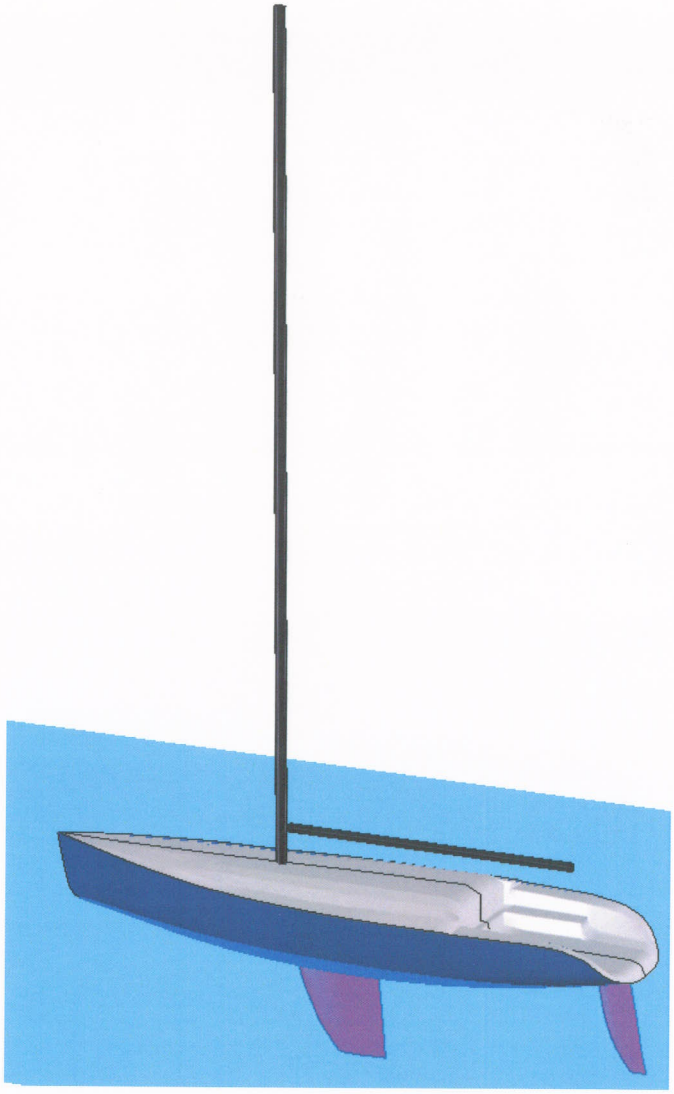
Problem Set 5

Design of a 15m Fast Cruiser



by
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Design Philosophy

The objective of this project is to design a fast off-shore cruiser, with reasonable comfort. The boat should be easily handled by a crew of two, and will provide long-term accommodation for up to 6 persons. This leads to consider a boat with an overall length of 15m, a maximum Beam of 4.2m, for a total displacement slightly below 13000kg. In order to obtain good performance in both strong and light winds, the Cp of the canoe body is 0.56 and the position of the LCB is at 4% of the waterline length aft amidships. The main dimensions of the design are presented in Table 1, with the corresponding non-dimensional ratios.

General Dimensions			Ratios	
LOA	15	m		
Lwl	13.5	m	LOA/Lwl	1.11
Bmax	4.24	m	LOA/Bmax	3.54
Tc	0.6	m	Lwl/Tc	22.5
Tmax	2.8	m	Lwl/Tmax	4.8
Cp	0.56			
Total Displacement	12.624	m3	LDR	5.80
Total mass	12940	kg		
Ff	1.55	m	Ff/Lwl	0.12
Fa	1.2	m	Ff/Fa	1.33
Total Sail Area	131.56	m2	SA/Disp^2/3	24.3
Wetted Surface	48.6	m2	SA/WA	2.7

- Table I: General Yacht dimensions -

Hull

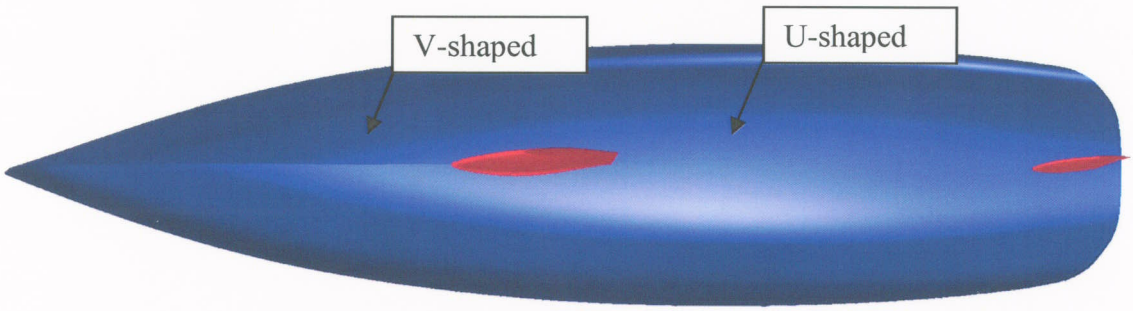
The design of the hull is performed using Maxsurf. The final design meets the most important geometric specifications, Tc, Bmax, Lwl, canoe body displacement, Cp and LCB with a good precision. Some others parameters such as Bwl or LCF slightly differ from the initial specifications, but this leads to a more consistent design. Accepting these minor changes allows obtaining a better hull shape and we expect improved performance and seakindliness. In order to improve the crew comfort, we made the bow less vertical, keeping the Lwl constant to 13.5m: the forward overhang increased from 0.4m to 0.55m. This is expected to decrease the amount of water that can reach the cockpit and wet the crew. By trimming the hull with the deck, we get a slightly shorter overhang aft, which exactly compensates the increase of overhang forward to keep the LOA at 15m.

Table II compares the main parameters of the final design to the initial specifications.
The profile view, the plan view and the body plan are respectively shown in appendix 1, 2, and 3.
As we can see on the profile view, the bow is slightly hollow below the DWL in order to ensure a fine entry in the water. For the same reason, the hull has a sharp V-shape forward of the keel. The hull then becomes perfectly smooth, with a wide U-shaped bottom aft of the keel, in order to avoid flow separation at the centerline when the hull is heeled and moves with a leeway angle (so, essentially when beating upwind). The flat bottom should also ensure good

performance downwind, with potential surfing in strong winds under spinnaker. These features of the hull shape are illustrated on figure 1.

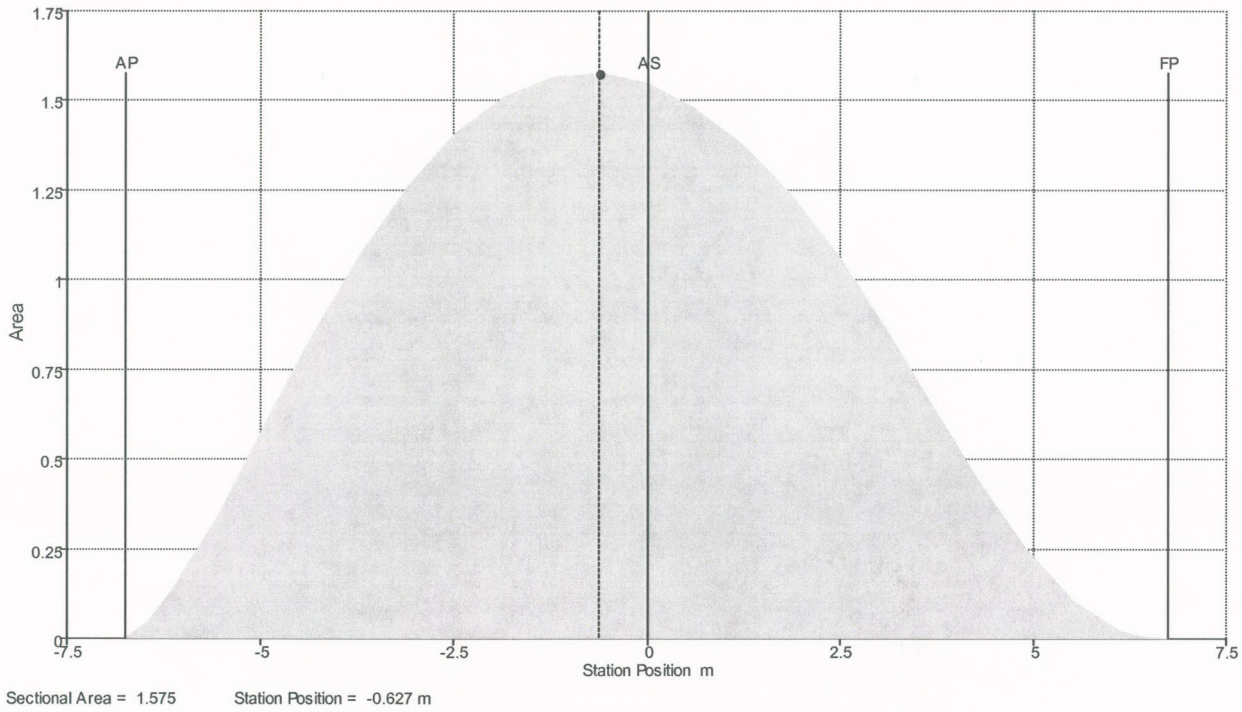
Hull Design Parameter	Final	Initial	Unit
LOA	15	15	m
Overhang Fwd	0.55	0.4	m
Overhang Aft	0.95	1.1	m
Lwl	13.5	13.5	m
Bmax	4.24	4.2	m
Tc	0.6	0.6	m
Cp	0.56	0.56	
Disp Canoebody	11.922	11.959	m3
Amax	1.581	1.582	m2
WSA	37.4	32.24	m2
LCB	3.8%	4%	% of Lwl aft from amid
LCF	6.8%	3%	% of Lwl aft from amid
BM (canoe body only)	2.158	2.534	m
Bwl	3.499	3.68	m
VCB (canoe body only)	-0.217	-0.2	m

- Table I: final hull design parameters compared to initial specifications -



- Figure 1-

Figure 2 shows the sectional area curve of the canoe body. The aft part is almost linear to ensure good performance, and the forward part slightly convex. Table 2 shows the results of the upright equilibrium analysis by Hydromax. The LCG has been adjusted at the vertical of the LCB, such that the hull has no trim angle.



- Figure 2: Canoe body sectional area curve -

Displacement kg	12940
Heel to Starboard degrees	0.0
WL Length m	13.984
WL Beam m	3.499
Wetted Area m^2	47.687
Waterpl. Area m^2	34.084
Prismatic Coeff.	0.444
Block Coeff.	0.092
Midship Area Coeff.	0.216
Waterpl. Area Coeff.	0.697
LCB from Amidsh. (+ve fwd) m	-0.307
LCF from Amidsh. (+ve fwd) m	-0.691
KB m	-0.279
KG fluid m	-0.203
GMt m	1.968
GMl m	26.861
Immersion (TPc) tonne/cm	0.349
MTc tonne.m	0.249
RM at 1deg = GMt.Disp.sin(1) kg.m	444.428
Max deck inclination deg	0.0
Trim angle (+ve by stern) deg	0.0

- Table 2: Free floating equilibrium analysis (Hydromax) -