AMATEUR BOAT BUILDERS' ASSOCIATION

NOV/DEC '02

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Contact any of these four people for clarification of association activities.

EVER DREAMED OF FLYING YOUR BOAT?

Geoff Leggatt

Our guest for September is involved in designing sailing vessels which do exactly that although the fluid through which the wings pass is water rather than air. Mark Pivac's presentation topic was hydrofoil sailing design, in particular focussing on the design and construction of *Spitfire*, a 12m (40) long hydrofoil sailing catamaran. Mark is director of *By Design Group*, a design consultancy company in Welshpool who employ both design engineers and industrial designers allowing them to design products with both form and function in mind.

Mark himself is an Aeronautical Engineer, giving him an excellent knowledge of foil design, and the ability to consider all forces involved in the hydrodynamic lift and drag produced by the hydrofoils. Mark first started getting serious about foil design and construction when he decided it was too tedious and restrictive to shape foils by hand. Instead of putting complex shaped foil construction in the too hard basket, Mark decided to design and construct his own CNC router in his backyard to do all the tedious and complex foil shaping for him, based on numerical foil shape data sent to the machine.

Mark's first involvement in hydrofoil sailing design began when he was asked by Brett Burvill to design some foils for his moth sailing dinghy in order to provide some additional lift. Mark suggested that they design the foils to be able to lift the entire hull out of the water. The design was very successful and as a result Brett won a number of heats of the Moth World Championships.

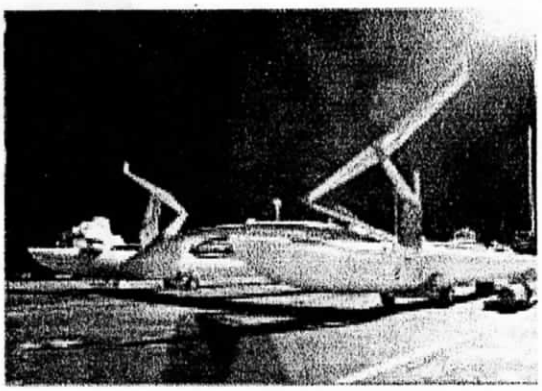
Spitfire was designed to be a pure speed machine with no allowance for creature comforts or accommodation. To date the vessel has reached speeds of up to 30 knots in winds speeds of 15 to 25 knots, and has an anticipated top speed of more than 40 knots, (hang onto your toupees boys). The hydrofoils generate sufficient lift at 12 knots hull speed to lift the hulls clear of the water surface. Launched on the 17th January

2002, Spitfire can now be seen racing on Pittwater, creating havoc for the handicappers. The foil configuration consists of two main foils, one attached to each of the symmetrical catamaran demihulls and a third acting as both rudder and balancing foil, attached to a central pod (easier for both you and I that you look at the attached photos rather than I try and describe the configuration more eloquently). The two main foils pivot outboard in order to allow stowage on deck when they are not required for sailing. The aft, smaller rudder mounted foil retracts up into a rudder case. The rudder foil has a trailing edge flap for trim control which is actuated using a throttle control lever at the helm station. The main foils are a surface piercing design with a vertical support strut. Each of the slender demihulls has been designed in order to minimise both the hydrodynamic and aerodynamic resistance, as when foil-borne the major drag component of the vessel is air drag. The cross beams between the hulls are aerofoil shaped in section in order to create a slight lift component and minimise drag. They plug into the demihulls in order to allow disassembly of the vessel and storage in two 40 shipping containers. The rig consists of twin unstayed rotating masts each carrying soft wing sail mainsails in a biplane configuration. The sails are unique in that the mast forms the leading edge of two sails separated for the leading third of their chord length by a horizontal transverse spacer bar, then joining to form a single sail for the remaining two thirds of the chord length. Spacing between each mast has been maintained at two chord lengths to allow each to operate without influence from the other, however all sail controls operate both sails in unison.

Now onto the construction which was undertaken by Windrush Yachts over a ten month period. Spitfire's demihulls are constructed of a balsa cored, fibreglass skinned laminate. The hulls were laid up using a vacuum bagging and resin infusion method, whereby the outer hull skins are laid dry into a female mould, followed by the crosscut balsa core panels and finally the inner hull skins are laid dry on top of the balsa. A matrix of resin feed tubes is then laid over the dry inner skins, and covered in bleeder cloth (in this case simple shade cloth), and finally clear plastic sheeting which is taped down to the outer edges of the female mould. Vacuum lines are connected into the plastic sheeting, feed tubes are connected to a resin supply, and the vacuum pump is started. The resin is now drawn through the dry layup due to the applied vacuum. Sounds easy doesn't it? It's not. The trick is to ensure that the resin feed tubes are positioned so as to allow complete wetting out of the laminate. If this doesn't happen you pop the final product off the mould and throw it away. If it does happen you end up with a homogeneous, lightweight laminate which has minimal excess resin, no gas inclusions, and complete wetout. Windrush found the use of spiral tube (used for encasing loose computer cables into a single tube) to be effective for the resin inlet and vacuum outlet tubes. The resin used had a low viscosity of around 100 centipoise.

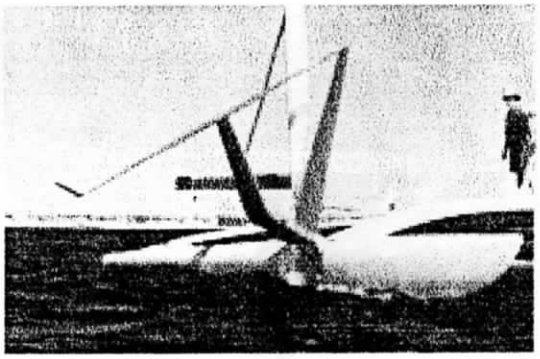
The twin masts are circular tube in cross section with solid carbon walls. The mast height is 12m with a base diameter of 250mm and a head diameter of 75mm. Total weight per mast is 45kg, which may not seem very light however when you consider the velocity of the air flow over the sails for a vessel which creates 40 knots of apparent wind when travelling at full speed it is more apparent why the additional structure is required. It is interesting to note the apparent stiffness of the mast in the attached photos of Spitfire under sail, especially considering these are unstayed masts. Prepreg carbon was used in this situation as it was found to be the cheapest way of buying carbon cloth. Prepreg cloth consists of a fibre weave saturated with the required quantity of resin maintained at a lowered temperature in order to prevent cure (requiring that cloth remain refrigerated until ready for use). An important note to be made is that Mark performed destructive testing on samples of a number of the products he was producing and found that tested material properties were significantly less than the figures

SPITFIRE - THE FOIL BORNE CAT

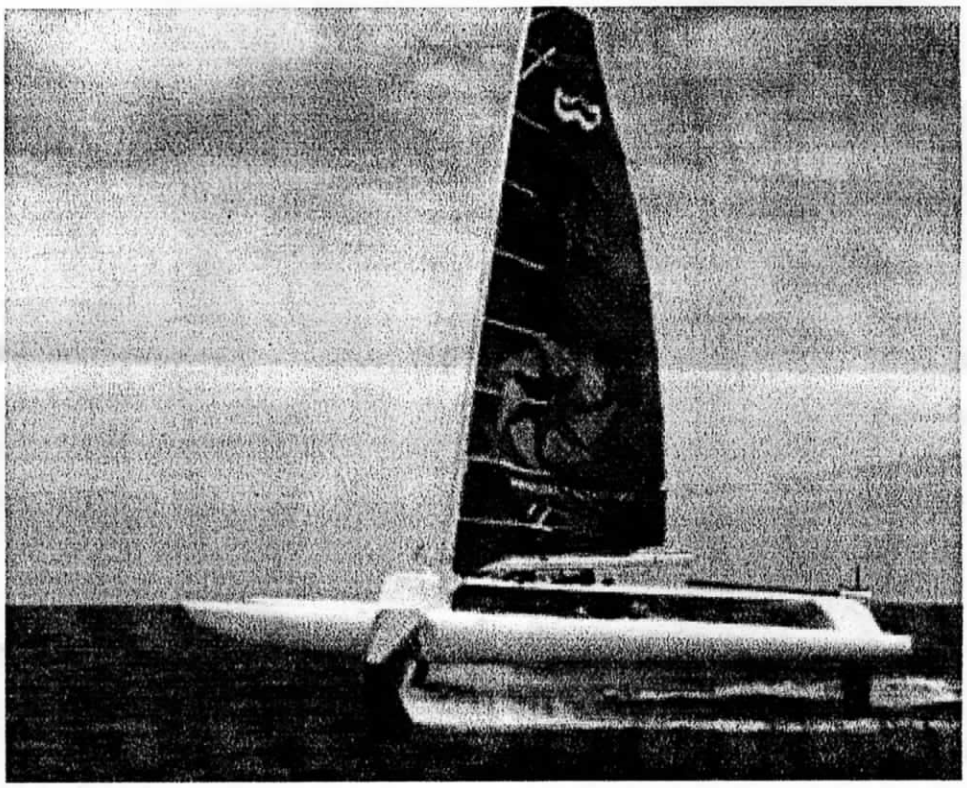


De-rigged on the hard
Foils areretracted

Almost at rest on the water
Note the square topped sails



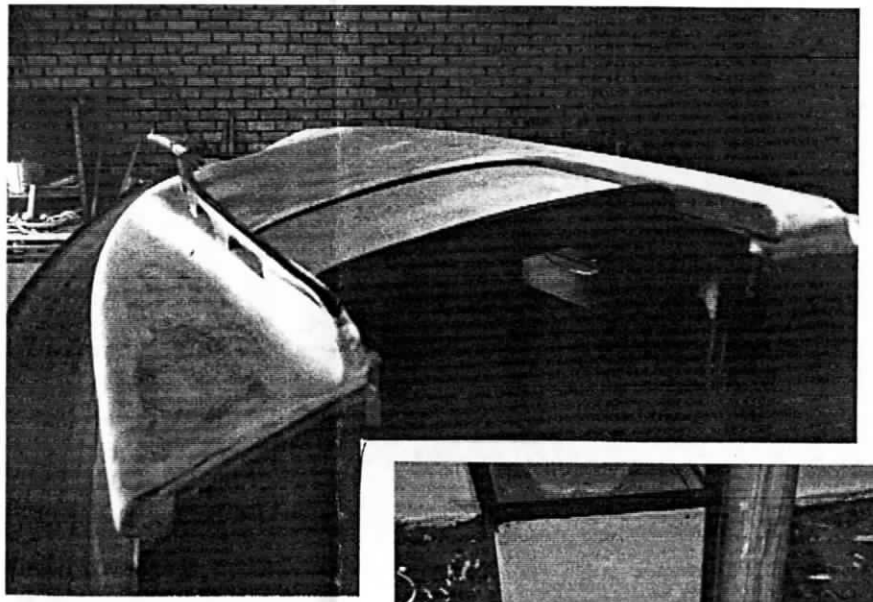
The foils are lowered after launching



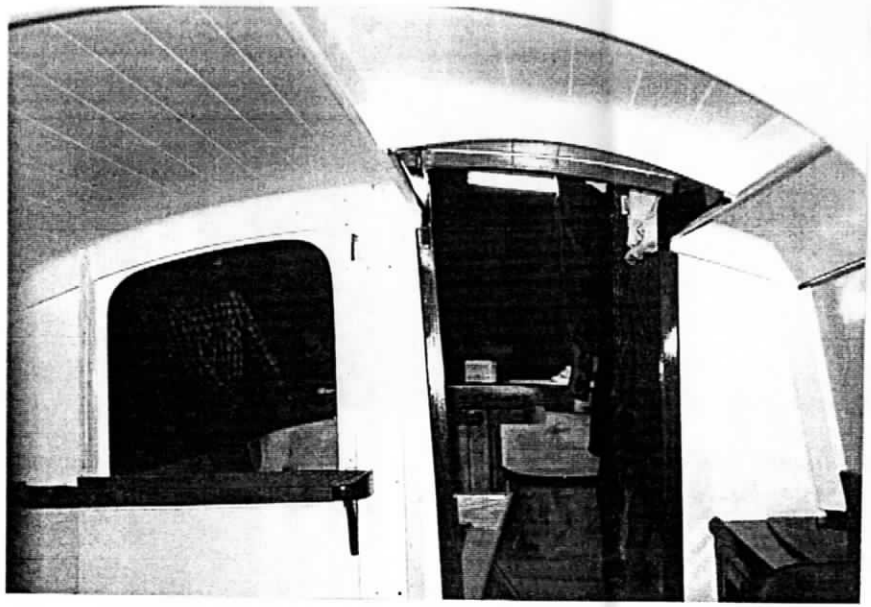
Spitfire on the foils at speed

A VERY BUSY WORKSHOP - BRIAN PHILLIPS

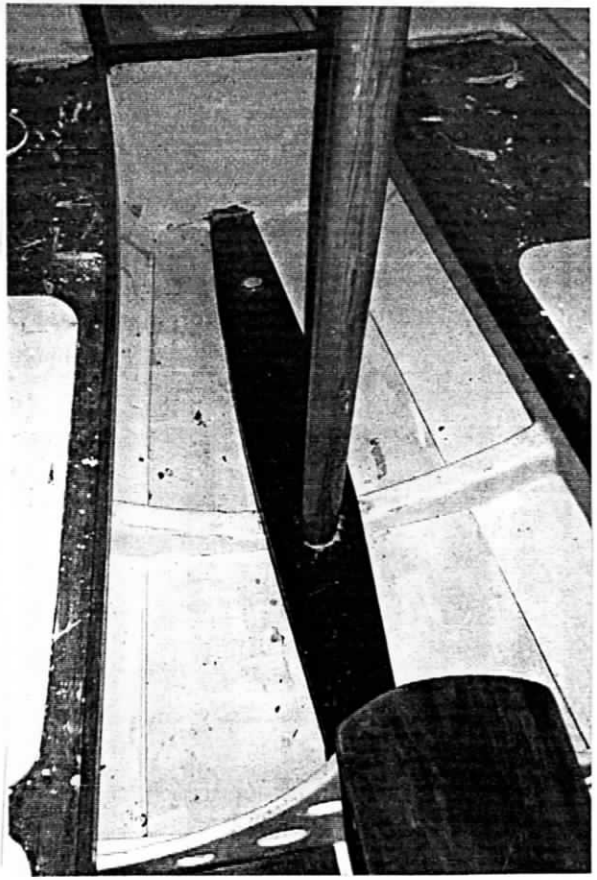
Twenty two of the models so far completed towards Brian's present target of ninety six.



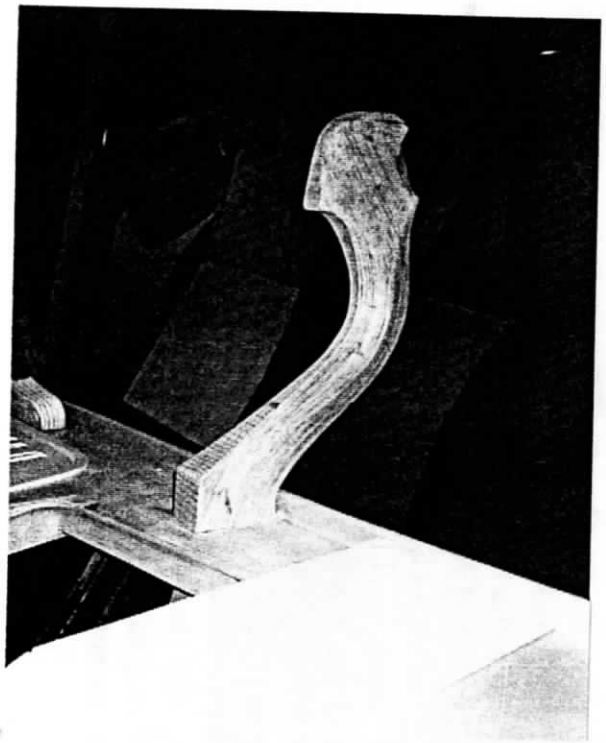
Coachroof of the trailer-sailer; fibreglassed and very waterproof.



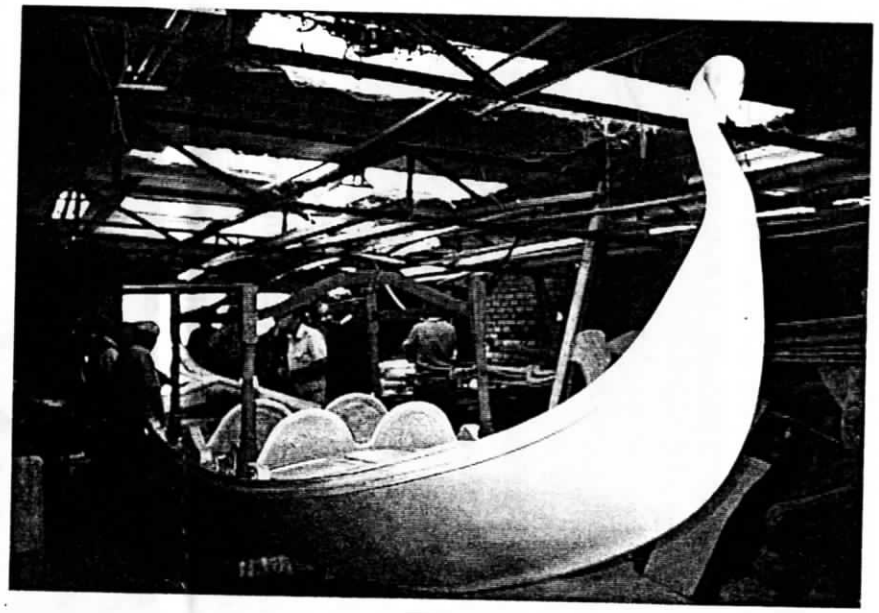
Interior shot of the trailer-sailer. Note the curvature of the coachroof camber.



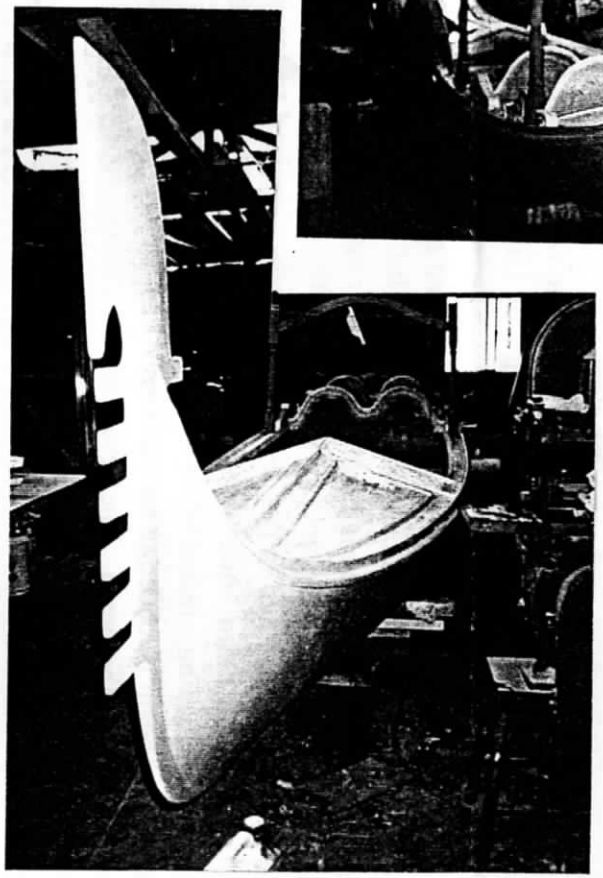
The mast strut heel in the bilge of the trailer-sailer.



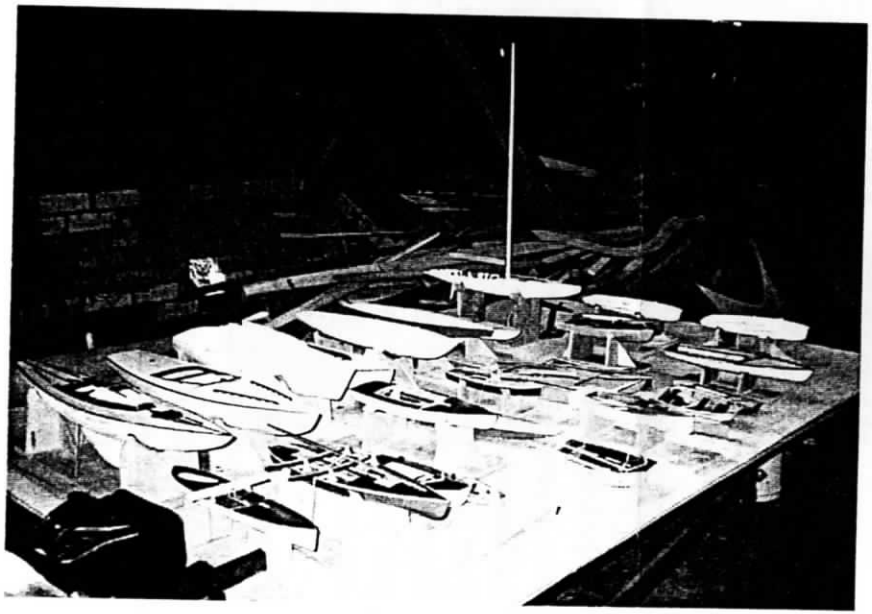
The *fórcola*, or rowing lock near the gondola's stern.



The stern of the gondola. With its swan's head, it's just as ornate as the bow.



The gondola's bow piece. This is aluminium, epoxied over and into place.



Another view of the models.

stated by the manufacturers of the materials. If you are building critical parts of your vessel structure this is a good practice in order to check the effect that both the actual material properties and your method of producing the product have on the strength of the final product. The mast base rotates in what is effectively a large rod end, and the deck bearing was a large custom made stainless steel spherical bearing allowing for the mast movement caused by both mast rotation and flex. In order to prevent electrolysis between the carbon mast and the stainless steel spherical bearing, a layer of glass cloth was laminated to the mast in way of the bearing contact surface area.

The foils are constructed from a combination of solid carbon laminate and cored laminate. One interesting aspect (well for me anyway) which had to be carefully considered in the design and construction of the main foils was what is known as Brazier loading, created when a curved laminated or box beam is loaded in such a way is to try and straighten the beam. The result is a load which has the effect of forcing the upper and lower faces of the curved beam apart. In areas such as this, and in other areas where high shear stress existed between the upper and lower faces of a cored laminate, shear webs were placed between the upper and lower faces in order to prevent relative movement between these two faces. These shear webs were created by stripping up a cored carbon laminate, and laying these strips on edge in order to form the core for the final carbon cored laminate. A very creative and effective solution.

The wing sails are fully battened and were made by Hill Sails using Technora sail material. As opposed to a hard wing sail the soft wing sail used on Spitfire can be reefed and yet, as does a solid wing sail, provides far superior aerodynamic performance to a traditional single soft sail.

I was surprised to learn that this was the first time Mark had been approached to talk about Spitfire. Thank you Mark for providing us with such an interesting presentation and passing on some of your knowledge.

AND YOU THOUGHT YOU WERE BUSY!

Geoff Leggatt

The majority of you know how time consuming it is to build your own vessel, now imagine doing this at the same time as constructing a 10.4m long Gondola, 96 (yes you read correctly 96) 1:12 scale yacht models, and trying to sell an unfinished 14 sailing/ rowing dinghy. Welcome to the life of our host for the October Tool Box visit, Brian Phillips. Brian is a professional boat builder who originally started his career in timber boat building in Victoria working for Savage. Brian was also involved in the Gretel II project, and was master shipwright for the Endeavour project.

Brian's own private project is a 22'5" (in Infernal, sorry Imperial units) gaff rigged centreboard sailing vessel. The vessel has a beam of 8' 1", a shoal draft of 600mm, a draft with the plate down of 1700mm, and an anticipated lightship displacement of 1700kg. The centre plate weighs 65 kg and the vessel carries tankage provision for 500kg of water ballast. Construction is of 3 laminations of Gaboon Marine Ply (4mm, 5mm, 4mm) with fibreglass sheathing on the exterior hull surface and triaxial glass reinforcement used on the inner shell in high stress areas. The deck is a fully sprung 6mm thick Queensland Beech (as opposed to teak) laid deck, laid on 1/2" ply. The deck was laid with a Sikaflex seam, however Brian has so much trouble trying to get the recommended bond breaking tape down the seams that he opted to caulk the seams directly with Sikaflex, and feels confident that the seams will remain watertight for the lifetime of the deck. He found that the best method for applying the Sikaflex was to carefully tape the edges of the seams so as not to get Sikaflex on the top deck timber

surface, and use a curved knife to push bubbles from the joint. Brian says that the Queensland Beech is as oily as teak, lighter in weight, as resistant to the elements, and cheaper. The laid deck has also been applied to the cockpit sole with neat margin boards used around all hatch openings. Brian has used epoxy glue and resin throughout, and all items of trim such as gunwales, cockpit coamings, and window surrounds are of Mahogany. The vessel centre board is constructed of a mild steel plate which has been sandblasted, epoxy coated, encased in Oregon with fibreglass sheathing. The final plate is of aerofoil section shape with a 1.5" finished thickness, and drop through a shallow skeg which is winged in order to reduce leeway in the shoal draft condition. The vessel comfortably accommodates two people with two bunks, a galley, and a head in the forepeak The vessel has been under construction for three years to date and Brian hopes to be in the water by Christmas (plenty of Guarana and coffee required to achieve this I would suggest looking at the quality of finish Brian is achieving.)

The first of Brian's commissioned projects is a 10.4m long Gondola for a Perth photographer, intended for the bridal party that can't afford the airfare to Venice for the wedding. Unlike Venetian Gondolas this vessel's hull is symmetrical and its construction is of two forms. The main hull is constructed of two laminations of 10mm ply, while the more curvaceous sections of topside are constructed of 20mm epoxy glued western red cedar strip planking. The forward and aft voids have been required to be filled with buoyancy foam in order to pass survey for use on the Swan River. In order to make the Gondolier's work look effortless the wedding party will be deceived by the use of a silent 50lb thrust electric outboard hidden in an outboard well. The finishing touches on the vessel include a traditional black paint scheme, an adornment of wooden hand carvings surrounding various panels and a curved black swan's head on the aft extremity of the vessel. The forward head piece is constructed of epoxy encased aluminium as opposed to the traditional stainless steel. One item of the construction which Brian mentioned he had difficulty in sourcing information for the *fórcola* (the shaped timber post against which the oar pushes when being used). From the brief research I have done into these they come in many different shapes and sizes depending on the particular technique of the Gondolier. I have attached some photos of the various types available. For more information refer to the websites mentioned below. Attached are some drawings of Gondolas I dug up off the internet. An interesting web site for anyone interested in reading up on the techniques of the Gondoliers and other Venetian watercraft is www.venetia.it/boats/.

Brian's other commissioned project is of a totally different scale. 1:12 scale to be precise. Roley Tasker has commissioned Brian to construct a 1:12 scale model of every class of sailing craft on the Swan River which had or has a fleet of ten or more vessels. To date the total number of models requested is 96 however this number will continue to grow as new fleets emerge. The eventual home for the models will be in the Australian Sailing Museum in Mandurah. Here they will be accompanied be a number of historic sailing paintings. The first 28 are pictured in the attachment.
Thanks very much to Brian and his wife for their hospitality. The event was thoroughly enjoyed by all who attended and I personally found it very inspirational.

REWARD

$5.00 Discount on your next membership for ideas for future meetings and Toolbox Visits.

THIS IS A SERIOUS OFFER!

AND NOW AS AN EXTRA, HERE ARE SOME WEB SITES TO SURF

http://www.boat-links.com/boatlink.html This is "The Mother of all Maritime Links" and is a really good place to start with dozens of links sorted into 121 categories. Beware starting here is one way to fill many precious hours which you should be using to finish your current boat!!

http://www.boatcraft.com.au/ Provides details of Boatcraft Pacific's products and services, including Bote-Coat products.

http://www.duckflatwoodenboats.com/index.html This is the Duckflat Wooden Boats site. A very useful site providing details of a variety of designs, designers and materials. Well worth a look.

http://multihullboatbuilder.com/ Some interesting links here featuring designs, workshops and "other stuff", including an interesting article on lightning and sailing boats.

http://www.oceanoutlook.com.au/ A new site which provides 5 day swell & wind forecasts as far north as Gnaraloo to as far south (south east) as Esperance both online and in various other forms. Includes other information on tides etc.

http://www.scruffie.com/ The home of Scruffie Marine. Another Australian site that provides details of various kits including the Secret 20 which looks like a very pretty vessel.

http://www.seabreeze.com.au/ This site is for those of you who need to know what the wind is doing on the coast of Australia. Provides live graphs which are refreshed every 10 minutes. Well worth a look

http://www.sailingcatamarans.com/ This page features the multihull designs of Richard Woods. It is updated regularly

http://www.awoodboatfest.com This is the page for the Australian Wooden Boat Festival which commences in Hobart on 7th February 2003.

ADMINISTRATION

CALENDAR

NOV 26 - Evening meeting at RPYC Junior Club, 7.30 for 8.00pm. Speaker is Glen Lyons, Technical Representative for Sika (Aust), makers, amongst other things, of Sikaflex. Glen will talk about the range of Sika products and this should be very valuable information. Available LIBRARY BOOKS on this evening will be on Boat Electrics.

DEC 14 - Tool Box Visit, 2.00pm. This will be to the Sport Aircraft Builders' Club at the Serpentine Airfield, Yangedi Rd, Serpentine. Yangedi Rd is off the limit of maps between Baldivis and Serpentine. It turns south off Karnup Rd, which itself can be accessed from Baldivis Rd to the west or from South Western Hwy to the east, where it starts opposite Falls Rd. The airstrip is about 2km down Yangedi Rd.

VALE:

It is with deep regret that we have to report the deaths of two of our members in recent months. Neil Litster was a member of long standing and Dennis Welsh had joined our numbers more recently. They will be sadly missed and we extend our deepest sympathies to their families.