Planing (boat)

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Planing is the mode of operation for a waterborne craft in which its weight is predominantly supported by hydrodynamic lift, rather than hydrostatic lift (buoyancy).

A Contender dinghy planing on a broad reach. Note the typical way the bow lifts up while the stern skims over the water.

Contents

History

The earliest documented planing sailboat was a proa built in 1898 by Commodore Ralph Munroe; it was capable of speeds of more than twice the hull speed.

Planing a sailing dinghy was first popularised by Uffa Fox in Britain. In 1928 Uffa Fox introduced planing to the racing world in his International 14 dinghy, Avenger. It had been designed with a hull shape which permitted planing. He gained 52 first places, two seconds and three third places out of 57 race starts that year.[1][2]

This performance was noticed by other designers who took on his ideas and developed them. Over the years many dinghies have acquired the ability to plane. Advances in building materials have allowed for lighter boats which will plane faster and in lighter air. There are now many high-performance dinghies (sometimes called skiffs) which will plane to windward.[3]

Royal Navy World War II MTB planing at speed on calm water showing its Hard chine hull - note how most of the forepart of the boat is out of the water

How planing works

When it is at rest, a vessel's weight is borne entirely by the buoyant force. At low speeds every hull acts as a displacement hull, meaning that the buoyant force is mainly responsible for supporting the craft. As speed increases, hydrodynamic lift increases as well. In contrast, the buoyant force decreases as the hull lifts out of the water, decreasing the displaced volume. At some speed, lift becomes the predominant upward force on the hull and the vessel is planing.

A simple model of this effect is a solid slab of material which is heavier than water (like a steel plate) but is shaped and oriented to have a positive angle of attack. At rest, the slab will sink because it is heavier

than water; the buoyant forces are overwhelmed by the force of gravity. However, if the slab is kept in the same orientation and pulled horizontally through the water, it will force the incoming water downward. This results in a reactionary force upward on the slab. At a high enough speed, this reactionary force (plus any small buoyant force) is larger than the force of gravity and the slab will stay afloat. In this way, the horizontal force (which may be supplied by a motor or a sail) is converted into a vertical force upwards. The concept of planing is often interpreted as analogous with aerodynamic lift (See lift on an airfoil), but in reality the acting forces are very different.

Although any hull will plane if enough power is provided and enough speed is attained, a hull designed for operation in the planing realm is *sometimes* distinguished by a flat run aft. In other words, in side view, the bottom is more or less a straight line towards the stern. (Exceptions to this include surfboards and other recreational planing hulls, which utilize rocker throughout for enhanced maneuverability when banking through turns.) In contrast, in a displacement, or non-planing hull, the bottom is curved in side view (the curvature is called "rocker") all the way from bow to stern, in order to minimize wave drag. In front view, the sections in the aft area may be straight, as in a racing hydroplane, to maximize planing forces and speed, but for practical reasons of stability and comfortable ride are often V-shaped, especially in boats intended for offshore use.

To plane, especially to initiate planing, the power-to-weight ratio must be high, since the planing mode of operation involves moving the hull at speeds higher than its natural maximum speed when in displacement mode. All boat designs for planing benefit from minimised weight; planing powerboats are commonly made from light alloy or use other reduced-weight construction techniques- RIBs are typical examples. Planing sailing boats need a good sail area and powerboats need a high-power engine. Steps and chine ridges may also be incorporated into the design to encourage both ease of planing and stability. Most surfboards are planing or semi-planing hulls that utilize the push of the waveform more or less in combination with gravity and specific angles of attack for the airfoil to maximise propulsive force and reduce the net downforce and thus achieve planing lift. Many forms of marine transport make use of planing, including fast ferries, racing boats, floatplanes, flying boats, and Seaplanes. Beyond planing, fast vessel designs have seen a transition to hydrofoil designs.

Sailing techniques used to promote planing

Planing may be achieved in most sailing dinghies. In light to moderate conditions, planing is best initiated by a combination of the following.

Albacore dinghy planing

- Maximise Power: Sail on a reach or broad reach to begin.
- Minimise Surface induced drag: Raise the centreboard or daggerboard about half way
- Maintain Power: When a gust hits, bear away slightly and ease the sheets
- Maintain Flat Form of Immersed sections of hull: Keep the hull level side-to-side, trapeze if necessary
- Move your weight aft to lift the bow
- Maintain Power if necessary: Flick or pump the sails (although there are some restrictions on doing this in a race)
- Seek optimal form and speed of immersed hull: If there are waves, surf down them to initiate planing
- As the gust begins to pass, steer slightly to windward to keep the apparent wind forward.[4][5]

See also

- Hydroplane (boat)
- Dinghy racing
- Dinghy sailing
- Windsurfing

External links

- Some videos of planing sailboards at windsurfing.com (http://www.ukwindsurfing.com/pics_n_vids/)
- REPORT 1355: *A Theoretical and Experimental Study of Planing Surfaces Including Effects of Cross Section and Plan Form* By CHARLES L. SHUFORD. Jr. -Seminal 1958 NACA technical report on hydroplaning available from NASA (http://naca.larc.nasa.gov/search.jsp?R=62010&id=1&as=false&or=false&qs=Ntt%3D1355%26Ntk%3DReport%2B-%2BPatent%2BNumber%26Ntx%3Dmode%2Bmatchall%26Ns%3DHarvestDate%257c1%26N%3D0)

Notes

1. Uffa Fox biographical notes at UffaFox.com (http://www.uffafox.com/uffabiog.htm)
2. Article re Uffa Fox on the International 14 website (http://www.international14.org/index.php?option=com_content&view=article&id=26&Itemid=22#_Toc350832806)
3. "In the UK, the well-known designer Uffa Fox ... researched and developed planing...It is from his trend-setting design that most of today's high-performance sailing dinghies have evolved. Boats have also become lighter through the low weights achieved by today's hi-tech building materials. They are therefore able to plane much faster in much less wind, and many are capable or planing to windward." *The Sailing Handbook* By Dave Cox Stackpole Books, 2000
4. *The Complete Sailing Manual, Third Edition*. Steve Sleight. Page 126. (https://books.google.com/books?id=s5uNcHo1PkQC&pg=PA181&lpg=PA181&dq=%22planing+to+windward%22&source=bl&ots=w8Pc6p_WVA&sig=R-KEFqbTI36BxVEKjock5tWLNas&hl=en&sa=X&ei=Z14YVKOEI4WlyAS6-YDgAQ&ved=0CCcQ6AEwAg#v=snippet&q=%22planing%22&f=false) DK Publishing, 2011 ISBN 9780756697600
5. *Boats for Sailing*. Ian Proctor. Macdonald and Co./ Council of Industrial Design, 1968 ISBN 9780356015217

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