The turboed Gunboat 66 *Phaedo* revelling in her new and not so subtle blood-orange paint scheme. The RORC Caribbean 600 was used as the course model for the latest upgrades to this fast all-carbon – but still very comfortable – world 'cruising' cat, which included a modest reduction in all-up weight but an 18% increase in sail area plus new and more aggressive appendages

ALL IMAGES RICHARD LANGDON

Orange crushed

Design engineer Dave McCollough was tasked with pulling together an aggressive range of performance upgrades to the already turboed Gunboat 66 *Phaedo*…

On 15 July 2013 the Gunboat 66 *Phaedo* hit her new 24-hour record of 427 miles in the Transpac Race. Hours later she lost her rig. Debris was cleared and the boat secured before a long motor back to Newport Beach in California. Before stepping ashore the comeback was already being plotted… Owner Lloyd Thornburg was leading the charge with varying options and ideas. I was privileged to be part of that crew and six days later I left the boat with a notebook full of ideas.

In an attempt to organise the improvement possibilities available to Lloyd, we created a grid of option packages similar to what you encounter when purchasing a new car. The low, medium and high packages were codenamed Boom, Sonic Boom and Super Sonic Boom. Careful research was conducted to support each decision, and gradually it became clear that *Phaedo* options package. This included but was not limited to a new mast, longeron, forward crossbeam, full set of sails, daggerboards, rudders, rudder bearings, cabinhouse windows, exterior paint, interior paint and deck hardware.

The new rig was quickly determined to be our longest lead-time item and became our initial focus. Lloyd flew off to visit several spar manufacturers. In the meantime, I began to draw sailplans, determined to restore helm balance to the boat. Over the years *Phaedo* had grown some nasty lee helm characteristics. She was difficult to keep in a groove upwind, and easy to stall downwind, losing apparent wind speed.

About this time I was also participating in sea trials in Maine on *Phaedo*'s Gunboat 66 sistership *Slim*. She had just received new longer daggerboards. The helm balance on *Slim* was, frankly, the best I had felt on a Gunboat and provided wonderful validation of the preceding numerical analysis.

By now Lloyd had completed his reconnaissance mission and Southern Spars were selected as the manufacturer of the new mast, boom, longeron and forward crossbeam. Paired with this decision, Burns Fallow from the North Sails New Zealand loft was selected as *Phaedo*'s new sail designer with support from Mark Sadler of North Sails Palma.

Rig height was increased 9% while by 18%. Focus was given to maintaining a reasonable vertical centre of effort while still boosting the available area for optimal light-air performance. As the sailplan and initial appendages were developed the decision was made to optimise for the RORC Caribbean 600 race. This is *Phaedo*'s home racetrack and an adventure that she has already enjoyed twice.

A custom mast section was optimised using CFD analysis and issued to Southern Spars who built a new female mould specifically for *Phaedo*. Engineering advances in the TPT Gold laminate and EC6 rigging allowed Southern to remove further weight from the mast (around 27kg) within the confines of the aerodynamic section. The result is a spar that is taller, lighter, yet some 140mm lower in vertical centre of gravity, and more aerodynamically efficient than the original rig.

We spent some time looking at the option of a rotating rig, but in the end stayed with the fixed rig. There are those who believe a rotating rig is always the right answer on large performance cruising catamarans, but the facts are not that black and white. For example, the Gunboat 66 is an extended Gunboat 62 that was drawn in 2002. By 2014 standards *Phaedo*'s hulls have ample rocker and very round sections. This combination does not offer the longitudinal stability of modern hull forms. The

For a boat with hot and cold-running everything, *Phaedo* pops a hull (*below*) with little encouragement and makes a fearsome match for raceboats like the Maxi 72s over an offshore course. The reduction in chord of her new and deeper foils (*right*) is evidenced by the 'spacer' that now fills her daggerboard slots. Nice lifting rudder foils (*far right*) complement shallow water access while the latest spar from Southern is both lighter than its predecessor and also boasts a lower VCG

seaway, and the rig wags fore and aft. This movement dramatically decreases the lift generated by the mainsail.

A fixed rig is typically lighter than a rotating rig with a lower vertical centre of gravity. Pitch amplitude is decreased by using a fixed rig, thus increasing aerodynamic efficiency. Of course, a rotating rig increases aerodynamic efficiency by providing more favourable flow into the mainsail. So which solution offers the better efficiency? For *Phaedo* it was too close to call. The rig configuration split in the Imoca 60 fleet highlights how fixed and rotating rig solutions can converge in performance. In the end, *Phaedo* went with the simpler solution with fewer moving parts. This also allowed the deck plan to be cleaned up and sailing operations to be simplified. The deck-stepped mast base executed by Southern Spars, featuring Winmar turning blocks, is a work of art.

The single largest performance gain available to a stock Gunboat 66 is to replace the daggerboards. When the Gunboat line was originally conceived they were cruising boats first that occasionally participated in intermural racing. Gradually, the driven individuals who own these boats have demanded more performance. So the stock daggerboards that did not extend above the decks when retracted have gradually been replaced by longer daggerboards that feature reduced chord, thickness and drag. Both asymmetrical and symmetrical solutions had been designed and implemented prior to *Phaedo*'s refit. Given this previous experience, Lloyd Thornburg asked me to further optimise

The first step was to get the tools in order. We worked with Clay Oliver to calibrate his latest VPP software. I was also able to feed Clay live performance data from *Slim* while racing in the 2014 St Maarten Heineken regatta. This data, and Clay's tireless development, have increased the accuracy of the WinDesign VPP for the entire Gunboat fleet and other new performance cruising catamarans currently under development.

We then created a Caribbean 600 race model within MatLab. This high-fidelity tool allowed me to input different VPP polar sets and 'race' the boats. Controls were established to change course conditions to simulate a wide range of 'what if' scenarios. With the tools in place three candidate daggerboards were created:

- S-Boards – designed to provide some downwind vertical lift while still maintaining upwind pointing (asymmetrical sections).
- C-Boards – primarily targeting offwind vertical lift (asymmetrical sections).
- Straight Boards – engineered to maximum possible span within the confines of the existing daggerboard cases. Targeting light-air upwind work (symmetrical sections).

Polars for each daggerboard set were loaded into the race model and the virtual Caribbean 600 was on! The results were fascinating as there were multiple lead changes around the course. Each option pulled to victory in different conditions. Overall the S-boards were the fastest, the C-boards were second and the straight boards were last. What was surprising was into a remarkably tight data cluster.

The dock consensus that the Caribbean 600 is won or lost behind Guadeloupe was reflected in the race simulation. And in that situation it was always good to have the long, straight boards to get out of the hole. Armed with the results of the race model, all agreed that the straight boards offered the best value while producing the largest improvement on *Phaedo*'s weakest point of sail, upwind in light air.

With the straight daggerboard decision made, the focus then shifted to executing the appendage details to the highest possible level. We contracted Nat Shaver to optimise foil sections for both the daggerboards and the new rudders.

Nat was rolling off an intensive few years with the Emirates Team New Zealand America's Cup challenge specialising in foil development. During the Cup very specific programs were developed that allowed the team to save time and become much more efficient in pursuing the many and varied foil concepts tested. After the Cup ended it was clear that this sort of tool would be very useful for projects outside the Cup, saving time and therefore clients' money while allowing a level of analysis not usually applied to those projects. Nat took it upon himself to develop a set of tools from scratch that work well for this sort of project, and the *Phaedo* refit was a perfect place to put these tools to work.

Built into the code is a lifting line and vortex lattice analysis to quickly analyse changes in the design. Using a quick

parameterisation of the foil geometry inherent in the tool, it is a simple task to add optimisation routines. Applying a cost function based on VPP derivatives of drag and roll moment, design changes such as tip twist and chord distribution can be explored and optimised for the expected operating conditions of the foil. Once these parameters are set, you can automatically create an iges (or any other format) file which can go straight to a CNC or analysis program. Removing the usual multiple steps between the design definition and the analysis tool or the builder has proved both to save time and reduce human error.

While the daggerboards and rudders on *Phaedo* might not have all of the curves and kinks of the AC72s from the last Cup, their development was directly influenced by the AC72s' design methods. Using integrated geometry definition and analysis tools, the client was able to take advantage of a level of analysis that is not usually applied to projects outside the Cup. Using these methods, the section drag was decreased by 8% at the design cruise condition when compared to old reliable NACA sections.

With the section finalised the composite structural engineering was completed. With first-hand knowledge of how the professionals 'send it' on *Phaedo*, adequate safety factors were maintained within dynamic load cases. Well aware that the engineering did not leave any room for construction abnormalities, Core Composite Builders in New Zealand were selected to fabricate the daggerboards and rudders.

Core use an innovative build method that avoids a blind centreline glue bond on each foil. The result of their meticulous attention to detail is an inspired confidence in the appendages as *Phaedo* blasts through waves at speed.

Overall weight has been reduced in both racing and cruising modes. Solar panels have been stripped from the cabinhouse, drawer on the boat with featherlight carbon and foam units. Each stainless steel bolt and padeye has been replaced by titanium hardware supplied by Ti64. Even the new rudder bearings are titanium. All these small weight reductions have a positive cumulative effect on the boat's motion and performance.

Overall the boat has lost some 288kg in dry-weight. Probably more important, the vertical centre of gravity has been lowered by 48mm which together with the lighter rig delivers a measurable reduction in pitching and consequent improvement in the aerodynamic efficiency of the sailplan.

On most projects the devil is in the details. On *Phaedo* the pirate is in the details. The boat's pirate logo can now be found everywhere from the tip of the longeron to the front of the BBQ. No stone was left unturned in terms of finish quality both inside and out. The recognisable Lamborghini Orange has now taken on a metallic blood-orange hue that makes the old colour pallet look tame.

On the first day of sea trials Brian Thompson, Jules Verne record holder on *Banque Pop V*, was monitoring performance through the Expedition software on the nav station computer. The numbers that Brian was referencing were the old numbers that matched *Phaedo*'s performance perfectly during the Transpac Race before the refit.

We were heading upwind in light air, and it did not take Brian long to proclaim that we were sailing at '120% of the old polars'. We cross-referenced the new VPP estimates and, sure enough, 120% made sense. When the Expedition software reminded us how far the boat had come there were high-fives and smiles all around. The *Phaedo* refit effort was a team effort led by Lloyd Thornburg and managed by Captain Paul Hand. The process was enjoyable, and we have already begun work on the next project. I would like to tell you more, but it

ULLMAN SAILS

PERFORMANCE
WORLDWIDE

AUSTRALIA
BRISBANE +61.7.3348.7245 andrew@ullmansails.com.au
SYDNEY +61.2.9529.8546 bruce@ullmansails.com.au
WHITSUNDAY +61.7.4948.3016 whitsunday@ullmansails.com.au

CARIBBEAN
ST. MAARTEN +721.544.5231 rgilders@ullmansails.com
TRINIDAD +1.868.634.4178 info@ullmansailstrinidad.com

CROATIA
RIJEKA +385.51.288.661 grego@ullmansails.hr

DENMARK
AARHUS +45.29.42.05.79 larsbo@ullmansails.dk

FRANCE
LORIENT +33.0.297.350.723 ceb@ullmansails-atlantique.fr
MARSEILLE +33.68.776.8998 pboronat@ullmansailsrsa.com

GERMANY
SCHWERIN +49.385.581.33.12 info@ullmansailsne.de

ITALY
PARATICO +39.035.917.847 info@ullmangz.it
TRIESTE +39.040.832.3434 ullmansails@ullmansails.it

JAPAN
KANAGAWA +81.46.882.2791 info@ullmansails-japan.com

NETHERLANDS
BROUWERSHAVEN +31.111.695.222
wgarschagen@ullmansailssouth.nl

NORWAY
DRAMMEN +47.32.818.495 peter@ullmansails.no

RUSSIA
ST. PETERSBURG +7.921.797.30.11 ullmansails@mail.ru

SOUTH AFRICA
CAPE TOWN +27.21.593.1620 warren@ullmansailsrsa.com
DURBAN +27.31.304.5504 c.millar@ullmansailsrsa.com

SWEDEN
SKARHAMN +46.0.730.608.493 info@ullmansails.se

SWITZERLAND
ROMANSHORN +41.71.793.1249 info@ullmansails.ch

TURKEY
IZMIR +90.232.257.6341 info@ullmansails-turkiye.com

UNITED KINGDOM
PLYMOUTH +44.0.1752.550040 chris@ullmansails.co.uk

UNITED STATES OF AMERICA

CHESAPEAKE
EASTON +1.410.310.7992 msimington@ullmansails.com
DELTAVILLE +1.804.776.6151 jerry@ullmansails.com

GREAT LAKES
CLEVELAND +1.216.486.5732 ullmancleveland@aol.com

SOUTH
NEW ORLEANS +1.985.626.5638 gulfcoast@ullmansails.com
SARASOTA +1.941.951.0189 ullmansails@ullfl.net

WEST COAST
HONOLULU +1.808.593.9958 ullmanhi@artnelsonsailmaker.com
SAN DIEGO +1.619.226.1133 sailsinfo@ullmansailssandiego.com
SANTA ANA +1.714.432.1860 ullman@ullmansails.com
SANTA CRUZ +1.831.454.0868 dhodges@ullmansails.com
SEATTLE +1.206.234.3737 sailsinfo@ullmansailsseattle.com
VENTURA +1.805.644.9579 ullmanventura1@att.net

ULLMAN SAILS
ULLMANSAILS.COM