom seam, tying the hull and extension together. The reinforcing fabric had to taper onto the hull to evenly distribute the loads. I ground ½" of thickness off the 1" thick original hull laminate at the seam. Then I tapered away from that seam about 6".

I made a template of the tapered area on a piece of 6-mil polyethylene sheeting. I marked the different sizes of the layers of fabric that would need to be cut to feather the patch evenly into the hull. Then, I cut out all the layers of carbon fiber, Kevlar®, and "S" biaxial fiberglass cloth.

Kevlar is very difficult to cut compared to carbon fiber and fiberglass; however, like carbon, it wets out very easily. I wanted Kevlar because it will provide good abrasion resistance. The last layer was biaxial fiberglass so I would not have to sand the Kevlar.

I made a piping bag out of a Ziploc® bag and squeezed out the thickened epoxy to make a neat fillet. After rounding the fillet, the small lines were scraped away before the epoxy dried. No mess, no waste.

At this point, the extension's thickness was ½". There was another ½" to go. I built up more layers (top and bottom) of fiberglass, Kevlar, and carbon to reach 1" of thickness.

Building the New Transom

Now, it was time to start building the new vertical transom surface. I used my prototype template to cut out two pieces of ¾" marine-grade plywood. I laminated the two pieces together with a layer of fiberglass in between.

At this point I had spent over $1,000.00 (CA) on WEST SYSTEM Epoxy and fillers. In the end the total ended up being over $1,600.00 (CA). It was well worth the money for as much bonding and laminating as I did in this project.

I put a layer of polyethylene sheeting on the new hull extension and covered it with thickened epoxy. I bedded the newly laminated transom piece in the thickened epoxy. This ensured a perfect fit and placement when I was ready for the final installation. After it cured, I peeled the sheeting off, leaving the epoxy bonded to the transom.

TOP:
The starboard stringer after I doubled the width of it with two ¾" pieces of plywood.

TOP:
Two layers of "S" biaxial cloth and another carbon, then trimmed to size.

TOP:
Getting ready to Laminate the two pieces of ¾" marine grade plywood together with a layer of fiberglass in between.

I temporarily reinstalled the new vertical transom piece, which allowed me to position the motor's transom plate and mark where I would need to drill my mounting holes. At this time, I also marked on the stringers where the motor mount pads should be located.

My rented drill made quick work out of the holes for the motor transom plate. A jigsaw was used to cut the opening in the transom for the motor. New saw—quality blades. No problem.

The Motor Mount Pads

I laid a few more layers of fiberglass between the stringers to help tie the stringers together and reinforce the hull for the new motor mount pads. These ran along the hull from the transom up to the first bulkhead.

The motor mount pads were built from four pieces of ¾" marine-grade plywood, epoxied together into one rectangular block. I sawed this block in half on the diagonal to get two triangle-shaped blocks. Once these blocks were epoxied to the hull, they formed a level mounting surface. The trial fit was perfect.

Attaching the Knees

The first step towards permanently attaching the new transom was to apply thickened epoxy to the inside of the transom and bed the knees into it. I used the squeeze out to create standard fillets. After that cured, I mixed more epoxy and went back over them, creating even larger fillets. This served two purposes: It created an even stronger bond and was a more gradual transition for the tabbing cloth that came next.

For tabbing, I applied three layers of biaxial fiberglass, a layer of carbon fiber, and one additional layer of biaxial fiberglass on top. This process was applied to both sides of each knee, which were attached to the transom.

Installing the New Transom Section

While the tabbing cured, I cut and test fit my ¾" plywood filler strips. These would connect the sides and top of the new transom to the original one. The filler strips were intentionally inset from the edge of the new transom section. This space allowed additional reinforcement layers.

It was time to begin the permanent installation of the new transom. I applied a good bed of thickened epoxy to all the mating surfaces—the hull extensions, transom knees, stringers, filler strips, etc. Once cured, the bond would be strong enough to hold all the pieces in place, so that I could begin reinforcement.

Across the bottom of the new transom section, I used two layers of fiberglass to tab the hull extension/transom joint. Around the remaining perimeter of the new transom section, I applied five layers of fiberglass. Then I added a layer of ¾" plywood to both the sides and the top. This was all then covered by two layers of fiberglass, one layer of carbon fiber, and followed by one layer of fiberglass. One more ¾" plywood piece was added to the top, then a couple more layers of fiberglass completed the layup. This brought all the sides flush with the edge of the new transom section.

To attach the new transom section to the inside of the hull, I applied three layers of fiberglass, a layer of carbon fiber, and then another layer of fiberglass.

The knees were already bonded in place with the initial placement of the new transom section, but they needed reinforcing fabric. I used fiberglass to cover the stringer/knee joint and to tab the knees onto the hull. Though I had used carbon to tab the transom to the hull, I used fiberglass to attach the knees since they had more surface area for a stronger bond.

TOP:
Positioning the motor mount pads prior to laying more layers of more fiberglass underneath.

TOP:
Carbon fiber on top of 3 layers of biaxial, then one more biaxial glass on top of the carbon.

TOP:
The side pieces are glued on and are being glassed in.

TOP:
Almost finished. Ready for the engine and trim tabs. The Swim grid will go on after the fall haul out.

Almost Finished

I gelcoated the exterior of the new transom, and it finally felt like the end was in sight. I installed all the engine hardware. Luckily, the engine fit perfectly on the new motor mount pads. I measured correctly.

After that, I reconnected everything and installed the brackets for the trim tabs. The swim grid will go on after the fall haulout, but for now, it's time to get her out on the water again.

TOP:
I measured right. The motor mount pads were perfect.

WEST SYSTEM®

Publications

WEST SYSTEM® offers a range of detailed publications that can help you get started on your building or repair projects. These publications are available at your local WEST SYSTEM dealer or as free **downloadable PDFs at westsystem.com**.

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EPOXYWORKS®
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Readers' Projects

WOODEN BOAT BUILD

10' KAYAK BY RAY MCCARTHY

My son's high school graduation present in 1998, I built this 10' Kayak. The kayak was built with WEST SYSTEM® Epoxy, okume plywood, and 4 oz. fiberglass cloth. I used the "tortured plywood" or stitch and glue technique. The hard chines make it very stable. 26 years later, my son still fishes from it on Cape Cod ponds and marshes. It's still light and watertight. Thanks, Gougeon Brothers!

KNIFE BUILD

KNIFE BY DUANE NORTHRUP

I have been successfully using the excellent G/Flex® 650 Toughened Epoxy for the last five years. The ease of use, the working time and the epoxy's waterproof nature makes steel to wood, or composite bonds simple and permanent. No G/Flex 650 bonded knife that has left my bench has experienced a failure. I am confident that this WEST SYSTEM® testimonial is not just from me but from knife builders worldwide.

BOAT RESTORATION

1968 13' BOSTON WHALER RESTORATION BY CHRIS BENZEN

This boat sits in Newport Harbor, California. I fully restored it a couple of years ago. I used WEST SYSTEM 105 Epoxy Resin® and 206 Slow Hardener® to fill the holes left from removing the oarlocks. I mixed cut-up chop strands and 105/206 to a mayonnaise consistency and filled the holes. I also used the mixture where I had a crack. I built up the area and sanded it flush. Here's the finished boat on a small beach in the harbor that I frequent with my dog and friends.

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