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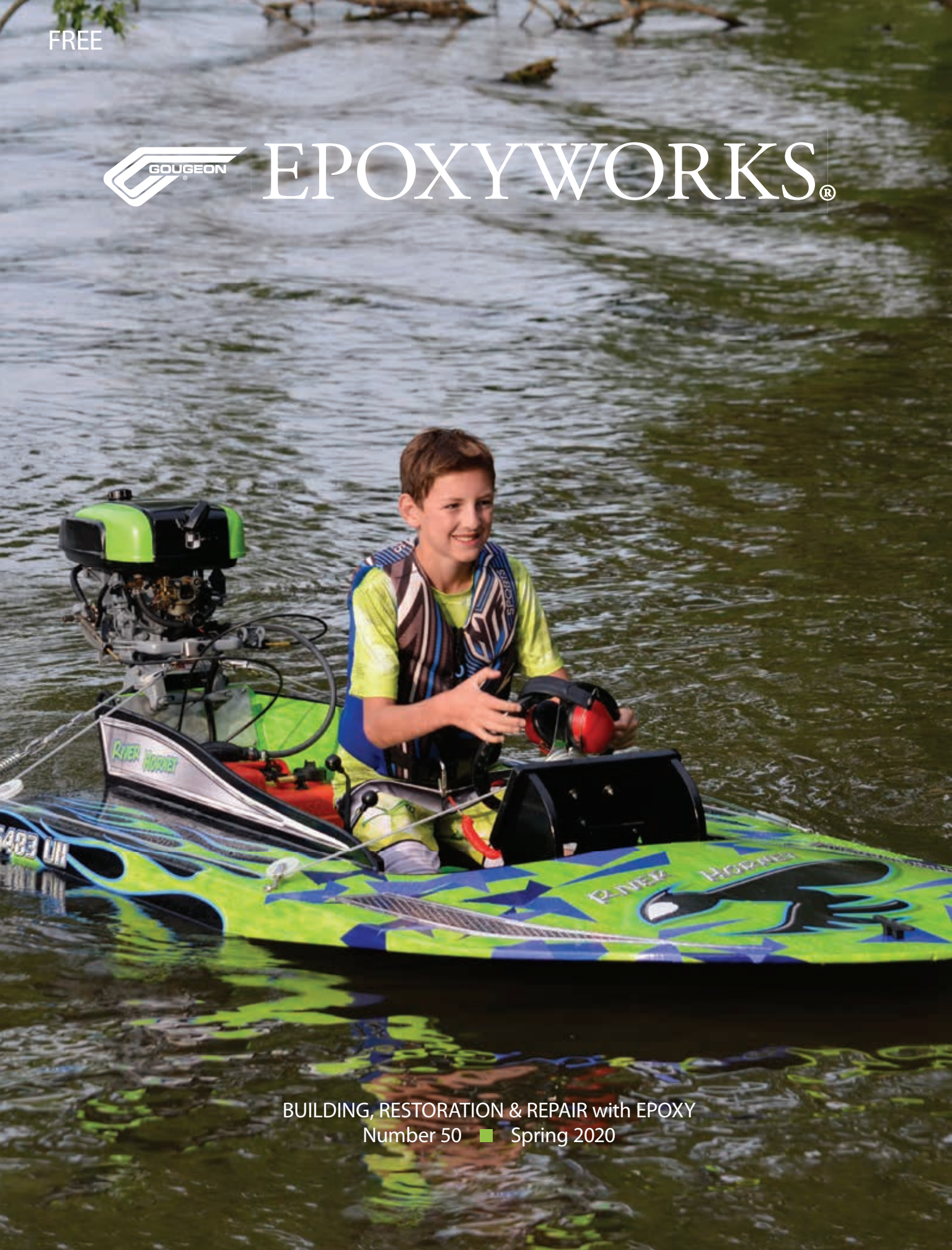

EPOXYWORKS®

BUILDING, RESTORATION & REPAIR with EPOXY

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In This Issue

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Joshua mixing a pot of 105/206 epoxy.

Editor's note: safety glasses should always be worn while working with epoxy.

River Hornet

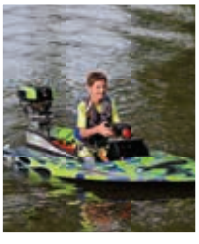
A MiniMax Hydroplane

By Jeffrey Carpenter

In late 2018 my son and I were given a unique opportunity by the Michigan-based Water Wonderland Chapter of the Antique and Classic Boat Society (ACBS) to build an 8' MiniMax hydroplane based on original plans from the early 1960s. Almost anything from that era seems to be popular again. Maybe it's nostalgia or maybe the designs of that groundbreaking decade were just ahead of their time. Either way, the MiniMax's appeal seems as relevant today as it did in 1962. We accepted the challenge without hesitation.

The youth-centric building project commenced in February 2019 at the Grand Rapids, Michigan Boat Show. We were in front of a live audience, and ACBS members generously donated wood and fasteners. Sons and daughters participated and even younger siblings got involved. Those initial marathon building sessions were the start of a nearly seven-month journey to complete our boats.

Joshua and I wanted this boat to last for generations and knew that the most effective defense against deterioration was to encapsulate the structure in a waterproof coating. We were both new to boat building and restoration. The volunteer advisors from ACBS, many with a lifetime of experience, suggested WEST SYSTEM® 105 Resin and 205 Fast or 206 Slow Hardener to waterproof our hydroplane.



Cover Photo: Joshua and his MiniMax.

A coating of neat epoxy was brushed onto the boat.

After brushing the epoxy on, Joshua tipped the coat with a section of a 300 Roller Cover with a clamp for a handle.

The assembled mini max boat with a coat of neat epoxy.

Rolling out fiberglass to reinforce the bottom of the boat.

Epoxy was rolled on to wet out the fiberglass reinforcement.

Joshua putting his new build through its paces.

One proud kid—as well he should be.

As fabrication moved forward we found many practical uses for epoxy: sealing the flotation compartments, applying fiberglass cloth to the bottom of the hull and critical seams, adding strength to the transom, and ensuring that every square inch of the boat was waterproof. If you have not experienced a small hydroplane it must be stated that you need a swimsuit and a positive attitude as you will get wet. It's all part of the fun.

I have always wanted to try out the process of vinyl wrapping and decided this would be the perfect test case. We selected Edgewraps of Ashley, Michigan and Joshua worked with the staff to design his own custom wrap. The styling is quintessentially 11-year-old boy–lime green, blue, black, and chrome with plenty of hot-rod inspired flames. It's named River Hornet.

Will this boat stand the test of time? Absolutely. The epoxy served as a perfect base for the wrapping process after wet sanding with 220-grit to ensure smooth vinyl adhesion. Under the three coats of epoxy is plenty of fiberglass reinforcement and a lot of sweat equity—perfect for a youth-centered project. Our MiniMax is rigged with period-correct controls, many from Portage Bay Systems of Seattle, Washington, and a restored 1956 Sea King 12hp outboard (manufactured by the Gale division of OMC) that Joshua helped tear down and re-assemble. The motor is complete with a modern safety lanyard and yes, more lime green paint.

This project demonstrates that the next generation of inventors, fabricators, and builders is ready, willing and able to learn new skills. The experience deserves to be celebrated and we hope more youth become interested in this or any similar endeavor.

In August 2019, Joshua displayed his finished hydroplane at the 42nd annual Les Cheneaux Antique and Wooden Boat Show in Hessel, Michigan located in Michigan's beautiful Mackinac Straits region. He represented his accomplishment alongside several other youth projects and their families sponsored by ACBS. The conversations with attendees about their own childhood boating experiences alone was worth the effort. I am proud of Joshua—he is my son after all—but I am equally as proud to have confirmed that today's youth are just as capable as ever.

Thank you for sharing in our journey and best of luck with your own inspired projects.

David Petro-Roy, a member of the Mattatuck Drum Band, and his repaired 1837 Eli Brown rope tension drum.

The Stradivarius of Drums

By David J. Petro-Roy

I restored my 1837 Eli Brown rope tension drum using WEST SYSTEM® Epoxy to repair a longitudinal crack running about a third of the way around the drum shell.

From at least the late 1600s to about the mid-1800s, the Brown family of Windsor (now Bloomfield), Connecticut made rope tension drums to supplement their income as farmers and coopers. Over time, these drums have become highly sought after. Their unique sound and rarity has earned them the distinction of being the Stradivarius of rope tension drums.

To date, only about 90 of the Brown family drums have been accounted for. Some are owned by museums and historical societies. Others, such as mine, are in private collections. Many others are owned and still played by ancient fife and drum corps such as the Mattatuck Drum Band (mattatuck.org) of Waterbury, Connecticut who, having been formed in 1767, purchased many Brown drums new. I am proud to be a member of the Mattatuck Drum Band and I will be playing my restored drum in future parades and concerts.

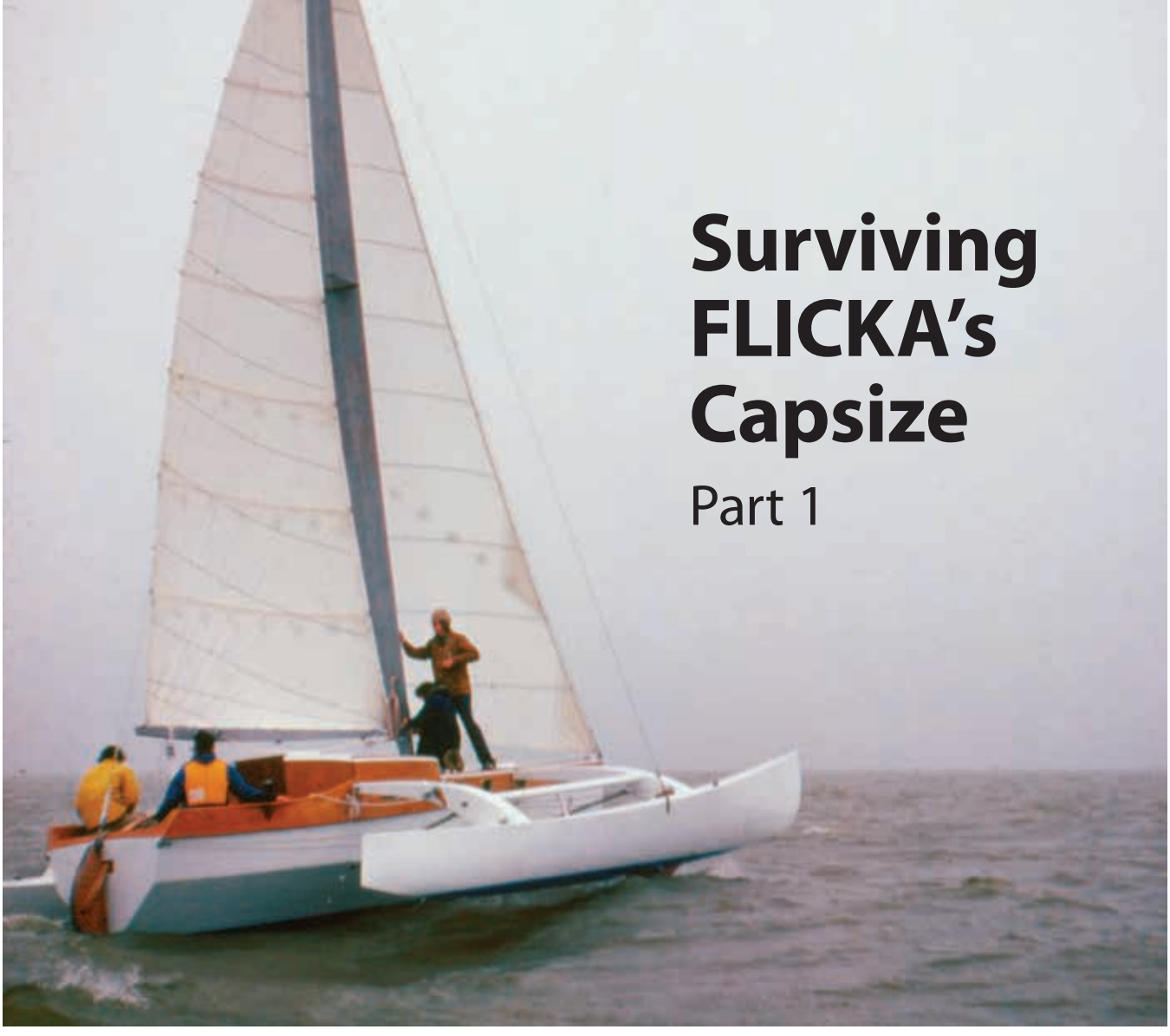
The drum in its purchased condition.

The drum has been stripped in preparation for the repair.

The drum had a severe crack a third of the way around the drum on the grainline.

WEST SYSTEM 105/205 was injected directly into the crack and clamped to cure.

Another of my projects using WEST SYSTEM was my mailbox post. I was tired of the snow plow trucks knocking down my mailboxes so, as a hobbyist welder, I built a mailbox post out of steel using square tube, box tube and angle iron. I wanted the post to look like wood. To avoid grinding an excessive amount of welds, I affixed a number of components as well as all the trim work using Six10® Epoxy Adhesive. I believe I achieved my goal. WEST SYSTEM products are "bulletproof" and my post has already withstood our first major snow storm here in the northeast.



Surviving FLICKA's Capsize

Part 1

On Wednesday, June 20, 1979, while sailing in a qualifying race for the OSTAR (Original Single-Handed Transatlantic Race), Jan Gougeon's self-designed and built 31' trimaran FLICKA was capsized by heavy seas in the North Atlantic. Jan survived on the overturned plywood/epoxy multihull for four days before he was rescued by a passing freighter. The following is the transcript of a phone call between Jan, his brothers Meade and Joel, as well as fellow multihull designer/sailor Mike Zuteck. Their discussion takes place on June 26, 1979, just hours after the freighter that rescued Jan delivered him to dry land.

FLICKA was never recovered.

We've divided their lengthy discussion into two parts. In this first installment, Jan discusses FLICKA's capsize, what it was like surviving in the upside-down trimaran.

Jan Gougeon: The wind is shifting around to the Northeast so I figure if I can make good enough time I can get across the Gulf Stream before the Northeast wind. Absolutely, if it is blowing strong out of the NE you just don't go across the Gulf Stream. It's that bad.

So, Wednesday morning after I got my sun sights… going there was really a hassle but on the way back, man, I had the sun sights right. I was really gung-ho on the navigation thing. I was getting close to the Gulf Stream and it was getting pretty late and the wind was picking up strength. I decided I wouldn't sail across and instead I would hove to.

I was hove to and playing around with letting the boat lay beam to the sea. That

was absolutely treacherous. A trimaran, one thing it can't do is lay beam to the sea in any condition. It absolutely can't do that.

Meade Gougeon: What was happening?

Jan: OK, here's what the deal is when you lay a beam to the sea: as the wave comes it picks up the center hull and the outrigger. There is no weight on the outrigger but you are heeling 50 degrees instantly. That's the flow of the trimaran–you can't be beam-to-sea, you've got to be nose-to.

Right away I said, Huh, I can't be beam-to cause I'm going to tip over instantly. So I put the main[sail] up and put two reefs in the main and took all the headsail off and the two reefs in the main. I tied the tiller over.

It was absolutely perfectly sitting there. And then I went down below and made something to eat and the boat almost tacked on me. So I said, boy, if it ever tacked on me, it would bear off on the other tack and go roaring off downwind and tip over on the other tack. I took the ties off the tiller and I let the tiller go stop-to-stop. It still stayed beautifully head-to-wind. It was sitting there like a duck on a pond. The motion was so comfortable and everything.

All of a sudden the sun came out so I ran down below, grabbed my sextant, got up there and took a sight. I was working out the sun site down below and all of a sudden a wave a little bigger than the rest came along and broke just as it got under the boat. I mean, it flipped me over so fast that there was no... the centrifugal force was so great that it would be like the Loop-O-Plane [carnival ride]. You're standing on the bottom of the boat looking down at the water but you are not falling down yet, you know what I mean? In other words, the boat isn't using its outrigger at all.

The proa* is the way to go. Absolutely, it is the way to go. I've got this neat boat all dreamed up already. I'll show you when I get home. It's self-rescuing, self-righting, won't sink, and you can get out of it. It's got all the answers to everything in this multihull thing.

Anyway, the trimaran–no one has figured out the answer until now. No one has said why they tip over; I absolutely know why they tip over. I can make a little model and a diagram and show you instantly why they're absolutely treacherous if you leave them beam-to-sea. Absolutely treacherous.

Now, the next thing is, what you do right now, is lookup in the catalog for *Adagio*** and you order one of the hand-held VHF radios. You do it today, don't wait until tomorrow. You do it today. You don't buy any flares. You take all the flares you own and throw them in the Saginaw River. Take all the smoke signals and throw them in the Saginaw River. Take all that space [the flares used] and put radios there. Radios are the only thing that work.

Get this little hand-held VHF radio and build a little plywood box that it goes in. The top of the box is glued right in there with 1/16" birch plywood and it is tied in the boat somewhere so it stays dry. All that happens now—if you ever flip over or anything—just take your jackknife and cut the top off, take out this little VHF radio and you can talk to the ships. I actually shot a flare so close I thought I was going to burn the ship up. It didn't see me. The only flare to get are the parachute flares. If you're going to have flares, have parachute flares.

Adagio sailing in the Gougeon Brother's Multihull regatta in 2019.

**Proa—a boat with a single outrigger/ama.*

*** Adagio—Meade's 35' trimaran, designed and built by Meade and Jan Gougeon in 1969. It is still competitively racing on the Great Lakes.*

Meade: So, how did you finally get hold of this guy?

Jan: OK, Gram [the Gougeons' maternal grandmother, Olive Delong] is up there. You got to believe that she's there. It's the only way. This ship was further away than the rest and the ships sailing along. By this time, I decided that the only way anyone is ever going to see me is I'm going to build big piles of stuff on my boat. So I started dismantling the boat and putting it all on the bottom. There is stuff stuck all over: foul weather gear flying off, little shrouds. I'm working so hard building all this stuff on the bottom of the boat that I don't–

Meade: OK, is it rough now or what?

Jan: Oh, it was blowing 24 knots. The seas are crashing right over the boat. You can't even imagine what it's like to build this stuff.

Joel Gougeon: How did you hang onto it?

Jan: It was just, you know, bare guts and, you know. When it's your life, it gives you a great amount of strength.

Meade: Have you got lines strung around the boat?

Jan: No, you can't do any of that. You're just lucky to even hang onto the boat.

So anyway, it took me one day. When the boat tipped over the mast imploded and then came up to leeward and busted one of the trampoline boards, so I used that as a spar. It took me the better part of a day to erect that with three ropes. You can imagine what it was like. I finally got that thing up. I also took the speedo[meter] tube out and I put my man-overboard pole in the speedo tube, see, with a flag flying.

I saved three lights and I immediately took them in the cabin and took them all apart. I silicone-greased everything. I saved my silicone grease. Of all the lights, I had actually three good working lights.

Joel: Did you have to dive underwater to get in your cabin?

Jan: No. I was inside when I tipped over, see, so I had to cut my way out. I didn't want to dive out because there was so much stuff crashing around underneath the boat I was afraid that something would stab me or something underneath there. So I cut a hole in the back bunk that I could [use to] get out onto the boat.

Joel: So you had a handy saw or something there, hey?

Jan: I had my toolbox in there. Rip open the toolbox and there's anything you need. So I took a chisel and a winch handle on the bottom of the boat through the ¾" plywood and I cut a nice hole that I could get in and out of. Once I had that, I no longer had to actually get in the water for anything anymore as far as the lookout thing. The only time I ever got in the water was to rig stuff.

Meade: OK, are you in the Gulf Stream now, is it warm?

Jan: No, actually I'm not in the Gulf Stream but it's still warm. I think I was in the Gulf Stream, on the fringes of it, when I tipped over. But the wind blew me out of it and then miraculously enough the wind blew me back. When they picked me up four days later I was almost in the same position as when I tipped over.

The interesting thing is that I'm tipped over, right? And they pick me up and as I get up on the bridge, there's these two little spars moving along up ahead of us. He's five miles away and its *AZULAO**–Nick Clifton and *AZULAO*.

I talked to him on the telephone and stuff. He had spent a couple of days with me in Bermuda working on my self-steering and helping me to do stuff and figure out how to make it steer better and all this neat stuff. He was very understanding. He had great amounts of grief that I had lost my boat and everything.

Meade: In other words, you talked with him on the telephone?

**AZULAO—In 1977, Nick Clifton capsized his trimaran AZULAO and drifted in the Atlantic Ocean in a life raft for three days before being picked up by a freighter. His boat eventually washed ashore in England. It's unclear whether Jan is referencing the AZULAO that had previously capsized, or Clifton's later Dick Newick-designed AZULAO II*

Flicka was built in the Gougeon Brothers boatshop on the Saginaw River in Bay City, Michigan.

Jan: Yeah, I talked with him on the radio.

Meade: When you were upside down?

Jan: I was on the ship.

Meade: Oh, you were on the ship. OK. Oh, I see. All right.

Jan: It was right after I got rescued. I mean, I'm still watching my boat disappear, dying slowly in the wake.

Joel: Did it sink or is it still out there floating?

Jan: Oh, it's still floating around. The cabin–the problem is the rear window, plastic window, was leaking pretty bad. I had boards jammed up against it to slow it down, so probably by now that back compartment is flooded and it's gone down. I had to bail it out like once in the morning and once at night, that one compartment.

Meade: What compartment is this now?

Jan: Well, where the window is in the back bunk, I had a hanging locker there. That [provided] great amounts of buoyancy to keep the stern up. But it would leak, oh, maybe 15 gallons of water a night.

Meade: Did you… Actually were you able to sleep very well during the four days?

Jan: Well, I was comfortable but I didn't spend much time sleeping because I'd go to sleep for a few minutes and then I'd get up and watch—the only chance to see something. If you went to sleep for 15 minutes a freighter would come steaming right by. I'll tell you the real scary thing is how many freighters there are. Unbelievable amounts of ships cruising around out there. I mean, the chances of getting run down while you're single-handing…

Joel: How many flares did you fire? You fired every flare you had?

Jan: Yeah, I used them all up on the ships that came first and they were all gone. [I] threw the flare gun away. I had two fire extinguishers. The first one, I used that up and then I dove underneath and got the next fire extinguisher. When the ship came I was getting ready to get my propane tank. I was going to rig up, you know, a fire thing with the propane tank because I had lots of propane. Figuring I could get some of the... I had some sea boots laying around and stuff. I could hang something and get a black, smoky thing burning to attract attention.

Mike Zuteck: Well, what do you reckon it is, [the freighters] don't have guys on watch? You mean they're just not watching?

Jan: Yeah, they're not watching. This one ship, the first officer was actually up and he saw me. He was further away than most of the other ships and he saw me.

Meade: So this was a big tanker that picked you up?

Jan: Pretty good size, an old one but a big one. I ate more in two days there… It's like Grandma DeLong feeding you. They're not happy unless you eat five times as much as you possibly can shovel down. You're so full you're begging to get out of there and they bring you another course. They bring you steak, fish and potatoes, and more fish, and ice cream.

Meade: You must have been pretty whipped though by the time they picked you up.

Jan: Actually, I was doing pretty good. I was pacing myself. I was concentrating on all the survival stuff and everything. I mean, I had the boat. Once I'd gotten the hole in the boat I was in danger if the wind shifted. The rig was acting as a sea anchor, keeping one side of the boat beam-to the seas. If the boat were all of a sudden to drift around somehow, water would be coming in the hole that I cut to get out. So I built a shutter for it that I could open up during the day to ventilate the cabin. The first day of course I got everything soaking wet back there getting in and out of there and stuff.

Meade: In other words, your mast was kind of dragging on the shrouds out there?

Jan: Yeah, right. I cut the one shroud loose so that the thing would get far enough away from the boat not to bang and crash.

Meade: Yeah, right.

Jan: After the first couple of days, the mainsail was gone, but the headsail was still streaming out there with the backstay to hold [the mast] at the right angle to where the boat drifted, about perfectly. I saved all my money, and passport, and travel checks, and everything. I've got everything, all my papers, my wallet, keys, all that stuff. I've still got them, miraculously enough.

I decided my next boat not only has to be self-rescuing and self-righting and go fast, but it has to be trailed behind my Honda. So the displacement of the boat with no food or crew has got to be about 600 pounds. Wait until you see this thing I dreamed up.

Joel: When did you get off the ship? Just a few minutes ago?

Jan: Oh, it was about twelve o'clock today. But I was going through Customs and Immigration and they might–they still have the Search and Rescue [alert] from New York. It's got some urgent message for me but I haven't been able to actually get the message yet. So there is the slight possibility that I might get my boat back but it's about a thousand to one odds.

Joel: They didn't have a boom or anything so they could haul aboard any of your other stuff? Sextants and all that?

Jan: No, they couldn't. They had to come and get me in a lifeboat. It was too rough, you know.

Joel: So you lost everything besides your wallet?

Jan: I saved my sextant and I saved [now retired GBI tech advisor] Jim Derck's compass and his foul weather gear.

Right. The most tragic and the most heartbreaking thing though is to stand on the bridge of a freighter and watch your beloved piece of work drift away behind you and know that pretty soon it's going to be sunk and gone and all that.

Editor's Note

In part II, Jan goes on to discuss the failure of his EPIRB unit, what he learned from surviving FLICKA's capsize, and his conviction that all multihulls should be self-rescuing.

105 or G/flex?

Take the quiz

By Don Gutzmer - GBI Technical Advisor

"Should I use the 105 System or G/flex® Epoxy for my project?" This is a great question. Here's what a Technical Advisor thinks about when recommending one type of WEST SYSTEM® Epoxy over another. Let's start by comparing the handling characteristics and mechanical properties of both the 105 System and G/flex. This will show you the advantages of each and when one system is better suited over another for your project.

105 System

WEST SYSTEM 105 Resin mixed with any 200 Series Hardener has a viscosity similar to 50-weight motor oil or warm corn syrup. It is pourable and great for coating or bonding applications. The 105 System is versatile because you can select one of four hardeners for the working time you need. If clear coating, choose 105 Resin and 207 Special Clear Hardener. The epoxy can be modified with any of the six WEST SYSTEM Fillers to create a thickened adhesive or fairing compound. For information on fillers, see my article "The Basics of WEST SYSTEM Epoxy" in *Epoxyworks 49*.

Additives can also be used to modify the mixed epoxy, such as 420 Aluminum Powder, 422 Barrier Coat Additive and 423 Graphite Powder. You can tint epoxy with a variety of pigments or dyes up to 2% by weight while still maintaining similar structural properties.

The low-viscosity of the 105 System is advantageous for easily wetting out fiber reinforcements such as fiberglass and carbon fiber. Because of the lower viscosity, it releases air more effectively to ease self-leveling.

Consider what mechanical properties you need from an epoxy system when deciding on which formulation is best. On the next page is a comparison chart of the physical properties of various WEST SYSTEM Epoxy formulations.

You will notice that when cured at 72°F (22°C) for two weeks, the 105 Resin System has a compression strength of around 11,000 pounds per square inch, or psi, and tensile strength around 7,000 psi. The ultimate tensile elongation averages 4% for 105 Resin and 200 Series Hardeners.

Using the epoxy for fastener bonding takes full advantage of its mechanical properties. Hardware on the deck of a boat can be under high load. The high tensile strength the 105 System provides is needed to prevent failure of the fasteners. For most general applications, the epoxy is stronger than what is ultimately needed for bonding and coating.

PHYSICAL PROPERTIES	105/205	105/ 206	105/207	105/209	650	655
Mix Viscosity @ 72°F (cPs)	975	725	760	650	15,000	Gel
Pot Life of 100 g @ 72°F (min.)	12	21.5	22	62	45	45
Specific Gravity of Cured Resin	1.18	1.18	1.15	1.16	1.11	1.11
Hardness @ 2 weeks (Shore D)	83	83	84.4	82	75	75
Compression Yield @ 2 weeks (PSI)	11,418	11,500	11,043	11,960	5,268	5,268
Tensile Strength (PSI)	7,846	7,320	6,748	7,280	3,440	3,440
Tensile Elongation (%)	3.4	4.5	3.8	3.6	32.7	32.7
Tensile Modulus (PSI)	4.08E+05	4.60E+05	4.40E+05	3.98E+05	1.44E+05	1.44E+05
Flexural Strength (PSI)	14,112	11,810	11,324	12,459	5,192	5,192
Flexural Modulus (PSI)	4.61E+05	4.50E+05	4.12E+05	3.97E+05	1.56E+05	1.56E+05
Heat Deflection Temperature (°F)	118	123	117	117	127	127
Onset of Tg by DSC (°F)	129	126	116	122	138	138
Ultimate Tg by DSC (°F)	142	139	116	130	154	154

Another thing to consider when determining if the 105 System or G/flex is a better option is the substrate you'll use. The 105 System will bond well to most substrates like wood, fiberglass, concrete, and ceramic. G/flex bonds better to certain high-density woods, plastics or metals.

Now let's talk about what G/flex Epoxy has to offer.

G/flex Epoxy

There are two versions of G/flex: 650 and 655. The liquid version, G/flex 650, has a viscosity similar to honey and the thickened version, G/flex 655, is similar to gelled toothpaste. Both versions of G/flex can also be modified with any of the six WEST SYSTEM Fillers and any 400-series additives mentioned earlier. Using a high-viscosity system for bonding offers the advantage of bridging gaps. The base resin of G/flex is much higher in viscosity than the 105 System.

We prefer G/flex for bonding together dissimilar substrates such as metals and exotic woods. G/flex epoxy's advantage is that it can bond to many substrates, even those that are considered difficult: white oak, Ipe, damp woods, aluminum, copper, stainless steel, PVC, high-density polyethylene, polycarbonate, and many others.

The toughness of an epoxy formulation is measured by tensile elongation and strength. G/flex was formulated to have a high ultimate tensile elongation of around 30%. If you are bonding to stainless steel that has been sanded with 80-grit, the average tensile adhesion for the 105 System is 1,000 psi and for G/flex it is 2,400 psi. G/flex has a tensile strength averaging 3,400 psi and a compression strength of around 5,200 psi.

Do you think like a Technical Advisor?

Put your knowledge of the 105 System and G/flex to the test. Select between 105 System or G/flex epoxy for the most suitable epoxy for these real customer applications.

1. I need to bond an aluminum jib car track onto my fiberglass sailboat. Which epoxy is recommended?

105 SYSTEM or G/flex

2. I have a small damaged area on my carbon fiber mast that I'm going to repair with carbon fiber cloth. Which epoxy is recommended?

105 SYSTEM or G/flex

3. Which epoxy is recommended for applying fiberglass cloth to a cedar strip canoe?

105 SYSTEM or G/flex

4. My high-density polyethylene canoe has a crack on the hull side. Which epoxy do you recommended to repair it?

105 SYSTEM or G/flex

5. I need to fill a river table with epoxy. Which epoxy is best?

105 SYSTEM or G/flex

6. I want to coat the edge of a wooden paddle to minimize impact damage. Which epoxy should be used?

105 SYSTEM or G/flex

7. What epoxy formulation is best for embedding boat cleat fasteners into my deck?

105 SYSTEM or G/flex

8. I need to repair the crack on my sailboat's keel-to-hull joint. Which epoxy is recommended?

105 SYSTEM or G/flex

9. I need to bond the plywood transom onto my Hypalon dingy. Which epoxy is best?

105 SYSTEM or G/flex

10. What epoxy is recommended to coat a fiberglass boat, creating a barrier coat?

105 SYSTEM or G/flex

Did you answer them all?

No peeking!

Answers

1. *I need to bond an aluminum jib car track onto my fiberglass sailboat. Which epoxy is recommended?*

   G/flex is recommended for bonding dissimilar materials like aluminum and fiberglass because it is a toughened system. The 30% elongation allows the flexibility needed for bonding materials that may move at different expansion rates.

2. *I have a small damaged area on my carbon fiber mast that I'm going to repair with carbon fiber cloth. Which epoxy is recommended?*

   The 105 System is a better option for repairing carbon fiber because it provides higher mechanical properties. The carbon spreader can be subject to high loads, and the 105 System's average tensile strength of 7,300 PSI and average compression strength of 11,500 PSI provide the mechanical properties needed for a lasting repair. It will also easily wet out and saturate the carbon fiber cloth.

3. *Which epoxy is recommended for applying fiberglass cloth to a cedar strip canoe?*

   The best option for fiberglassing a cedar strip canoe is 105 Resin and 207 Special Clear Hardener. The 105/207 will easily wet out lightweight fiberglass and provide a clear epoxy coating. G/flex will give the canoe a cloudy, caramel hue and its high viscosity makes it difficult to quickly wet out fiberglass without entrapped air bubbles.

4. *My high-density polyethylene canoe has a crack on the hull side. Which epoxy do you recommended to repair it?*

   For repairing a cracked HDPE canoe, G/flex is the best option. Proper surface preparation is crucial to ensuring a successful HDPE plastic repair. For bonding to high-density polyethylene, we recommend an alcohol wipe and then flame treatment with a propane torch. Move the flame at a rate of 12 to 16 inches-per-second over the repair area, similar to the speed you would use for spray painting. Flame-treating oxidizes the surface, improving the epoxy's adhesion. A heat gun will not improve adhesion to HDPE; a propane torch is needed.

5. *I need to fill a river table with epoxy. Which epoxy is best?*

   A low-viscosity, clear epoxy is needed for castings in river tables. 105 Resin/207 Special Clear Hardener is the best WEST SYSTEM option. The epoxy can be tinted to the desired color, and its low viscosity makes air bubbles easier to remove. For most casting applications we recommend ¼" maximum thickness per pour.

6. *I want to coat the edge of a wooden paddle to minimize impact damage. Which epoxy should be used?*

   For the end of a wooden paddle, G/flex 650 should be used to take advantage of its toughness for greater impact resistance. It quickly builds up to a thick coating that helps absorb shock from impacts during use. As a thin coating, the epoxy deflects without cracking, maintaining adhesion to the wood beneath, when the wood gets dented.

7. *What epoxy formulation is best for embedding boat cleat fasteners into my deck?*

   The 105 System will provide better holding capacities for fastener bonding and can be thickened with a high-density filler for bridging gaps. G/flex can also be used in hardware bonding but the 105 System is stronger.

8. *I need to repair the crack on my sailboat's keel-to-hull joint. Which epoxy is recommended?*

   G/flex 655 is recommended for repairing a cracked keel-to-hull joint. To prevent G/flex from running or sagging on a vertical surface, add 406 Colloidal Silica filler to achieve the desired consistency. G/flex's high tensile elongation, allows it to endure more movement or flexing before failure offering better adhesion to dissimilar substrates.

9. *I need to bond the plywood transom onto my Hypalon dingy. Which epoxy is best?*

   G/flex bonds well to Hypalon that has been sanded with 80-grit. Any time you need to bond dissimilar materials, consider G/flex as an option.

10. *What epoxy is recommended to coat a fiberglass boat, creating a barrier coat?*

    The 105 Resin is an excellent barrier coat for fiberglass hulls. You can add the 422 Barrier Coat Additive to create an even more effective moisture barrier. This system's low viscosity also makes it easier to roll onto large surfaces.

Now, a long answer to the short question, "Should I use the 105 System or G/flex?" The answer depends on multiple factors. What are you bonding to? Do you need a low-viscosity epoxy? Should the epoxy have high mechanical properties like tensile strength and compression strength? Does the epoxy need to be able to move or flex? Does the color of the epoxy matter? What will the cure temperature be? As a Technical Advisor, I quickly think through all these things when helping our customers make decisions on which epoxy formulation to select for their project.

For some applications, either epoxy system will work. However, if you get into a project and are not sure which WEST SYSTEM Epoxy product is your best choice, call our toll-free Technical Service line: 866-937-8797. Our goal is for every customer to have successful experiences using WEST SYSTEM products.

How did you do?

10 CORRECT — You're well on your way to being a superb WEST SYSTEM Technical Advisor.

6-9 CORRECT — You've definitely been around the block a time or two, but practice makes perfect.

0-5 CORRECT — You're a novice to WEST SYSTEM, but don't worry, the pros are only a phone call away.

Avoiding Respiratory Irritation

By Glenn House - GBI Health and Safety

When our team of experts select the raw ingredients for WEST SYSTEM® Epoxy products, we strive to achieve excellent physical properties with the lowest possible risk to human and environmental health. There is a safe exposure level for most substances. The more toxic the substance, the lower that level will be. Overexposure occurs when the safe exposure level is exceeded. When this happens, the substance can impact your health.

Hazardous substances can enter the body through skin absorption, ingestion, or inhalation. The route for a particular substance depends on its physical characteristics and how it is being used. This article will focus on a less common route of overexposure, inhalation. We'll discuss how to prevent inhaling epoxy vapors and reduce your risk of respiratory issues when working with epoxy products.

Organic vapor respirators should be worn when working in a small, unventilated workspaces.

Low VOCs

Our epoxies have very low VOCs (volatile organic compounds), and any evaporation takes place quite slowly. However, if epoxies are heated or if workspace ventilation is inadequate, the risk of overexposure by inhalation increases.

Breathing highly concentrated epoxy vapor in a small, unventilated workspace such as a boat interior or small workshop, can irritate the respiratory system and cause sensitization. This is a type of allergic reaction resulting from the immune system overreacting to a substance. If you've already been sensitized to epoxy, exposure to low concentrations of epoxy vapors can trigger this type of reaction very easily.

Even with low VOCs, epoxy vapors can build up in confined spaces. Providing ample ventilation when working with epoxy in confined spaces is important in preventing overexposure. Effective ventilation can range from basic floor or window fans to expensive, high-tech air-filtration and

exhaust systems. If you can't adequately ventilate your workspace, be sure to wear appropriate respiratory protection. We recommend an air-purifying respirator with an organic vapor or multi-contaminate cartridge.

Pots of curing epoxy can get hot enough to ignite surrounding combustible materials and give off hazardous fumes. Because of the complex variety of fumes given off by exotherming epoxy, standard respirators are ineffective. Therefore it's important to place pots of mixed, exotherming epoxy in a safe and ventilated area, away from people and combustible materials. Dispose of the solid mass only after it has completely cured and cooled.

An N95 dust/mist mask is effective for preventing the inhalation of sanding dust.

Partially Cured Epoxy Dust

Sanding partially cured epoxy produces airborne dust, which increases your risk of exposure by skin contact, inhalation or ingestion. Although epoxy is often firm enough to withstand sanding within eight hours after application, depending on the ambient temperature it may not cure completely for up to two weeks. We never recommend sanding until the epoxy has at least cured overnight, and longer if the cure is taking place in a cooler environment. The dust of epoxy that hasn't completely cured contains unreacted hazardous components. Never overlook or underestimate this hazard.

Do not breathe the sanding dust of partially cured epoxy because the chemicals in epoxy remain reactive until they have fully cured. Serious health problems can result from sanding partially cured or "green" epoxy. If inhaled, these dust particles get trapped in the mucous lining of your respiratory system where the reactive chemicals can cause severe respiratory irritation and/or respiratory allergies. To avoid this, provide good ventilation and wear a dust/mist mask or respirator when sanding any epoxy, especially partially cured epoxy.

The approved respiratory protection against epoxy dust, wood dust, and nuisance dust is a dust/mist mask or respirator with an N95 rating or better.

The Scoop on Epoxy Fillers

WEST SYSTEM fillers present few concerns in the way of acute hazards. However, as is the case with just about any nuisance or respirable dusts, long term or repeated exposures can result in chronic respiratory problems or worsening of existing lung conditions. Smokers, and others whose lungs are under strain, are far more likely to develop serious respiratory problems if fillers are inhaled. A particulate dust mask can help prevent inhalation of airborne fillers.

Don't Spray Epoxy

Although it is possible to spray WEST SYSTEM Epoxy, we strongly recommend against it. Leaving aside the practical difficulties such as equipment expenses, the associated health and safety issues are enormous.

To effectively spray epoxy and obtain a desirable finish, it must be atomized. As epoxy leaves the spray gun nozzle, it is reduced to tiny droplets (spray mist). Most of the spray mist that doesn't land on the surface remains airborne before settling to the ground. While the mist is suspended in the air there is a tremendous risk of inhalation. This can cause respiratory tract irritation, burns, sensitization, chemical pneumonia, and other serious health complications. Spray mist settling on unprotected skin or eyes can result in eye injury, skin sensitization, and allergic reactions. Spraying also increases the amount of hazardous volatile components released from the epoxy compared to other application methods.

In addition, using solvents to thin the epoxy so it can be sprayed poses dangers to health and safety. Solvent-related hazards would be similar to those of any spray painting operation and involve serious health and explosion risks.

Conclusion

Inhalation is one of the less common routes of epoxy overexposure, but should still be taken into serious consideration when setting up your work area and selecting personal protective gear. Visit the Safety pages at westsystem.com or call our Technical Staff at 866-937-8797 for answers to any concerns you have about using epoxy safely and appropriately.

Laminate Repair: Infusion vs. Wet-Bag

By Rachael Geerts - GBI Technical Advisor

Many products, especially boats, are now being manufactured with a process called Vacuum Assisted Resin Transfer Molding (VARTM), also frequently referred to as infusion. The main topics of this article are: what infusion is, how to repair an infused part with vacuum bagging vs. infusion, and the results of our study comparing a vacuum-bagged repaired laminate and an infused repaired laminate.

What is Infusion?

Infusion uses a vacuum to create a pressure differential between the part and a resin bath which pushes the resin into the dry laminate, wetting it out. To make an infused part the reinforcement fabric and coring are laid dry into a mold with vacuum bag, release fabric, flow media, etc. laid on top of the laminate. Then the vacuum bag is sealed and vacuum is pulled on the part. The vacuum removes the air from inside the bag so the pressure of the atmosphere acts as a clamp on the part and creates a pressure differential that allows the epoxy to be pushed into the part. The assembly is checked for leaks before the feed line(s) can be opened to infuse the part.

A low-viscosity epoxy is needed to effectively wet out the fibers during the infusion process. In general, a system with a mixed viscosity of 300-400 cps or lower should be used. WEST SYSTEM® 105 Resin mixed with any of the 200 series hardeners has a viscosity of about 650-975 cps at room temperature. Therefore, we do not recommend 105 Resin for infusion. In addition to requiring low-viscosity systems, the infusion process limits what fabric (weave types and weight) and what types of core material can be used so that the resin can flow through and wet them out. While this process works well for manufacturing composite parts, do these parts need to be repaired using the same method? No.

The rest of this article assumes that you are already familiar with the vacuum bagging process. For more information on, or to learn about, the vacuum bagging process please read my article "Vacuum Bagging Basics" in *Epoxyworks 49*.

Repair Concerns

Strength

Strength is determined by the materials and workmanship of the repair. Reinforcement fibers take most of the loads in a laminate, so using the same type of reinforcement will help make the repair successful. A fiberglass laminate should be repaired with fiberglass, and a carbon laminate should be repaired with carbon. Additionally, matching the fiber-to-resin ratio (commonly referred to as the fiber weight percent) of the original laminate will help maintain the strength of the repair. Using a different reinforcement material or more layers than needed in the repair area can create a hard spot and can cause cracking or other issues around the edges of the repair. Typical fiber weight percents are 35-50% (hand-laminated), 60-78% (vacuum bagged), 70-78% (infused) by weight. The higher percentage of fiber will result in higher stiffness and strength for the same overall thickness.

Stiffness

Stiffness is driven significantly by thickness. When asked what weight fabric to use on a repair we recommend focusing on maintaining the original thickness rather than trying to match a specific weight of reinforcement fabric. For instance, a ¼" thick fiberglass laminate may need to be repaired. One could use a few layers of a heavyweight fabric like WEST SYSTEM 737 (17 oz. non-woven biaxial E-glass fabric) or multiple layers of a lighter weight fabric like WEST SYSTEM 742 (6 oz. woven E-glass fabric). Both are fiberglass so the strength will be nearly the same but the time spent doing the repair will vary. Areas that have more contours or where the laminate is thin are best repaired with lightweight fabrics. Meanwhile, laminates that are thick or are relatively flat, like our ¼" fiberglass laminate example, might be better repaired with heavyweight fabrics to quickly build up the total thickness.

Matching the original thickness of the laminate will ensure that the repair laminate has similar stiffness as the original laminate surrounding the repair. This will prevent cracking around the repair

Product	Fabric Weight	Hand Lay-up Single Layer Thickness*
740 Glass Fabric	4 oz.	.008"
742 Glass Fabric	6 oz.	.010"
702, 703 Unidirectional Carbon Tape	11 oz.	.015"
729, 731, 732, 733 Glass Tape	9 oz.	.017"
745 Glass Fabric	10 oz.	.016"
727, 737 Biaxial Fabric	17 oz.	.035"
738 Biaxial Fabric with Mat	23.9 oz.	.042"

**Average of multiple layers applied by hand lay-up*

area due to differences in stiffness that can cause a stress concentration or "hard spot."

To determine the number of fabric layers required to achieve a specific laminate thickness, divide the thickness desired by the single-layer thickness of the tape or fabric you intend to use. The table above gives the average thickness of a hand laid laminate, so you should take into consideration the fact that vacuum bagging the laminate will consolidate it about 5%-10%.

The fiber weight percent, the ratio of fibers to epoxy by weight, affects the thickness. When vacuum bagging or infusion processes are used to increase fiber weight percentage, the amount of resin is reduced. This results in a thinner laminate and needs to be accounted for when determining the number of plies.

Weight

Although the weight of the repair may not be a concern, it is important to remember that the properties of a laminate are affected by the fiber weight percent. The fiber weight percent is the ratio of fibers to epoxy by weight. As described above, the fiber weight percent can vary depending on the application method. The overall weight of the repair is influenced by the materials selected for the repair, and just like the strength of the repair, it is also influenced by the workmanship. We can control our fiber weight percentage which improves the properties of the repair laminate.

The Repair

Surface Preparation

The damaged laminate should be removed and then beveled out to increase the surface area for bonding the new repair. The surface should be beveled at a minimum of a 12:1 ratio. When repairing a cored laminate, the core thickness should not be included in the bevel ratio, only the skin thickness of the repair area. Read section 4.1 of our *Fiberglass Boat Repair and Maintenance Manual* for more about beveling the surface. The bonding surface should be sanded with 80-grit and cleaned of all contaminants and loose debris. After this step, the processes differ between infusion and vacuum bagging.

Vacuum Bagging

For a vacuum-bagged repair, the layers of the laminate should be wet out and laid down one at a time to build the laminate. Then the vacuum bag consumables (peel ply, breather, vacuum bag, etc.) are applied and the vacuum is pulled down.

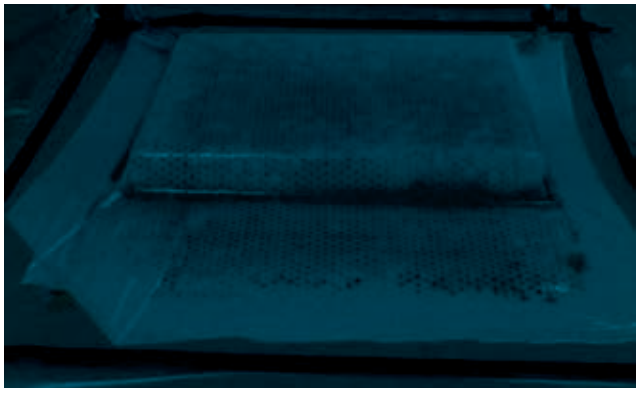
There are several disadvantages and advantages to the vacuum bagging process. The application of epoxy can cause more of a mess than infusion. This process also results in varying fiber weight percent and is more susceptible to a higher void content. However, the fiber weight percent can be better controlled by measuring and mixing only enough epoxy to wet out the fabric. For hand-laminated parts, this is typically about 50% by weight of the total laminate. Once the vacuum is pulled down on the part, the laminate will be compressed, squeezing out the excess epoxy which is absorbed by the breather fabric increasing the fiber weight percentage. The vacuum bagging process is also more user-friendly for the do-it-yourselfers because it requires less vacuum pressure and gives a wider range of materials that can be used in the repair laminate compared to infusion.

Infusion

Infusion also has its own disadvantages and advantages. The infusion process requires a higher vacuum pressure and can end up using the same amount or even more epoxy than a vacuum-bagged repair. Extra resin is needed to fill the feed line(s) and have enough left in the bucket so that no air is pushed into the part, which can create voids in the laminate. More vacuum pressure is needed to create the pressure differential that drives the resin into the laminate and to keep the part consolidated. This also means that the repair area needs to be sealed really well. Any air leaks could cause dry spots (areas not wet out well with epoxy), affect the consolidation of the laminate and cause

other issues. Sealing a cored laminate can be a challenge. If the core is open-cell, the repair area would need to be sealed off with resin to even have a chance at pulling good vacuum pressure.

Solid laminates might not be quite as challenging to make vacuum-tight but still could be difficult depending on the backing material. Backing materials only need to be used if the repair is on a hole in the laminate. Manufacturers have the benefit of being able to do the repairs in the mold, so the backing of the repair is the mold surface. For the average do-it-yourselfer, making a mold to put the part in to do the repair is not a realistic option. You may be able to shape a piece of foam or wood and seal it with a coat or two of epoxy to use as a backing for the repair. Just remember that it needs to fit well and be sealed around the edges to create a vacuum-tight surface for the repair. There are also fewer materials to choose from and the process can be more complex with different infusion manifolds. The benefits of infusion include fewer voids, cleaner processing, and no wet laminating work.



The vacuum bagged laminate

The infused laminate

Our Test

We wanted to perform a comparative study on repairing a laminate that was originally manufactured using the infusion process, with an infused repair and a vacuum-bagged repair. As we discussed earlier, surface preparation is critical to any repair and that process is the same for both methods, so our goal is to compare the properties of the laminates. The easiest way to do this was to fabricate two test panels, one infused and one vacuum bagged. For this comparison, we made cored laminates that consisted of six layers of 10 oz. glass fabric on either side of a Baltek TM 1.5" AL600 (AL600 is a factory-applied coating to reduce resin absorption) balsa core.

In our test, we used the same glass fabric and epoxy in each panel to provide the needed strength aspect of a good repair. By building up the same number of layers of fiberglass in each panel, we were able to determine if the thickness of each laminate would be the same which is required to achieve the same stiffness. For the vacuum bagged panel, we calculated the amount of resin needed to attain a 45% fiber weight percent to thoroughly wet out all the glass fabric and core. We then used the vacuum to compress the laminate to result in a fiber weight percent that was the same as the infused panels. With the infused laminate, greater emphasis was placed on vacuum-tight sealing and infusion manifold positioning. Because of its higher viscosity, we weren't able to use the 105 System for the infused repair. We used our PRO-SET® INF 114/INF 226 Infusion Epoxy instead. Both methods successfully created similar cored laminates.

Considering the properties discussed in this article are what makes a successful repair laminate and allowed us to make a vacuum-bagged laminate that would have the same properties of the infused laminate. The laminates were solid and structural, and we were able to match the properties between the two repair methods. Fiber weight percent and thickness are given in the table below, and since they are equal the strength was matched by using the same fiberglass and the same core material, although the infused panel did use more resin in filling the core.

In conclusion, a vacuum-bagged repair on a laminate is just as effective as an infused repair. The WEST SYSTEM 105 Resin/200 series Hardener in a vacuum-bagged repair should have similar or better properties than most infusion resins. If you have questions about repairing a laminate, contact us by email at support@westsystem.com or call us at (866) 937-8797.

	Vacuum-Bagged Repair	Infused Repair
Fiber % by Weight	74%	74%
Thickness	0.158 inches	0.158 inches
Epoxy in Core (unsealed)	0.031 fl. oz./in^2	0.075 fl. oz./in^2
Vacuum Pressure	20 in of Hg	29 in of Hg

Sea Hood Repair

By Terry Monville - GBI Technical Advisor

This Little Piggy racing on Tawas Bay, Michigan.

After a few years of racing on the J22 *This Little Piggy*, the owner was ready to take a step back and gave me the first option to purchase it. I took advantage of the opportunity. As with many boats I've owned over the years, the first couple winters I plan on spending money upgrading and doing repairs. Not that a lot has to be done, but a few changes in hardware placement and re-bedding the deck hardware are at the top of my list.

The sea hood of the J22 is the control center with mainsail, jib, and spinnaker halyard cleats along with the pole topping lift and cunningham. In the early days of J22 sailing, everyone was sorting out the best placement for hardware on the sea hood. By the look of the number of holes punched in the hood and refilled, every idea was tried. Today there is one ideal hardware layout and I'm about 95% there. I just needed to re-bed and add two upright blocks for the jib and spinnaker halyards.

Looking at the hood from the top it was obvious that two holes had been filled with an adhesive caulk, which had failed, and water was getting in. Most of the other holes were filled with a popular epoxy putty and appeared to be in good shape. Removing the sea hood, I was surprised to find many of the epoxy putty-filled holes had leaked, which was signified by the dark core around them. It was time to get to work. Fortunately, I could

The top of the epoxy putty repair.

You can see, with the skin removed on the underside of the hatch, the darker, more rotted wood around the column of epoxy putty.

A moisture meter measures the conductivity within a laminate and therefore can be helpful in determining where there is saturated core.

do the repair from the backside since it was not gel-coated. I removed all the hardware and planned out where I would need to remove the core based on its color and readings from a moisture meter. I cut the fiberglass skin back a bit from where I planned to remove the bad core. Using an oscillating saw with a fine-tooth blade, I cut through the fiberglass with good speed and control. After making my cuts all the way around the area, I used a wood chisel to pry up an edge of the fiberglass and peel it off.

The next step was to remove the core. Using the oscillating saw, I cut an outline of where I planned to remove the core. I then scraped and pried out the old core with a wood chisel. Removing it in nice straight lines with square corners made cutting the replacement material that much easier.

After removing the bad core, I let the surrounding core dry and then sanded the fiberglass smooth from where the core was removed. To prepare for the new fiberglass skin, I used the oscillating saw with a sanding pad adapter

Rotten and saturated core was cut away so replacement core could be installed. The area was then sanded with an oscillating saw.

to sand a 12:1 taper, with a generous radius on the fiberglass around the cutout area.

Next, I cut and fit the new balsa core into the areas where the bad core was removed. I used three layers of 10 oz. fiberglass to create the same laminate thickness as had been removed. I cut the first layer to cover the area out to the end of my taper, with the next layer cut slightly smaller and the third slightly smaller than the second. I used release fabric over the repair area to smooth the edges and prepare the surface for the finishing steps. This was cut just bigger than the overall repair.

Multiple areas had damaged core and needed replacement.

Now everything was ready to be put together. I used unthickened WEST SYSTEM® Epoxy to wet the balsa core on the sea hood, and the edges and side of the new piece of balsa. On the sea hood fiberglass surface, I used epoxy thickened with 406 Colloidal Silica Filler to the consistency of mayonnaise. This mixture fills imperfections and makes a nice bedding material.

With the fresh core material in place, I filled any gaps between the old and new core with the thickened epoxy and let it cure. The new balsa was thicker than the old, so after the epoxy cured I sanded it down to the same thickness as the old core. I then laminated the three layers of fiberglass and covered it with release fabric. If the coring had been the original thickness, I could have done the bedding and glassing at the same time. After the laminate cured, I removed the release fabric and was ready to install the hardware.

In a future *Epoxyworks* issue, I'll cover hardware bonding and installation on my J22.

Morning Sun a Workstar 17

By Chris Smith

The completed Workstar 17.

Small communities benefit when local groups work together to produce results greater than the sum of their individual efforts. Three organizations combined their efforts to create such synergy in a coastal county on Lake Huron. The Iosco County Family Court, local Elks Lodge 2525 and Heritage Coast Sailing and Rowing (HCS&R) combined efforts to develop a positive training program for youthful offenders and provide a staunch safety boat for the new not-for-profit sailing school.

The Juvenile Enhanced Accountability Program (JEAP), a Family Court Program, gives youthful offenders a chance to complete their court-ordered community service, in this case, by building a boat while increasing their manual and group skills. Elks Lodge 2525 has a long and laudable community service history. They have worked with the JEAP program for several years providing funding, project identification, and adult supervision.

Heritage Coast Sailing and Rowing, a 501(c)(3) not for profit, was expanding its community boatbuilding program to include a sailing school operating on Tawas Bay and needed a safety/coaches boat. The boat needed to be safe, stable, have a two-crew capacity (crew, plus up to five rescued from the water), be easy to get in and out of, and be built by a moderately skilled crew.

A Working Boats UK Ltd. designed plywood/epoxy kit boat, the Workstar 17, met the criteria. It was being used by police departments, towboat companies, and outdoor education schools. The group purchased an instruction license. Hewes and Company of Blue Hill, Maine prepared the kit.

The Workstar 17 became the eleventh boat built by HCS&R. All eleven were built using WEST SYSTEM® Epoxy, Gougeon Brothers, Inc.'s Technical Support services, and their extensive assortment of how-to literature.

Five general activities were involved in the building process and are summarized by the photographs. The designer's instructions provided an excellent step-by-step guide.

Cutting out parts

The kit arrived as 20 sheets of plywood with the individual parts nested and tabbed in the sheets. Each piece was first labeled, then carefully cut out and set aside in sub-assembly groups.

Top: Pieces were labeled, cut out and then grouped for easier assembly.

Bottom: Parts being coated with unthickened epoxy.

Epoxy wetted T-pegs were driven into slots through the butt straps and into the parts being joined, ensuring vertical alignment as well as strength.

Longitudinal sub-assemblies

Parts assemblies that run the length of the boat were built on the shop floor because it was relatively large and flat. The boat's sides, bottom, longitudinal stringers, and rub strakes were all done in the same way. Each sub-assembly was first dry-fit, then the joint edges and butt strap areas were coated with unthickened WEST SYSTEM Epoxy. This was followed by a coat of thickened epoxy. Epoxy wetted T-pegs were driven into slots through the butt straps and into the parts being joined, ensuring vertical alignment as well as strength. Weights were used to ensure horizontal alignment.

Joining frames, longitudinal stringers, sides, and bottom

Temporary legs were attached to two frames to obtain a good working height. After dry fitting, the longitudinal stringers, the sides, and bottom were added utilizing tabs, slots, and a wedge system. Locking pegs ensured good alignment. Bottom and side seams will later be armored with 17 oz. glass tape and the entire bottom will be clad in 10 oz. glass fabric.

Fillets were applied along the joints along with 17 oz. fiberglass tape for reinforcement on major joints.

Fillets, sole, and seats

The hull was turned over and extensive epoxy fillets added to the egg-box structure. Major joint fillets were also strengthened by 17 oz. tape. The sole, seats, and control console were added again using the tabs, slots and wedge system.

Primer being sanded before final coating.

Finish

The entire boat was covered with two coats of WEST SYSTEM before the finish coats of two-part primer and paint were applied. The youth named the boat *Morning Sun* and chose its colors, the colors of a sunrise.

Building the boat was a powerful lesson for the youth involved. They followed a plan that converted a pile of plywood and strange-looking parts into a well-built, functioning boat. They witnessed and participated in countless decision-making discussions, all very calm and focused on the outcome. They learned how to work together in tight quarters. They became proficient in the use of several hand and power tools. They saw the benefits of cooperative effort and synergy.

Boat building participants.

The three groups worked together to successfully build a second boat from scratch, a 1944 Lowell Coast Guard dory. All have expressed interest in maintaining the collaboration and continuing the program and relationship for interested, youthful participants.

Rock salt used for the lost method of creating nonskid.

Creating Nonskid Surfaces

By Greg Bull - GBI Technical Advisor

Nonskid surfaces may need to be replaced because they are worn down from years of use, or were removed during a deck repair. If you want to match an existing pattern, flexible molds are available for matching a production boat non-skid pattern or for use if a molded appearance is desired. Molded non-skid surfaces are often very open making them easier to clean and they have a more finished appearance (See *Epoxyworks 22*, "Repair Non-Skid and get Professional Results"). For applications where it is not practical to use molds, or a simple and functional non-skid surface is desired, there are some easy options.

It is important to note that when applying a nonskid surface with epoxy, you'll need to make it pretty rough because epoxy requires a UV-protective topcoat (typically paint). The topcoat will fill in or smooth over some of the new nonskid texture. Here are three different methods for creating nonskid with epoxy that do not require the use of a mold.

Textured Roller Cover

A simple method for creating a nonskid surface is to use a textured roller cover designed for painting rough surfaces. Be aware that if you slide on this type of surface it can also remove your skin. Mix WEST SYSTEM® 105 Epoxy with the WEST SYSTEM 200 series hardener of your choice, then stir in a filler such as 406 Colloidal Silica. The epoxy should be thickened enough so when you roll it on it will stand up and stay there, not slump or smooth back down.

A conventional paint roller (not a foam roller) with a longer (3/8" or ½") nap will also give a good nonskid surface. You'll need to experiment with the thickness of the thickened epoxy to get it to stand up and stay standing as it's rolled onto the surface. Both types of rollers require some experimenting to determine the right epoxy thickness and surface texture. Do some test panels or test areas to get the look and texture

Textured roller *½ inch nap roller* *⅜ inch nap roller*

Texture built with a roller cover for aggressive nonskid.

Grit media texture

Salt texture

you want. The tests need to be completed all the way to painting the topcoat. Keep in mind that it can be difficult to abrade a textured epoxy surface, but this is necessary so that the paint will adhere to the epoxy and protect it from UV exposure (which degrades all epoxies over time). A 3M Scotch Brite™ pad or a wire bristle brush can be helpful when trying to abrade the epoxy's textured surface.

Nonskid Additives

The next method is to use the epoxy to bond a nonskid additive to the existing surface. There are additives designed for paints that will work very well with epoxy. I've found that the coarsest additive available works the best. Here again, because adding a coat of epoxy and paint over the grit media smooths out the roughness to some extent. The coarse nonskid additive can be blended into the mixed epoxy resin and hardener, then rolled onto the surface.

An alternate method is to sprinkle the nonskid additive onto the uncured epoxy surface and allow it to tack up, but not completely cure, before applying a thin coat of epoxy on top to sandwich the nonskid material between epoxy layers. This will allow for a chemical bond between the layers of epoxy and save on sanding.

The nonskid material can be as simple as sand from a hobby store to Awlgrip® Griptex® nonskid additive from a paint store. If you're opting for the hobby store sand and applying the nonskid surface to wood that will be bright finished, you can get it to look uniform by sifting the sand through an old flour sifter or a piece of screen to ensure the granules are close to the same size. Any unevenness in grain size will be less noticeable on a painted surface.

The Lost Method

The final method I'll describe is what I call the lost method. Apply the epoxy to the surface and then broadcast a grit media such as sand, sugar, or salt onto the uncured epoxy surface. After the epoxy cures (usually the next day) clean the grit media away.

For a more aggressive nonskid surface, use salt or rock salt. For smoother nonskid surface, use granular sugar or sand. Be sure to apply the grit media uniformly across the entire surface so that when washed off with water or brushed off and vacuumed away, the surface texture is consistent. The resulting surface will have hollows or craters whereas the other two methods create bumps on the surface. The lost method surface is a little harder to keep clean because the tiny hollows catch water and dirt, but it still makes for a great nonskid surface.

Choosing Your Media

I have used these different methods for nonskid surfaces for different applications.

For a teak and holly cabin sole I did, where I want to see the beauty of the wood, I put the nonskid onto the holly strips and not on the teak surface. Nonskid is less apparent on lighter colored surfaces. If the nonskid is across the whole surface it may look a little cloudy or hazy, and you wouldn't be able to see the wood as well. Smoother nonskid media like sand or sugar works best to achieve this.

For the deck of a boat, a coarser surface is needed. In this case, I'd choose a more aggressive nonskid material. This could be crushed walnut shells or even a coarse sandblasting media.

There is no single way to achieve a good nonskid surface. Experiment with these materials and methods to determine the best approach to getting exactly the nonskid qualities you want.

Readers' projects

Jamie Wilkins of Wilkins CraftWorks in Elk Rapids, Michigan built this 17.5' Down East-style lobster skiff to enjoy on northern Michigan's small lakes. To construct the hull, he milled and dried white cedar from trees he'd removed from a building site. The boat features a lot of brightwork, including a mahogany transom, breasthook and gunwales. It's powered by a 60-horsepower Evinrude outboard. wilkinscrafterworks.com

Plywood Camper

Doug Redfield of Bellingham, Washington built his camper with marine-grade maranti plywood, G/flex® Epoxy for the assembly and joinery, and WEST SYSTEM® 105 Resin/205 Fast Hardener for coatings. He laminated a layer of light fiberglass cloth on the top, front, and sides.

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.

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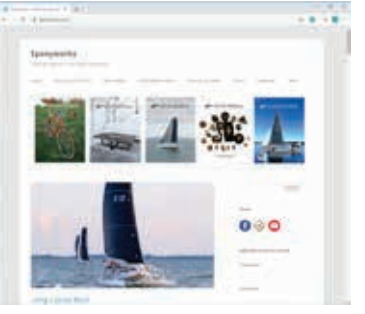

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