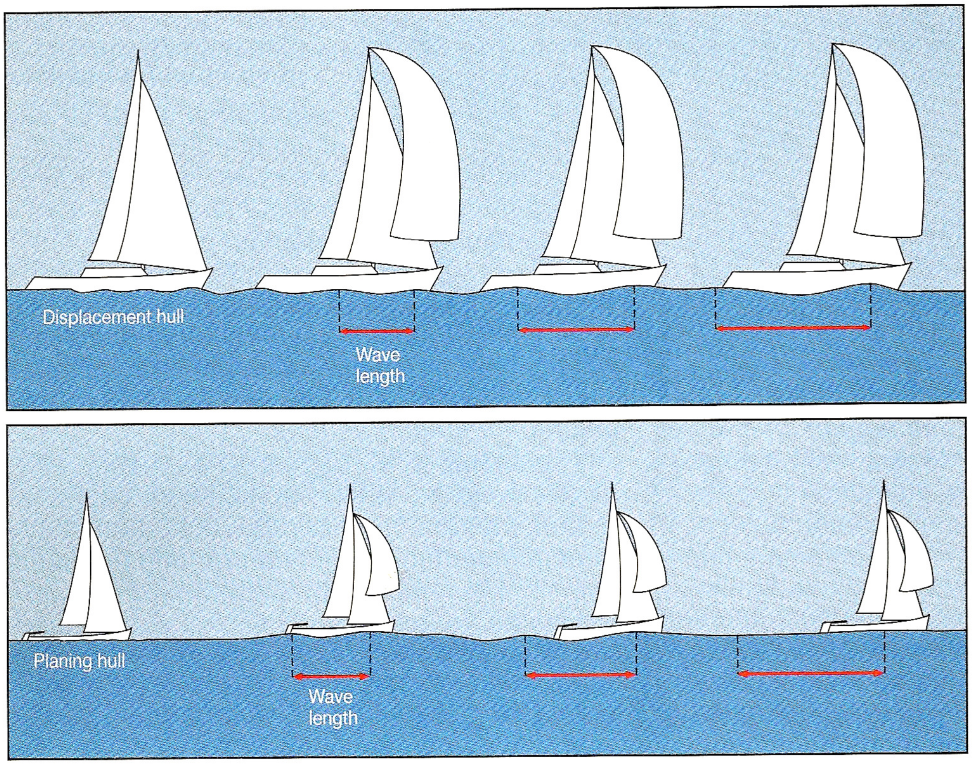

When a hull moves through the water, it produces waves that result in energy loss. The maximum speed of a conventional displacement hull *(top)* is a function of the longest wave it can make, which in turn is determined by hull length. No amount of sail can create enough power for it to climb over its own bow wave. On the other hand, the planing hull *(bottom),* like the racing dinghy and some multihulls, can carry enough sail to push it over its own bow wave and plane.

lots of sail (racing dinghies, multihulls, sailboards and even foil-supported boats), but it's not available within the realm of ballasted monohulls.

Therefore the implication for conventional boats is that, as long as a hull is trapped in its own wave, the vessel will never go faster than the longest wave it can make. That is the reason why longer boats are faster—and why, almost from the beginning of sailboat racing, length has been heavily factored into rating rules.

The challenge, within the limitations of rules and economics, is to make a longer wave, so that the hull has a higher potential speed when the horsepower (wind) is available, but to do so without seriously compromising the hull's performance when horsepower is scarce.

One common strategy is to design a hull that has two "personalities"—a shape that is relatively narrow and fine at the ends of the waterline when upright (at low speed when form resistance is less important), and a heeled, or high-speed, shape that is full at the ends. An overhang at the stern is very useful in this regard; as the stern wave builds, the waterline becomes longer and fuller, delaying the point at which the stern begins to settle down into the wave.

Obviously, this dual personality has limitations. In fact, if the designer has made the bow and stern of the boat especially fine so that they will be easier to push through the water, the waterline will actually seem short to the wave and the top speed will be lower. This leads to the paradox that hulls meant to travel at or near hull speed most of the time tend to be rather full in the bow and the stern, while hulls expected to travel more slowly, while making more efficient use of lighter winds, might be finer fore and aft.

If heavy winds were always available on demand and if sailboats always traveled with large apparent winds, yacht design would of course be much simpler. However, maximum horsepower from a sailboat rig is rarely available and conventional hulls therefore have to be designed in order to strike the best compromises.

Some very light sailboats, such as racing dinghies, are able to provide lots of horsepower by having their crews hike out against the power of very large sails. Since they are short, these boats reach their wave-resistance limit at a very low speed (just over 5 knots). But they have lots of horsepower still to absorb. Without much fuss, they rise over their bow waves and plane, just like powerboats, often reaching a respectable 17 to 20 knots. Of course, it takes two heavy sailors and perhaps three straining sails to do it, but that's all part of the attraction.

Catamarans and trimarans, with their unique stability, also have physics on their side when it comes to making waves. Because their hulls can be so much narrower than a monohull, the waves they produce are consequently much smaller. While the relationship between wave length and speed still holds, the "hole in the water" that is created by the passage of a narrow hull is much smaller. The stern of a narrow hull doesn't have as far to settle, and drag does not increase as much or as suddenly. In one sense, the narrow hull of a catamaran or a trimaran doesn't have to plane because it has broken the hull-speed rule.