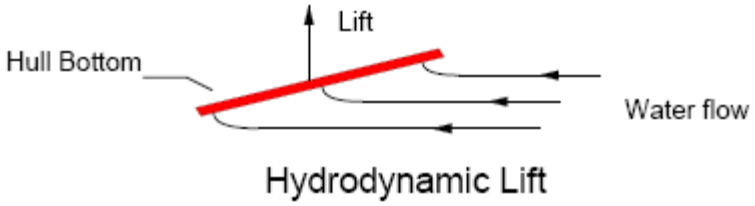
Planing Hulls

In my previous article, I briefly discussed and touched on the different hull shapes available, how they work and how to distinguish these hull forms from one another.
In this article, I will be focusing in greater detail on planing hulls – such as why they ride on top of the water, how to evaluate a planning hull and provide you with some tools to assist you in choosing the right planing boat for your needs.

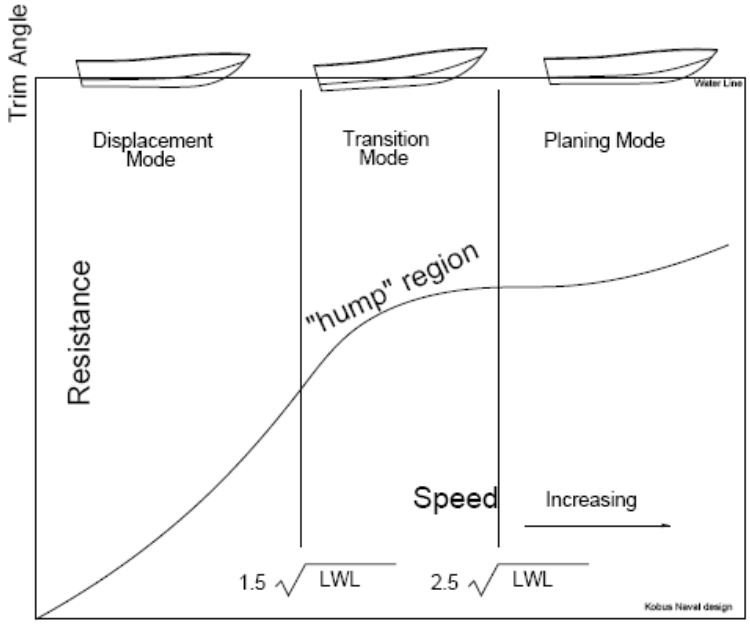
How do Hydrodynamics relate to planing of a boat?

A planing hull uses hydrodynamic lift to rise up and out of the water to reduce resistance. In order to plane the hull must achieve an appropriate angle of incidence to the water flow, trimming up by the bow to generate lift.

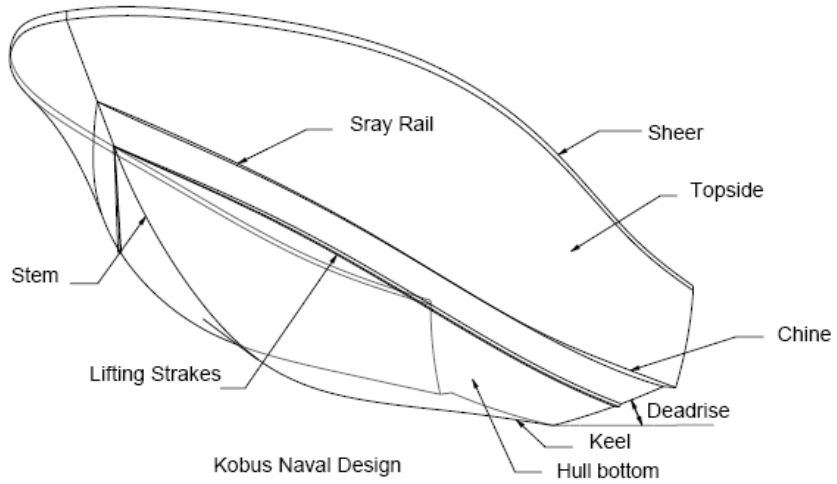


Hydrodynamic Lift

This is a similar lift principle that an aircraft use to get aloft. As the generated lift approaches the weight of the boat, the hull rises from the water and start to plane.
The speed-power curve below shows how much resistance a boat generates as speed increase. As the boats speed increase in displacement mode, the bow trims up and the stern squats. At a speed roughly equal to 1.5 times the waterline length, if the hull is designed to plane, it will move into a transitional region where it is neither planning nor operating in the displacement condition. In this semi planning or hump region, the boat will have pronounced bow-up trim. When it breaks through the hump to a true plane (thanks to hydrodynamic forces), its speed increases and trim levels out.



Common Features of Planing Hulls:
The need to generate hydrodynamic lift places constraints on planning hull designs such that all true planning monohulls share a number of features in common.



1. Chines
Look at many power boats from the side and you will see more or less a sharp corner on either side where the hull bottom meets the Topside. This is the chine. Because life is not as simple, chines comes in different forms – Hard chine (angular), Soft chine (rounded) or a reverse chine.

A hard chine is intended to throw spray to the sides of the hull and to prevent water from rising up the hull sides where it will increase drag. Chines with a wide flat area (called chine flats) contribute significantly to create lift in the moving boat.
Soft chines describe a sharp turn in the hull section but not a hard corner. The main characteristic of a soft chine boat is the smoother ride it creates in seaway. Much softer than a hard chine but top speed on soft chine boats is however not as high as hard chine boats.

Reverse Chine actually turn downward towards the water surface. The ultimate in reverse chine hull is the classic Boston Whaler (not regularly seen on the waters in SA), in which the chine forms a tunnel on either side. When the boat is underway, water thrown out by the center hull is deflected downward by the reverse chine to provide additional lift and gives an extremely dry ride. In extreme reverse chine design, one could almost say that the hull for is a cathedral hull (see previous article of leisure boating).

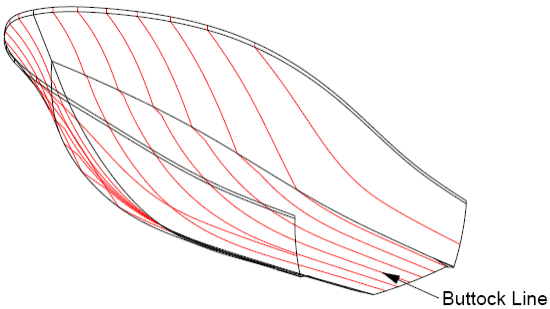
For most planing hulls the chine should be immersed below the waterline from midships (more or less the mid section of the boat) towards aft at a depth roughly 1.5% to 4% of the maximum chine beam. The chine should run parallel to the DWL (Design Waterline), from the transom forward to about midships. From Midships fwd to the stem, the chine sweep up higher, to the height above the DWL about equal to a distance 0f 20% - 25% of maximum chine beam.

2. Deadrise
Deadrise is the angle a hull bottom makes with the horizontal plane viewed from ahead or astern. The right amount of deadrise gives a boat directional stability, a softer ride and reduces wetted surface drag as the boat rises on a plane. Deadrise is said to be "constant" if it stays approximately the same from midships to the transom. Deadrise is "variable" if it changes from a deep angle at midships to a shallow angle at the transom.

For **inshore crafts**, deadrise can be about 10 – 12 degrees from the midships aft, increasing from midships as you go forward towards the bow.
For **coastal craft**, deadrise should be 15 to 20 degrees from midships aft, increasing as you go fwd towards the bow.
For **offshore boats**, deadrise should be 20 to 25 degrees from midships aft, increasing as you go forward. Some very high speed offshore boats use deadrise in the afterbody as high as 26 – 30 degrees. This is to soften the impact of reentry when the entire boats jumps clear of the water and slams back down, at speeds in excess of 50 knots

In general, the deadrise angle determines at what speed and seastate a planing boat can best power.

3. Lifting, Running strakes or Spray rails
Spray rails provide additional lift for high speed hulls. They are usually triangular in cross section with the bottom face parallel to the water surface.
The number and location of spray rails, as well as their run along the hull, is a subject on which there isn't clear agreement. Different designers and builders each have their favored system and each is sure that their system works best.



Kobus Naval Design

In the earlier years, many designers ran the spray rails along the buttock lines. *(Buttock Lines is a set of lines designers use to define the hull underbody. These lines are the curves that result from slicing the hull from top to bottom and front to back – like slicing your loaf of bread from end to end along the side. Experience designers can tell much about a boats potential performance from studying the buttock lines).*
In other words the spray rails were dead straight if you look from them from directly beneath the hull. This caused the spray rails to curve up in profile and intersected with the

chine. The reasoning was that water low straight aft along the spray rails which generated added lift with minimal added resistance. A few designers still prefer this method.

Generally, the modern thinking is the spray rails are dead straight (follow the buttocks) aft of station 4 to 5 (5 is generally midships), but curve in (in plan view) as well as sloping gently up, rather that following the buttocks as they run forward. In this way, the spray rail doesn't cause an intersection with the chine.

Within reason, the more spray rails the better, however more than four per side is overkill. The same hull without any spray rails will, through, be a little wetter and a little slower, and will have less dynamic stability.

My "Rule of thumb" for this issue:
Need to know how much fuel to carry in order to meet the range required? An easy calculation is:

For petrol engines fuel consumption can be estimated as:
Litres/hr = 0.508 x KWprop

For diesel engines fuel consumption can be estimated as:
Litres/hr = 0.274 x KWprop

Where: KWprop = Kilowatts from propeller power curve

Who is Kobus Potgieter and Kobus Naval Designs?
Kobus started in the inflatable boat industry 22 years ago. He was the first manufacturer of locally produced inflatable boats in South Africa. Through this company he and a few friends started the Trans Agulhas race, which led to a design revolution in the industry altering designs to have less resistant and smoother ride.

In 2002 he decided to stop manufacturing boats and rather focused his energies on Boat Design, specialising in the design of Ribs, by taking studies in Naval Architecture. This led to him establishing his new company Kobus Naval Designs which creates value through a combination of his practical experience and theoretical knowledge. He was appointed as the Principle Designer for Zodiac International for the design of a range of boats which will be launched in 2007. He has worked at various manufacturing plants within the Zodiac group, primarily focusing on the manufacturing of Military/ Professional Boats. Further, he has designed boats for companies in Dubai, Denmark, Sweden, Germany, India and France, some of which was done in collaboration with Volvo Penta and Rolls Royce.

Relocating back to his homeland with his wife Alyson in January 2006, he started his latest venture, Proxyz Systems, aimed at completing the design cycle through the production of prototypes, plugs and molds for his clients. This is the introduction of the first 5-Axis Robotic CNC machine into South Africa which have the ability to computer controlled cut designed products at a scale of 1 to 1 out of various materials with precision.

Kobus is a member of:
Royal Institute of Naval Architects (UK)
Society of Boat and Yacht Designers (USA)
Yacht Designers and Surveyors Association (UK)

Any questions? Contact details: Kobus@proxyz.co.za or Kobus@ribtrader.co.za