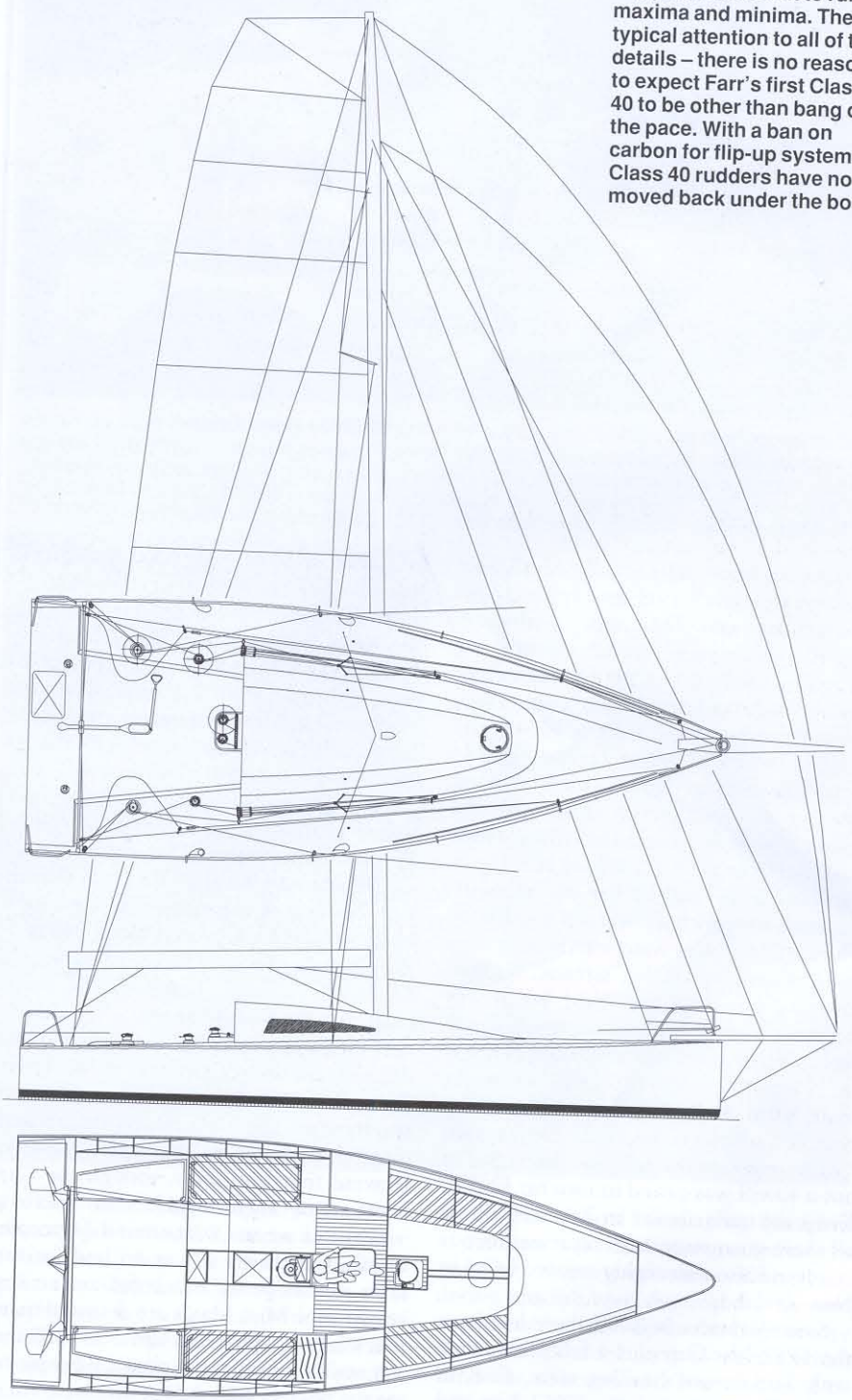
Into the fray

Farr Yacht Design enter the Class 40 arena



A refined shape with good engineering employed to get key parameters out to rule maxima and minima. Then typical attention to all of the details – there is no reason to expect Farr's first Class 40 to be other than bang on the pace. With a ban on carbon for flip-up systems, Class 40 rudders have now moved back under the boat

As evidenced by the many inches of copy devoted to new Class 40 projects in recent issues of this magazine, it should be apparent to all that the Class 40 market is continuing to grow in spite of the current economic situation.

There are many reasons for this meteoric growth but at its core the Class 40 rule promotes fast, high-performance offshore-capable boats that are well suited to shorthanded sailing. This is achieved within a strict and relatively stable set of rule controls that effectively limit build costs and produce equitable performance between different boats. The final ingredient is a diverse calendar of events covering the spectrum between inshore crewed racing, coastal sprints, transatlantic races and even round-the-world racing for the most adventurous.

At Farr Yacht Design we have been watching Class 40 developments with interest for some time, looking for the right opportunity to bring our extensive Volvo Ocean Race and Open 60 offshore design experience to bear on this exciting class. In October 2009 we contracted with Lapo Ancillotti's BTBoats of New Zealand to develop a new limited-production Class 40 design to be constructed in New Zealand by Cookson Boats. The hull tooling is well underway and it is anticipated that the first boat will splash down in August 2010.

The Class 40 presents some unique design challenges that require careful analysis and optimisation. While seen by many as a small Open 60, they are quite a bit heavier for their length than a modern Open 60 and this has important implications in the development of the hull characteristics. The boats are very powerful [righting moment at 20° is more than double that of a Farr 40 One Design!], largely a result of the large maximum beam, outboard water ballast and reasonably deep draft. The high beam-to-draft ratio results in a hull with large wetted area and so there is a premium on minimising this, especially when upright so as to keep light-air performance acceptable.

The rule limitations also present a rather low sail area for a boat of this power; while this serves the boats well in stronger breezes, especially offshore, it does pose challenges to maintaining light-air performance. This is one reason for the increased use of Code 0 sails tacked on the sprit to increase the available horsepower.

To gain a proper understanding of some of these trade-offs we felt that a focused computational fluid dynamics (CFD) study was required. Working with our longtime collaborator Len Imas of Stevens Institute of Technology we completed an intensive CFD study of Class 40 hull forms exploring the performance effects of chines, transom immersion, longitudinal hull shaping, bow fullness and section style. Over the course of multiple shape evolutions the insights from these simulations [both forces and flow visualisations] allowed us to refine our hull shapes progressively, resulting in drag reductions of 3-5% over much of the speed range at typical heel angles. Additional studies were completed

on the sensitivity of the boat to trim and in optimising the placement of water ballast.

The idea of applying such computational fluid dynamics technologies to a problem like the Class 40 would have been a non-starter only a few short years ago. But after many years of applying these tools we feel it is now feasible to complete such studies in an efficient and cost-effective manner. Calm water drag reductions of these magnitudes are significant and serve to remind us that even subtle shape changes can have significant impact on performance.

However, small boats such as the Class 40 do not really sail in calm water and in fact spend much of their time sailing in waves that are of significant height relative to the boat size. This has some very significant implications on hull form shaping, driving towards reduced transom immersion levels upright and at heel, generally more keel spring (rocker) throughout and a focus on bow shaping and overall bow fineness to maintain effective length without incurring added resistance penalties.

One of our prime objectives with this design was to create a hull that has exceptional handling characteristics when sailing both upright and heeled. This allows the boat to be driven harder even in adverse conditions and to dynamically maintain bow-up trim for better handling with less reliance on water ballast. These qualities translate into higher sustained average speeds, especially when running and high-speed reaching in deep ocean conditions. The challenge is to incorporate these features without sacrificing light-airs performance or adversely impacting upwind performance especially in waves.

The resulting hull shape is, as on many of the latest generation of designs, in the maximum beam corner of the rule space. The boat features a pronounced, almost full-length chine with very evenly radiused sections below to minimise wetted surface and provide a hull with an even and consistent heel response in drag and helm load.

The transom immersion levels and chine placement have been carefully tuned relative to expected heel angles and water ballast weight additions to avoid excessive drag in light airs but maximise effective length when sailing at heel and speed. To achieve a dynamic bow-up attitude at heel and speed the LCB of the hull is reasonably aft, also moving the keel and rig aft.

The section shape leading into the chine forward is designed to maximise the ability of the chine to shed water away from the hull and to provide significant hydrodynamic bow lift when entering a wave without requiring the added build complexity of a full VO70-style strake. This is also a more all-round performance solution for sailing upwind in waves, although a boat targeted specifically for upwind-biased races may be better suited with alternate chine/section shape treatments.

This design has been carefully refined to meet Class 40 controls including Category 0 compliance and new aft escape hatch requirements from the outset. A detailed focus on the construction and engineering of the yacht's structure has simultaneously allowed us to reach the minimum rule displacement and maximum 90° pull down test requirement, positioning the boat for optimal performance relative to the rule limits.

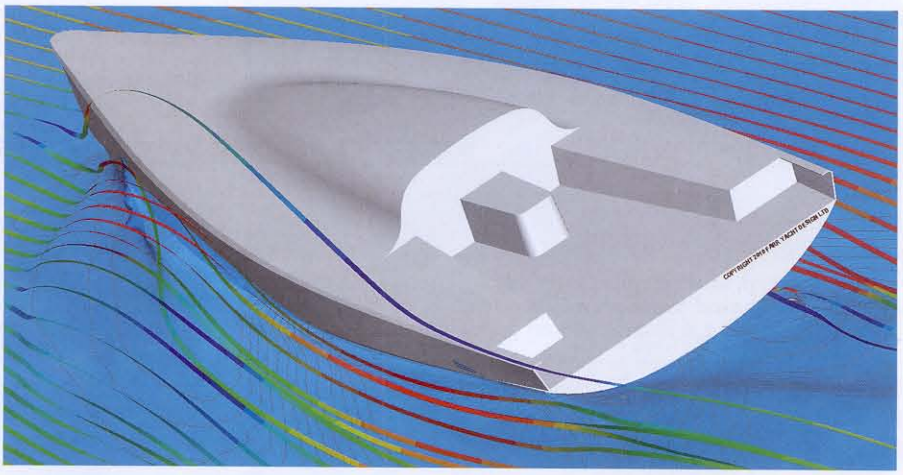
The deck geometry and layout incorporate input from a variety of areas to produce a clean, functional and ergonomically efficient arrangement well suited to short-handed sailing in distance races. The arrangement incorporates the dual companionway, central line tunnel concepts originally pioneered on our Open 60 Design 498 *Virbac-Paprec*, and a winch layout specifically suited to the unique Class 40 rule restrictions and demands. Careful attention has been paid to developing an ergonomic layout and efficient steering systems to maximise crew protection while allowing the crew to hand-steer effectively and trim the sails easily.

This logic has been extended through to the mast design and rigging layout where emphasis has been placed on maximising the crew's ability to control the sail trim and mast bend. This is highlighted by the selection of a keel-stepped mast with a proper vang arrangement to improve mainsail control. The mast is a two or three-swept spreader carbon mast with chainplates located inboard to allow narrow sheeting angles for the Code 0 sails.

Detailed studies of sail sizes and parameters have been completed to develop a well-balanced sail plan with appropriate headstay control. Additional time has also been invested to ensure an even usage profile over each of the sails to maximise sail life. We have also developed a set of candidate sail inventories that can be selected to mode the boat more appropriately for different races. This is of particular importance when sailing under Class 40 rules where the sail inventory is limited, magnifying the importance of each sail and emphasising the need to match the inventory to a particular event.

In developing this design we have opted where possible to create a flexible platform that can be customised for a client's specific needs and sailing programmes. The bowsprit may either be fully articulating or fixed with a separate spinnaker pole. Chainplate attachments and rig configuration have been designed to allow the option of inboard diagonal shrouds. Crew protection is facilitated by a removable dodger that can be used offshore and left behind for sprint races.

The interior arrangement has been designed for racing functionality with ample berths, head and galley for offshore use. The interior features the four rule-required fixed-bottom berths that are supplemented with pipe berths for racing. The engine is situated forward in the main compartment with its box forming the navigation seat. Various options for interior layout are available to suit individual owners but great attention has been paid to developing an internal structural arrangement that will permit easy moving of gear and sails to alter trim.



The keel is a high-aspect fin with T-bulb incorporating our proprietary foil sections to achieve a good balance of drag and lift. The fin is built from fabricated steel with a grp fairing, attached to a squished lead bulb. The keel attachment has been engineered to simplify boat assembly.

The bulb shape is an extension of an ongoing series of bulb studies using transitional flow CFD studies to minimise drag while taking into account the significant accelerations that occur due to boat pitching motions in real-life conditions.

The design features twin rudders mounted under the hull with a direct linkage steering system and single tiller. The rudders are located under the boat to simplify construction and installation and to minimise overall weight. The use of an Open 60-style kick-up rudder system can be incorporated for round-the-world racing but the construction material constraints of the Class 40 rule make this a heavy and costly consideration.

The rudder sections and planform shapes are optimised to provide excellent control while minimising cavitation at high speed and are within the structural limitations of class rules on rudder stock material. We are looking forward to seeing the first boat in the water later this year.

Britt Ward, Farr Yacht Design ❑