David Johnson, here demonstrating WEST SYSTEM epoxies at the Southampton Boat Show, is the guru of the gooey stuff. Who better to answer the question:

What's the Point of Epoxy Resins?

Wood has been the traditional material for boatbuilding since humans first realised that transporting themselves and their goods across water required considerably less effort and energy than any other form of transport. So, as soon as boatbuilders had progressed beyond the hollow log to using more than one piece of timber, they have looked for effective and versatile ways to fasten several wooden components together.

Traditional Boat Construction

As boatbuilding techniques in wood evolved, methods of construction became more advanced but still relied upon a 'plank on frame' structure held together by some form of fixing. Planks might be lapped or butted and intended to 'take up' when wet, as in clinker construction or sealed with flexible caulking in carvel seams – the entire surface perhaps left untreated or coated with paint systems having very little effectiveness at excluding moisture. Frames were 'grown' or steamed and fixings wood, leather or some form of metal.

This type of structure expands with water absorption and contracts when laid up ashore for the winter, stressing the wood fibres. Add to this the dynamic loads involved in taking to the sea and the result is that all the fixings live a hard life as the wood moves and works around them.

Reasonably enough then, builders and owners must be aware that the traditional boat requires regular and routine maintenance. However, when more major repairs are needed, those long established building methods will usually require the considerable skills of a traditional boatbuilder.

New Methods and Materials

With the arrival of plywood and clenched cold moulded construction – the Ashcroft system – boatbuilding techniques changed dramatically. Nonetheless, a lack of water resistance and reliance on metal fixings remained, even as these new methods evolved.

The development of adhesives in Switzerland in the 1940s resulted in the chemical invention of epoxy. Aero Research

WBTA member Tim Loftus – www.timloftusboatbuilding.co.uk – uses wood-epoxy methods for both restorations and new builds. **Above:** *Over the years, the carvel planking on this 1950 28' (8.5m) Alfred Mylne Glen class had been sanded away to half of its original thickness, so she was sheathed with epoxy-glued utile veneers.* **Below L & R:** *This 11'6" (3.5m) Iain Oughtred Guillemot is a new build in epoxy-glued clinker plywood, a method also used by CNC-cut kit manufacturers. Photographs: Tim Loftus.*

Ltd, a UK company based in Duxford near Cambridge, formed by the late Norman De Brun, became licensed manufacturers of epoxy in 1945. Having previously worked with the De Havilland Company on their innovative aircraft like the DH Mosquito and DH Hornet which were built using wood and adhesives such as Aerodux, Aerolite and Redux, their new epoxy adhesive became known as Araldite. Boatbuilders now had access to an effective and versatile glue.

In the early 1960s, the techniques developed in the USA by the Gougeon brothers, Meade, Joel and Jan, created a wooden boatbuilding revolution. Their methods reduced the number of metal fixings by bonding, coating and sealing every wooden component of a new build with epoxy, thereby stabilising the timber and inhibiting the uptake of moisture and oxygen, the two main causes of rot and movement. They developed one of the most famous brands of boatbuilding adhesives: WEST SYSTEM epoxy products.

Here, mention should be made of the yacht designers who embraced this golden era of wood epoxy construction: James Wharram, the Prout Brothers, Robert Tucker, Bruce Roberts, Bruce King, Rob Humphreys and David Thomas. There are also the boatbuilders who need to be noted: Farrow & Chambers, Elephant Boatyard, Camper & Nicholson in the UK; the Brooklyn Boat Company and Hogdon Yachts in the USA; Abeking and Rasmussen in Germany; Sangermani and Paulo de Cesari in Italy; and more recently the UK's highly successful Spirit Yachts, Fairlie Yachts and in France, RM Yachts of Périgny.

Smaller boat designs for the amateur builder have never been so prolific, from free plans downloaded from the internet, to the sublimely sweet designs from the pen – or PC – of Iain Oughtred, Andrew Wolstenholme, Paul Fisher and Francois Vivier and the custom ready-to-sail craft from Tim Loftus, Swallow Yachts, North Quay Marine and Lakeland Wooden Boats.

The understanding of structures and materials for wood epoxy composite construction has never been better, with production techniques optimised for a sound, robust and durable vessel. CNC-machined plywood for lapstrake, clinker or stitch and glue construction with epoxy fillets and possibly glass tape, give proven access to a project for the home builder. Yet epoxy-sheathed plywood, glass epoxy sheathing over cedar strip and cold-moulded veneers over strip planking appear to be the choice of the designers and builders at the cutting edge of wooden boatbuilding.

Which epoxy?

The editor says that in 20 years of publication, *Water Craft* has never run 'ed-vertising', so I must resist the temptation to promote our own products... but working for the last 20 years for Wessex Resins & Adhesives, the UK manufacturers of WEST SYSTEM products, I have provided technical support to customers around the globe and answered a plethora of questions about boatbuilding materials and methods for the self-builder and professional alike.

I'm often told that epoxy is, well, just epoxy. This is only partly true. There are epoxy systems for coating factory floors; there are epoxy systems used on the wing spars of the very latest passenger airliners. For a strong, resilient and robust boat project, you will need a boatbuilding epoxy, one intended for the marine environment.

I recommend using an epoxy with these attributes: up to 98% moisture exclusion effectiveness, durability as shown in tests for creep or permanent loading, adhesion which is beyond the physical strengths of any wood fibre, versatility, ease of use, full technical support from the manufacturer and finally availability online or from your local chandlery. You might also look for an epoxy which will cure thoroughly and achieve good properties in a typical boatbuilding workshop - down to 5°C – as long as it is thoroughly mixed at the correct ratio and stirred sufficiently.

Working with epoxy

To apply epoxy, use the tools the manufacturer supplies, implements specifically designed for their own special purpose to obtain the best results. Please do not use yoghurt pots for mixing, use the re-usable mixing pots supplied which allow you to consistently define your working times as you will be using the same pot time after time. Mixing sticks like the little black plastic ones in the WEST SYSTEM range are great: they are slightly flexible, with a radiused end for filleting and a chisel end for cleaning off the dribbles *(I let him get away with this plug because I always use them myself – Ed*). Please do not cut up pieces of scrap wood that have been kicking around on the floor for mixing; it only takes one piece of sawdust to ruin a coating or one scrap of contaminated wood to compromise a mix.

Make sure your workshop is clean and comfortable; a suitable environment would be one where you feel warm enough wearing a T-shirt rather than a woolly jumper.

Below: *Epoxy strip plank hull in build by North Quay Marine at Conyer in Kent. Photograph: David Johnson*

Always strive for the best practice and try to work cleanly. Avoid skin contact – blue nitrile gloves are more expensive than latex but give better protection and are non-allergenic. Wear eye protection and clean up any spilled epoxy while it is still liquid.

Choose the very best boatbuilding materials you can afford: quality timber and plywood; tried, tested and trusted marine-specific adhesives and reputable coatings and paints. You will know how good these materials are by the amount of product support you have from the manufacturer, either with product literature or over the 'phone.

You start a build with your own skills and by its completion you will have acquired new ones; it's best to learn them as early on as possible. Patience, persistence and the ability to learn are all prerequisites to completing a successful boat build. I've been privileged to be asked to provide support and give advice on epoxy usage on a vast number of self-build projects large and small and it's inspirational to see a successful finished project.

Before you begin, think carefully about what you want to achieve and realistically about your own skill levels – remember the editor's maxim, BASOF: Build A Small One First. If you are accurate with your measuring and cutting, then something challenging is for you; if not, look at the many CNC machine cut kits which are now available. Above all, consider what you will invest in your build, in terms of both money and time.

Using epoxy for the first time

Don't be frightened about using epoxy, there is enough information and technical support out there but gain confidence by the following, all based on questions we are asked when we are offering technical advice.

- Buy a small introductory pack and give it a try.
- Read the instructions. No, I mean properly!
- Ensure good working conditions; a warm, dry and dust-free workspace is a good start.
- Start by mixing small quantities of the resin and hardener - 30 grams of mixed epoxy will go a long way – and make sure you are precise with the mix ratio.
- Counting slowly to 120 while mixing will ensure you are mixing sufficiently. Mix right into the corners of the pot.
- Practice adding fillers by mixing high density structural fillers at 1 part filler to 1 part mixed epoxy by volume. Lightweight easy-to-sand fillers should be mixed at 2 parts filler to 1 part mixed epoxy by volume. Both mixes will achieve approximately peanut butter consistency.
- You may need a lower viscosity for a glue line, so less filler might be required.
- Make sure the surface of anything you intend to bond, fill or coat is clean, dry and well abraded – 80 grit is excellent for an epoxy bond.
- When filleting, use a mix thickened to a peanut butter consistency put into stout plastic bag with a small corner cut off. Pipe the mix right into the angle between panels, as if you are icing a cake. Then use a – *Water Craft* recommended – black plastic mixing stick to form the radius and clean up with the opposite chisel end.

David demonstrates filleting under the watchful eye of Nick Newland of the WBTA.. Photograph: Anna Walker.

- Stitch two pieces of scrap plywood together with cable ties to practice your filleting. When the epoxy has cured, try breaking your practice fillet in a vice. You'll be amazed at how strong the joint is and when you break it, you will clearly see the wood fibre failure.
- Practice glass cloth sheathing on a scrap of ply. Try the method of applying the fabric to a dry surface and then wetting both ply and glass with well mixed epoxy, with no filler added. Then try priming the wood beforehand. See which method works best for you.
- Master the art of applying peel ply, a nylon cloth you lay on the glass sheathing after wetting it out and remove once the epoxy has cured. It will save you hours of sanding for little expense and is fundamental to working with epoxy.
- In boatbuilding, the hardest step is the first. Take it.

David Johnson is the Technical Products Manager at Wessex Resins & Adhesives Limited. Tell him about your project at: www.epoxycraft.com

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