Design: OPEN 60 “SAFRAN” for Marc Guillemot

The architect association

We did associate two design offices to create this project:

-**VPLP** highly experienced in the multihull world: Groupama3 holder of the main Atlantic records in broken Atlantic in early 2007, designers of the winners of the 5th last Route du Rhum including Groupama2, designers of the next Banque Populaire4 120'record breaker trimaran to be launched in July 2008 and designer of the next fleet of 14 WSL catamarans for Lagos sports, Russell Coutts and Paul Cayard

Guillaume Verdier works nearly exclusively in racing boats, but both multihulls (Yves Parlier, appendages design together with VPLP) and monohulls (IACC designer +structure and appendage design for Areva; refit of PRB/VMI for last Vendée Globe together with Pascal Conq).

We thus decided to join our approaches and experiences believing that a mixed culture of offshore racing boats could be favorable.

From beginning we shared the work amongst us as follow:

VPLP was responsible for project management/deck layout/sail plan/ helm balance stability and weight estimate.

Guillaume Verdier was responsible for hull shape design / structure design/ keel and mechanic design.

We did share the performance analysis and the whole appendages design together with Mick Kermarec who was in charge of the VPP developments in accordance with the Woolfson Unit tank experience.

The boat Philosophy

Marc Guillemot and our design association were chosen together by Groupe Safran
We came as a group to present our philosophy of a radically light and simple boat (in appearance).

The Sponsor is a highly technological one: SAFRAN is the joint venture of two companies: SNECMA building aircraft and rocket engines, and SAGEM for civil and military electronics.
They proposed us to use some of their experience/ technology together with their usual design procedure.

Most of all they wanted to fully understand and trace our design approach.
They had a clear vision of all trade offs done in design, allowing them to discuss the choices.
They gave us the opportunity to develop with long enough timescale in order to build up the full spiral with Pre-Projects, CFD, Towing Tank, VPP, weight estimate, etc..

This design process was split in four phases:
Proposal / Pre-Project / final Pre-project / Project.
It sounds quite classical, but having a design process extremely formalized, with trade off fully argued saves time since you do not have to come back on the decision.

Marc Guillemot's large experience in single handed multihulls pushed for a very sober boat, with minimalist choices privileging before anything weight objective, reliability, and a very compact deck organization within the cockpit zone.
A light boat shall be less demanding both physically and mechanically. For a solo program, it was essential to minimize the human effort, and make sure that the boat won’t remain stuck if not tuned at its maximum potential.

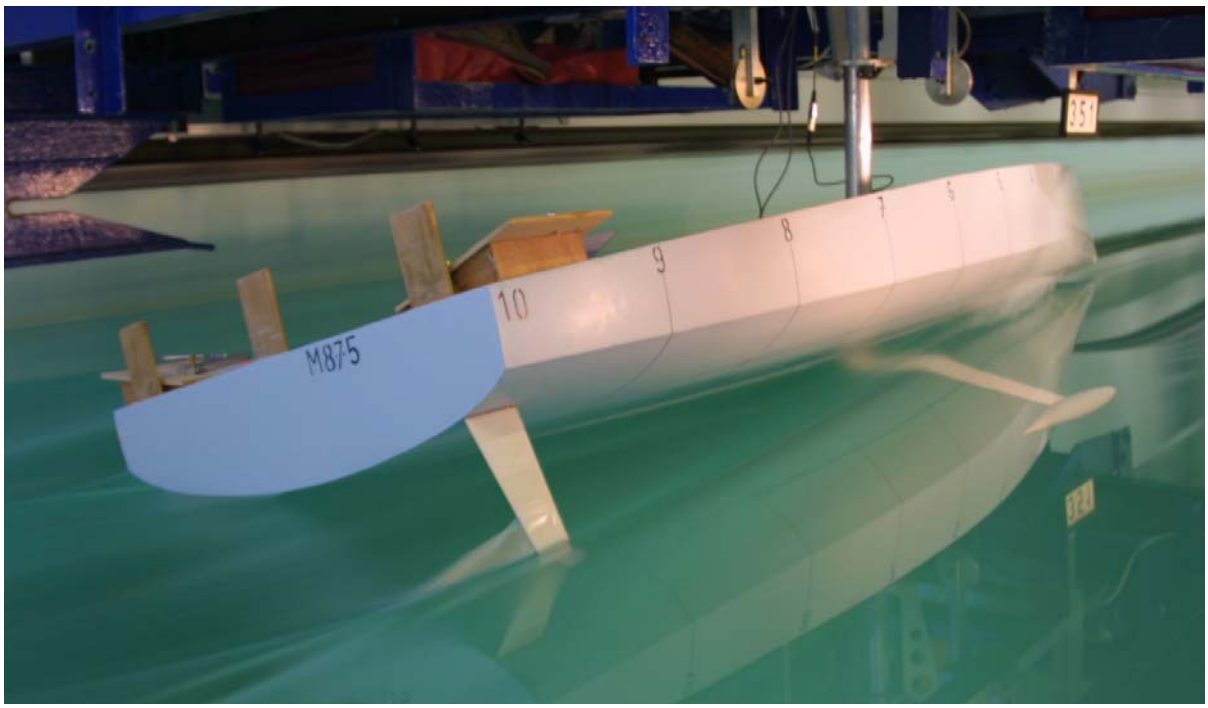
The cockpit concept is issued from last multihulls cockpits:
All winches are centered near boat center line: One pod in the cockpit front holds three winches while a second pod in the cockpit aft drives the 2 winches for backstays and main traveler. The mainsheet

track is curved and goes far forward in order to have a good leech tension when reaching .This configuration helps to center cockpit layout weights, and gives to the skipper a more sheltered and safer space when maneuvering. Such configuration allows lots of variants and is valuable in the case of limited crew.

Marc Guillemot and his team built up a full scale model of the boat in order to evaluate and refine choices in terms of deck/roof/interior. The model could heel as needed.

Photo Marc Guillemot: full scale model for ergonomic optimization

The hull shape



Sailing at 18 knots and 15 deg of heel - ***photo Wolfson Unit***

We selected using a CFD / VPP code run by Mick Kermarec/Sandrine Lescaudron three hull shapes, one of which was a reference, the two others having a variance in geometric parameters. The tests were done with the Wolfson Unit under the supervision of both John Robinson and Martyn Prince.

We first ran at speed up to 18 knots at the Southampton Institute in order to classify the geometric parameters.
Later on for a second tank cession we ran at higher speed on the Isle of Wight where we also did work more specifically on the appendages configuration. Each hull had similar righting moment in order to visualize quickly in the towing tank the effect of individual parameters on performance.
The work developed on such hull shape with hard chine started really in 2001 when Raphael Dinelli asked to design a new open 60. The mould was built, but the boat construction had to be suspended due to lack of money.
At the time the goal of developing such “aft” chine was to better exploit the rule and gain in dynamic stability.
The design of Safran’s hull was orientated in the view to start planning safely very early.
We tried to have a distribution of the righting arm spread over the hull length, thus avoiding the typical nose diving when reaching, and allowing us to reduce the overall max beam s expensive in terms of drag penalty.

The Sail Plan

The rig is classic with three spreader level. The choice was driven by the wish to have a very stiff appendage with pre-stress for which you do not have to worry about when sailing in solo. The mast is located quite aft in order to give more importance to the fore sails, as well as keeping a very high aspect ratio on the main.

OPEN 60 SAFRAN / SKIPPER : MARC GUILLEMOT
PREMIERES NAVIGATIONS AU LARGE DE LA TRINITE SUR MER (FRA) - 11/08/2007
PHOTO : JEAN-MARIE LIOT / DPPI / SAFRAN

SAFRAN

The construction

We chose together with Marc, his team driven by Thierry Brault and the sponsor driven by Pascal Chadail one of the most talented possible builders.
Thierry Eluere has built Ecureuil d'aquitaine 2 (T.lamazou), Lège Cap Ferret, Fujichrome,VMI, Aquitaine Innovation, Mediatis region aquitaine, Sodebo..).

The building quality and ingeniosity is a key for weight saving and boat reliability. Also the experience is essential for approaching safely the lower weight limit.

The yard starts by proceeding with the construction of samples to validate both the mechanical properties as well as the building process.
We also had the opportunity to choose amongst a wide variety of carbon, honeycomb and titanium at disposal from Groupe Safran.

Photo Groupe Safran

Photo Thierry Eluere

Photo Thierry Eluere

A lot of the quality comes from the immense help of Romaric Neyhousser who used to work with Guillaume Verdier. He was on site interfacing the work between the yard and the design office and was also in charge of quite a few complex design subjects such as the keel mounting and the rudder system.

The structure

The structure was performed in house by Guillaume Verdier.
Working on the structure together with the whole design allows keeping a global vision and remains logical in the integration of everything. The shape of things has to be in correlation with its structure. This is typical when comes the design of the appendages for which you look for a fine trade off between a resistance gain and the stiffness of the fin.
The weight goal was the key of this project, but for the Vendée, you also need a redundancy in the system allowing you to carry on whatever happens. It is a challenge because you do not want to make twice the structure weight for this goal.
Following this logic of redundancy we had a design approach that tries to foresee what happens when an element brakes. For instance such processes were deeply investigated on the hydraulic Ram system developed by Cariboni and followed by Messier Bugatti (Messier Bugatti usually build ram systems for airplanes). The boat should be capable to work in a degraded mode concerning the ram, the hydraulic, the rudder.
Similarly the hull is ramified like a tree's leaf with thin skins and numerous thin structures.

A global Composite Finite element model in shell elements was created. Secondary models were then built up to check for local load introductions such as the keel or the hydraulic Ram fixation. The FE model is linked to a parametric CAO platform (CATIA) thus allowing numerous structural optimisation (ballast position etc..) without having to rebuild everything.

The Appendages

Daggerboard
A set of curved asymmetric daggerboard was chosen for the following reasons: Not only a positive trade off was found to be efficient when reaching, but also it provides an interesting damping effect in the sea.
Finally it was very helpful for limiting the interaction with the fore sails on deck since the daggerboard head is located much more toward deck centerline.

Fin and bulb
The towing tank helped us understanding the optimum drag for the various appendages configurations. The balance under sail was finally checked with the VPP, as well as with our usual experience.
We went for a fin design with maximum aspect ratio, which goes together with a long slender bulb, also helping us to lower the center of gravity.
We did some research together with Groupe Safran to locate optimally the fin centre of torsion relative to the center of gravity of the bulb. We also worked on defining the trade off causing the keel vibration in a torsional mode as a function of the following parameters: Keel thickness –Thickness to cord ratio and bulb length. This problematic is well described in the case of a reactor fixed to an airplane wing.

The keel test

The keel was made out of a carbon. The calculations were performed in house but doubled check with Groupe Safran.
We decided to test the keel under load at the SNECMA with a specific bench mounted on site.
Such a test both gives confidence to the sailor into the integrity of his fin as well as it gives us the opportunity to validate our finite element calculations.
Not only we measure the level of stress and deflection along the keel, but we also check for the natural frequencies in vibration. Such a procedure is compulsory in the aeronautic field. By repeating the “Ping” test systematically after a transatlantic or long sailing cessions like a vendée gives a clear indication of an eventual degradation of the appendage. A lower natural frequency in vibration would indicate a degradation of the fin.

Keel fin after machining at Aircell from groupe Safran

Keel fin under load test at SNECMA-Villaroche – Photo Groupe Safran

The rudders

We all were in favor of lifting rudders. We got rid of the rudder cassette which is proven to weight as much as a rudder. We ended up by fixing directly the fin to the stern saving us a lot of weight. The forward part of the rudder is under the hull in order to increase its effective aspect ratio, and we developed a very compact mechanical system allowing us to lift up the rudder very easily without

loosing compensation. Romaric Neyhousser who also followed the construction for us was in charge of this mechanical system restrained by a hook in case of sudden impact.

Conclusion

We now are in the process of validating both its structural and performance qualities with the help of Charles Caudrelier assisting Marc Guillemot to verify our theoretical polar predictions as well as all the best possible keel / ballast / daggerboard / sail configurations.
The boat benefited from an outstanding construction quality that might comfort Marc for the Vendée Globe.

We now have a second boat sailing, very recently launched, for Kito de Pavant: “Groupe BEL” A lot of its architecture philosophy remains identical apart of the sail, deck plan, roof daggerboards and rudders.
Kito has opted for a wing mast a little shorter in height, but slightly more efficient aerodynamically and a well protected steering position. Its rudders are located under the hull and are fixed into a lifting box.