

Seahorse

International Sailing

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(Truly) something else

EAGLE CLASS 53

There have been a couple of previous more eccentric attempts to create a multi purpose foiling cat but none come with such impeccable credentials as the Eagle 53. Then again none of them tried to pack in quite so much experimental new technology...

– Paul Bieker

Tommy Gonzales of Fast Forward Composites approached us some time ago to design a high-performance catamaran primarily for day sailing in warm climates. The main focus for the design was on having fun and going fast rather than racing. A large proportion of Bieker Boats' work to date has been focused on fast and fun racer-cruisers; but without the weight and complexity of extensive overnight accommodation this boat was clearly going to take fast and fun to a new level.

When this job came to us I was deeply involved in the development of the AC50 class and the 45ft test platforms for Oracle Team USA and my availability for work outside the America's Cup was very limited. With that in mind, it was clear that to be successful we needed to put together a team of people to design the boat. My work in the America's Cup over the years has given me a deep appreciation of a team-based approach for the design of innovative machines – and an understanding that the choice of team members is crucial to the result.

Our first addition to the team was Andrés Suar, a talented Argentinian naval architect who I met while working in Juan Kouyoumdjian's office in Valencia. Andrés has a great combination of talent, creativity and a kind yet forceful personality that suited his role as the lead naval architect.

Our next addition to the team was Will Brooks, an English marine composites engineer. This was my first time working with Will but he came well recommended and he seemed to have the right sort of personality to be a good team player. Will was

responsible for the structural design of the platform and appendages.

Eric Jolley, an artist in computer lofting and design, was the anchorman in the careful design and detailing of the boat. Eric is co-owner of Bieker Boats and has worked with me for many years. I completed the technical team by providing intermittent design and technical guidance and review. In addition, Fast Forward Composites (FFC) brought in Eric Goffrier to provide some great steers on the interior and exterior styling of the boat.

On the construction side we had a strong team led by Wolfgang Chamberlain at the newly created FFC facility in Bristol, Rhode Island. Manu Armananzas, an Argentinian with whom we had worked on America's Cup foil-construction projects, came in to manage foil manufacture and other special projects in the shop.

Tommy Gonzales set up the FFC facility with all of the tools required to do a top-quality job, including three and five-axis CNC capability, CNC composite ply-cutting capability, a good oven for high-temperature pre-preg laminate cures, and



teams. The Eagle 53 is a beautifully built unique and striking yacht that has been living up to our expectations in the month or so that she has been sailing. And we still have a lot to learn.

EAGLE CLASS 53 – VPP AND HULL

– Andrés Suar

From a naval architecture point of view the boat presents different challenges. Apart from the actual layout and characteristics of the design we needed to create a good platform that allows high-performance sailing in both floating and foiling mode.

I believe strongly that, at the initial stages of the design, focus should go into the concept and those parameters that make the greatest improvements in both sailing experience and performance. For this reason we started with simple models that allowed us to make decisions in the design while we were learning about boat behaviour, balance and potential.

During this early process we realised that we did not want to foil only in strong breeze and for this reason we worked heavily on the foil size and boat weight to reduce the take-off TWS. As expected some practical limits are found for both.

Having looked carefully at the options in terms of our target wind range we began work on the relationship between beam and rig size which would give us some good foiling from 10kt TWS upward.

In understanding the balance of the boat we also learned that the best configuration for an early take-off and more

Thomas Coville would be at home with the forward helm position though he'd want to avoid burying the windward bow during bearaways. Fast Forward's hybrid rig has been looked at before in *Seahorse* and benefits from input from father-in-law Eric Hall... A reefable high-aspect sail and small chord wing that rotates through 360° under the shroud 'cap' also mean the boat can be left safely afloat with the wing free to feather

height stability so an effective electronic ride height controller will be required. However, for us to reduce the number of unknowns during sea-trials, the boat was launched with wingleted C-foil daggerboards and retractable, adjustable angle of attack T-foil rudders. As a team we decided that the hybrid wing and hard-top were enough novel features to start with.

Typically, it is challenging to maintain constant heel angle while flying the weather hull in a catamaran (foiling or non-foiling), so the plan is to include roll

control into the system through the differential control of the rudder wings while sailing at speed. The roll control system will be tested using the current C-foils and should reduce the amount of active trimming required during normal fast sailing – increasing the fun factor for all involved.

At this point the plan is to continue to sail and refine the EC53 with C-foils through the winter of 2019/2020 and to fit the foiling package in the spring of 2020.

We are very pleased with the result of the efforts of our design and construction

**IF IT CAN
SLIDE BETTER,
ROLL BETTER
OR FLY BETTER...**



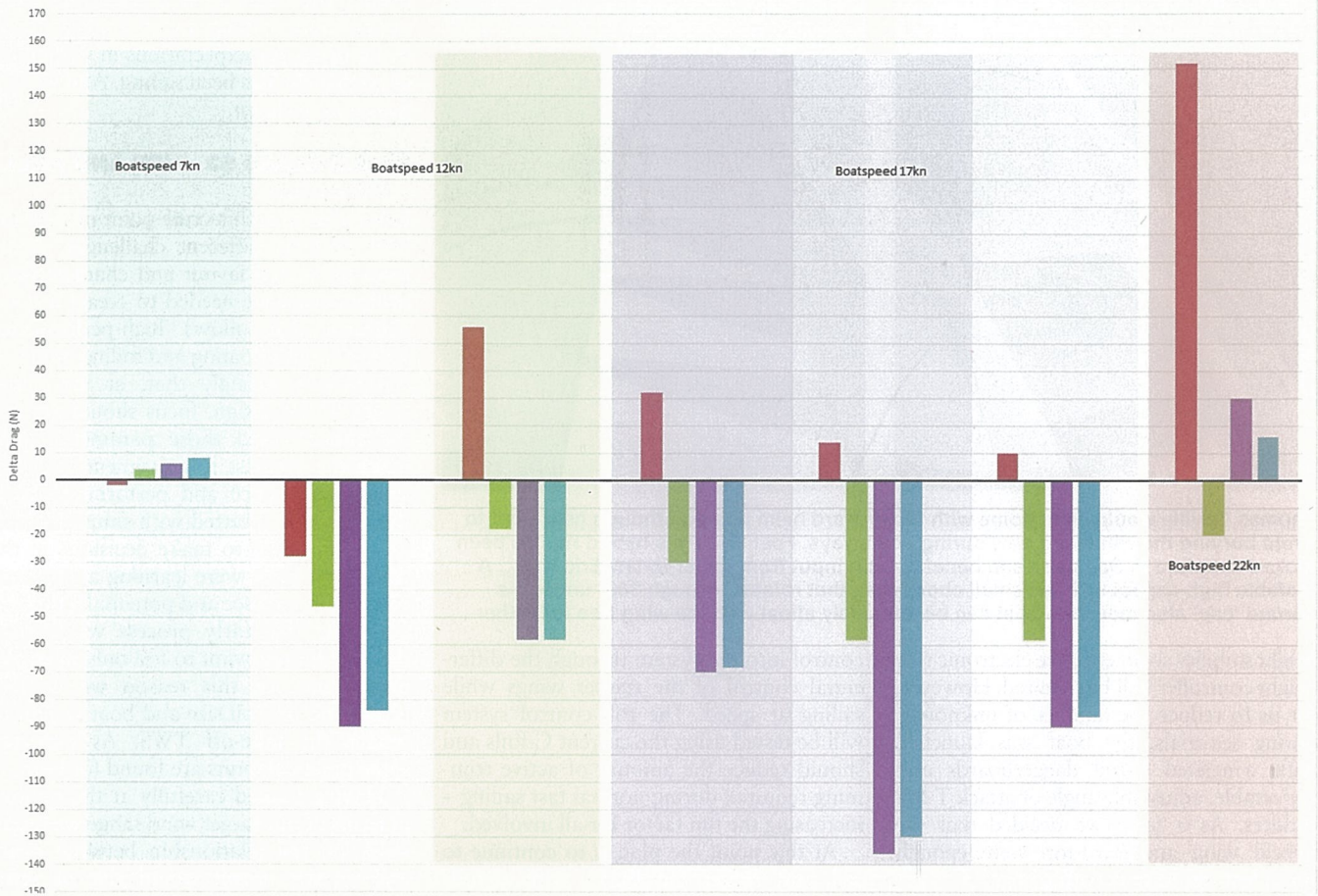
BETTER **McLube**



IT.



Delta Drag From hull 001



enjoyable foiling was with both T-foils down, but if you really wanted top speed you would need to lift the windward foil and control the heel with the rudder elevators. Also, the current C-foils are already producing a significant vertical force (up to 25 per cent of boat displacement) when we are in floating mode, to make the best use of the available power. The boat is plenty fun and fast in this mode.

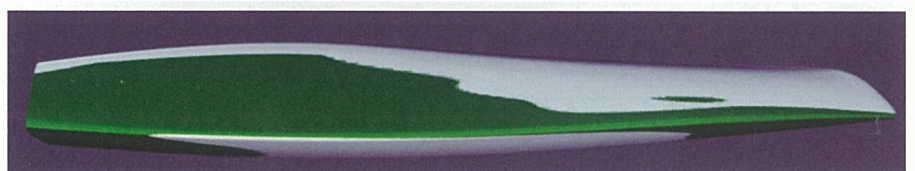
Some details are visible and some others are not evident to the eye, for example the weight distribution. We worked around the idea that most of the variable weights should be kept as close as possible to the foils so as not to impact pitch stability; driven by this we located our heavier items like tanks, systems and even crew position.

Once we got the main concept and a good understanding of boat behaviour we started refining different areas. One example of this refinement is the hull shape, where we improved it in both floating mode and take-off process, working around different speeds and displacement fractions (percentage of weight carried by the hulls).

Note this was only a refinement and not a hull concept study – we were already sure that we wanted a certain type of hull configuration with good volume in the ends while respecting the geometrical requirements for the interior accommodation.

We used as a reference hull our initial best guess: this hull had a relatively flat bottom (in transverse section) to produce some lift, and the necessary rocker to ensure a low transom immersion. With our first iteration we found that we could

TWS	TWA	Boatspeed (kn)	VMG (kn)	Sail	
14	46	14.44	10.03	JIB	"C" Foil
	110	23.62		JIB	
	131	22.10	-14.50	SCREECHER	
14	58	20.36	10.79	JIB	"T" Foil, both down
	110	30.28		JIB	
	136	26.16	-18.82	SCREECHER	
14	54	22.84	13.42	JIB	"T" Foil, only leeward down
	110	34.59		JIB	
	140	29.26	-22.42	SCREECHER	



Top: sample drag deltas for different candidate hulls and different sailing weights – essential to factor in when designing a performance-oriented multihull with pleasure sailing pretensions but historically too often overlooked. The small degree of rocker variations that were explored (above) – candidate hull no1 (grey) and candidate no7.

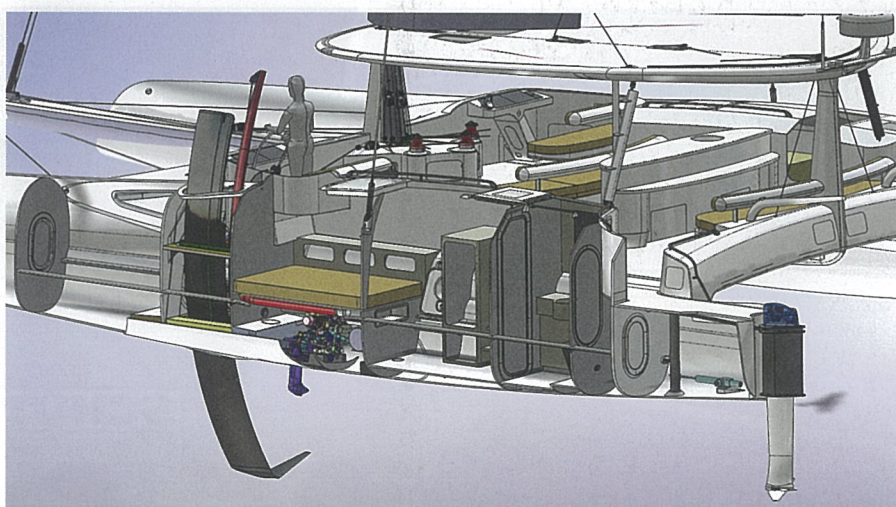
Centre: Performance predictions for the final design using the three foil configurations anticipated. Note the dramatic speed increases – especially in terms of VMG – plus the changes in true wind angle (TWA) progressing through from the current C-foils to two immersed T-foils to full-throttle America's Cup sailing with only the leeward T-foil down

improve in both floating mode and take-off by reducing some rocker – all this with a pretty small penalty in the low speeds.

On a second iteration we modified the transverse sections, moving from the flat sections towards a slightly more elliptical shape which helped to reduce drag at smaller lift fractions (take-off). Most of the time you would go to a pretty flat lower section for a boat like this, but in the end it proved hard to make it work for the hull beam we needed in order to respect the

internal space; the flat sections were presenting a pretty blunt waterplane at low displacement speeds considerably increasing drag. The limit on how elliptical we could go with our sections was the performance in floating mode over 22kt boatspeed, where we could see a drag increase if we pushed too hard with this kind of shape.

In the end the final decision on hull shape was easy. The best-performing hull in take-off was at the same time the best-performing hull in displacement mode! □



For a daysailer/weekender the Eagle 53 looks a lot like a test platform for a design boffin who's been locked away in the dark and having finally emerged into daylight wants to try all of his best ideas at once... The Gonzales/Smyth reefable hybrid wing – note the 360°-rotating cap attachment (*opposite*) for the super-simple standing rigging; racy negative camber hull set-up; numerous tidy details including discrete mooring eyes; hollowed-out jib clew for visibility; rigorous mass concentration of heavy items including engine, rig, tanks; the elegant structural cockpit roof that doubles as a wing end-plate; forward helm; vast open cockpit free of lines and surprisingly generous interior volumes

an autoclave for the high-pressure curing of critical parts (including our foils).

Performance catamarans have very high power to weight and heeling to pitching stability ratios. These facts make me a firm believer in high-buoyancy bows (with their improved pitching stability) for this type of yacht. Not only are they appropriate for the sorts of speeds that these boats are capable of, but they can provide the dynamic lift to keep the bows up and allow the crew to confidently push the boat hard without feeling as if they are on the edge of going over the handlebars.

To reduce weight and windage we balanced the high-volume lower bow shapes with a low-freeboard wave-piercing profile which gently rises aft to provide sufficient headroom and volume for comfortable overnight cabins and enclosed heads. A step in the profile near the stern allows easy ingress/egress from the boat onto tenders or piers without the large stairs typically seen on the sterns of large multihulls.

One of the big challenges during the early stages of the design process was the integration of an exciting 'hybrid wing' rig concept from Tommy and Randy Smyth,

with the concept of a fixed hard-top to provide protection for the passengers from both the sun and the running rigging. This hard-top integrates the wing step, wing angle adjustment, mainsail controls and screacher leads in a relatively lightweight, shallow and streamlined structure.

The hard-top also provides concealed runs for the wing, mainsail and screacher lines back to the pit located below the wing support post. We did not spend time on a CFD analysis of the airflow around the hard-top; however, I am confident that it will also operate as an effective and relatively low-drag end-plate for the hybrid wing.

The deck layout is based on the idea that

the boat can be sailed well without requiring the non-sailing passengers to move around to avoid being caught up in the boat-handling action.

The helm stations are at the forward end of the wet deck on either side of the central line-handling 'pit'. All of the rig and board-handling controls are led to this pit where three Harken Performa 50.3 electric winches handle the line-management tasks. This concentrates the boat-handling action at the forward end of the wet deck and leaves the rest clear of lines and rigging.

One of Bieker Boats' strong points is that we learned the value of CNC-aided construction long ago. We do not just draw 'pictures' of our boats – we numerically model them in enough detail to create accurate tooling and laminate patterns directly from our design files. This increases the quality and accuracy of the resulting boats as well as minimising weight. The Eagle 53 is beautifully built almost entirely of high-temperature cured pre-preg carbon laminates. All of the primary structures were built from infused carbon tools built off CNC-cut masters. The result is that there is very little fairing compound or primer on the boat, allowing us to achieve a lightship weight of slightly more than six tons – significantly lighter for its length than any other mixed-use multihull that we know of.

One of the places where CNC-aided construction has allowed us to make great steps in strength and quality is in the production of the foils. The first foils we built



Who'd have thought we'd wax lyrical about a faucet in *Seahorse*... well, the comfy bits are pretty cool too on this extraordinary yacht and, together with the carbon sinks and other deck furniture, remind guests just how good the team at Fast Forward Composites are for a relatively young company. Everything down below is kept just as light – locker doors are zip-up sailcloth. And the plush mattress and pillows? All inflatable, obviously

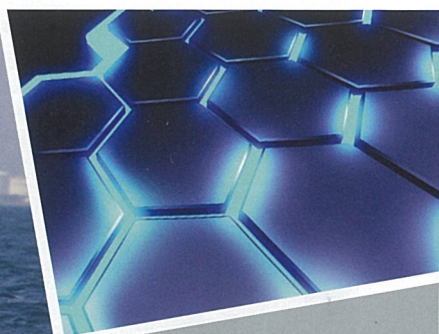
that relied on CNC pre-preg ply cutting and multiple CNC machining steps during the construction process were the dagger-foils for the Oracle 120ft deed of gift trimaran in 2008. It was the only way to reliably achieve the strength requirements without exceeding the boat's strict weight budget constraints.

The structure of the EC53 C-foils is a direct descendant of the deed of gift trimaran float foil structures and they came in at a weight of 126kg each. The structural challenges of foil building have

increased even further as we started to fly the boats and push the proportions of the flying foils to greater and greater extremes.

The Eagle 53 was designed from the start with fully foiling sailing in mind. The foiling arrangement uses T-foil daggerboards rather than the L-foils used for foiling in the past two America's Cups and on boats such as the GC32 and Nacra 17.

The T-foil arrangement has less drag and is less structurally and mechanically challenging than an L-foil arrangement, but this comes with a reduction in intrinsic ride



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