Helm Control

The Delicate Balance

By **Dave Gerr** illustrations by the author

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Sailors talk endlessly about the feel and balance of the helm. Often, you'll hear a boat described as "hard mouthed," or "balanced," or "light helmed," or as having too much weather helm or lee helm. These terms refer to the amount of steering force required to hold a boat on course on various points of sail and in differingwind strengths, and they directly affect how comfortably or - efficiently a boat sails. But what exactly is weather helm or lee helm? And what can you do to control it?

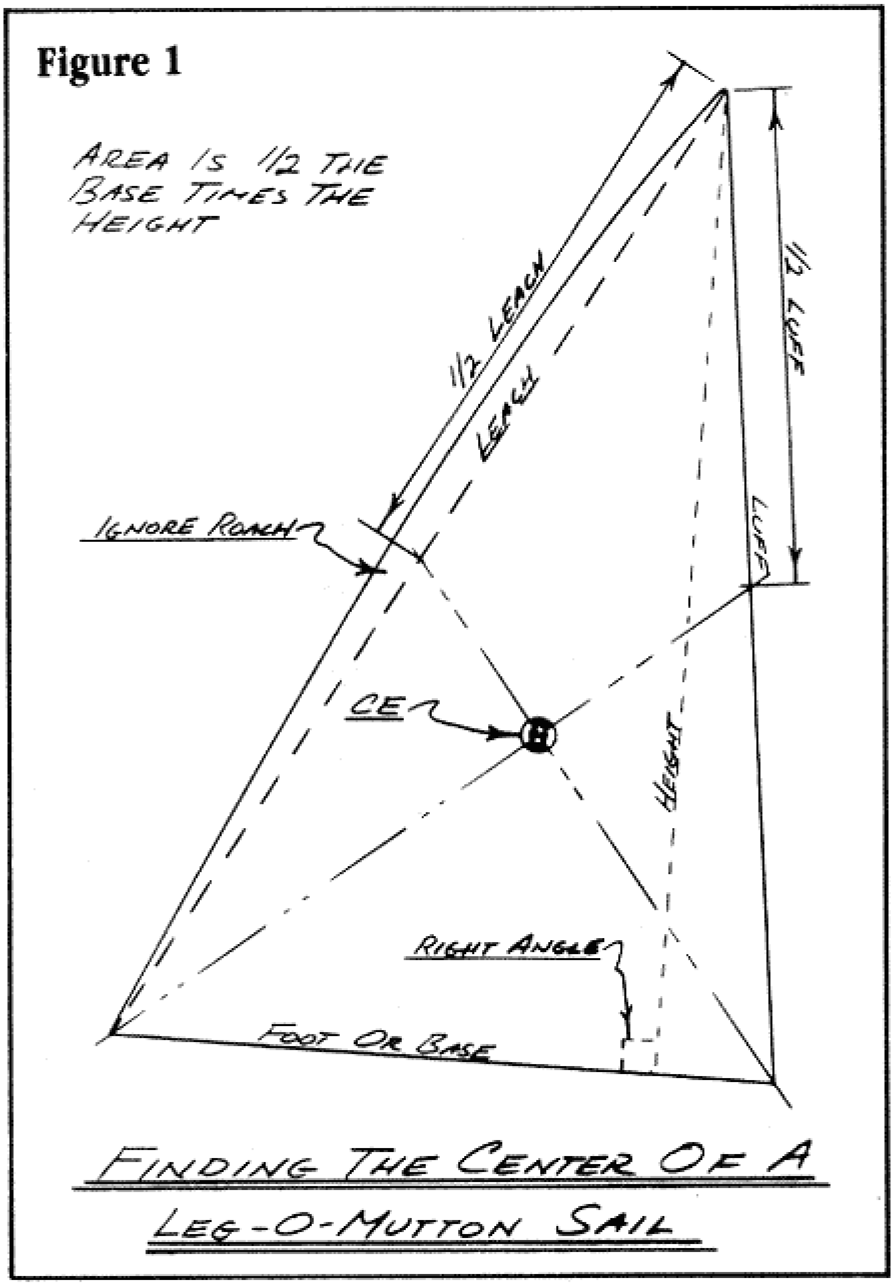
The answers are both simple and complex — simple because the effect is very clear, and complex because many factors interact to create that effect. Weather helm is the force needed to counteract the vessel's tendency to round up into the wind. On a tiller-steered boat, weather helm means you have to hold the tiller up to windward ("to weather") to maintain your course. On a wheel-steered boat, it means turning the wheel to leeward.

In moderation, weather helm is highly desirable. One very important benefit is this acts as a sort of dead-man's brake. If you suddenly let go of the tiller — say, in an emergency — it will swing amidships and your craft will head up and, ideally, lie to, in irons.

Another important benefit of moderate weather helm is that it improves upwind performance. The slightly angled rudder deflects the water flow in much the same way that a curved airplane wing deflects airflow, thus producing lift and reducing leeway.

Too much weather helm is not at all desirable, however. A vessel with excessive weather helm is called "hard mouthed." It is tiring to sail because you're constantly fighting the tiller or wheel and it slows the boat down. A rudder over more than 10 or 19 degrees ceases to act as an aid in increasing lift and starts behaving like a brake.

A boat with helm feel so light that the merest nudge will swing the tiller widely might seem at first like the ultimate in fingertip control. But without the slight continuous pressure on the rudder generated by moderate weather helm, you can't really sense where your boat is going. I once owned a boat with neutral helm. The minute you glanced away she'd wander off course. A helm with feather-light touch like this simply doesn't give you the tactile feedback you need to steer under good control, by the seat of your pants.



Least desirable is lee helm. A craft with lee helm requires her skipper to hold the tiller to leeward or turn the wheel to windward to keep her on course. Not only does this hinder upwind performance, but such a boat has no dead-man's brake. If you release the tiller, the vessel will fall off and, quite possibly, sail you into serious trouble. If you're sailing close hauled with the sheets dealed, for instance, you could end up broadside to the wind with the sails in flat — conditions that invite knockdowns or even capsizes.

Helm Factors

What are the factors affecting helm or balance? One of the most significant is the relationship of the sail plan to the underwater area of the boat. Essentially, a boat that has weather helm weathercocks into the wind like a wind vane. If the sails' center of pressure is too far aft relative to the hull's center of pressure, the boat will have too much weather helm. If, on the other hand, the center of pressure of the sails was too far forward, the boat will have lee helm, causing the stern, not the bow, to point into the wind.

In practice, all this is complicated by the fact that a boat's underbody is anything but a plain flat shape. In fact, it is essentially impossible to find the actual center of water pressure since it moves around in response to course changes, angles of heel, speed through the water, sea state, and a whole host of unpredictable factors.

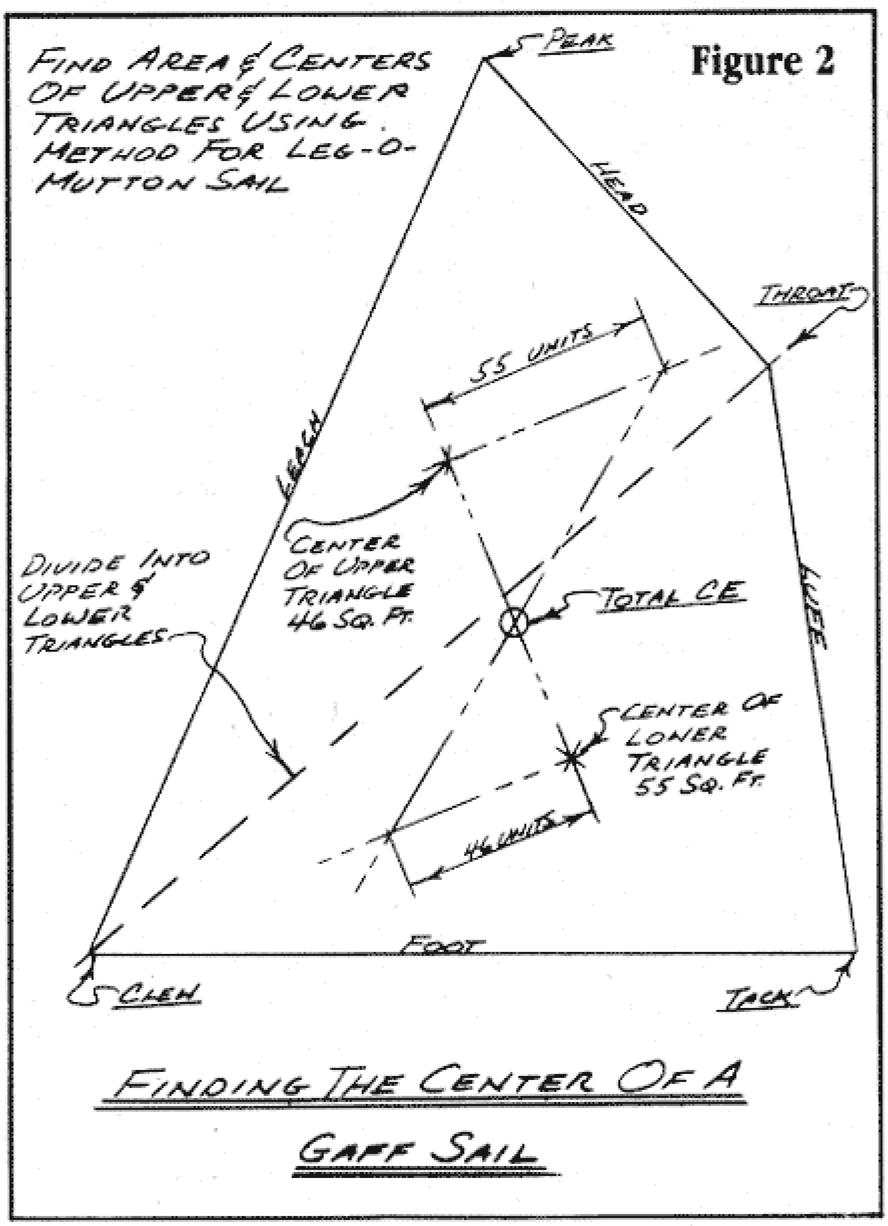
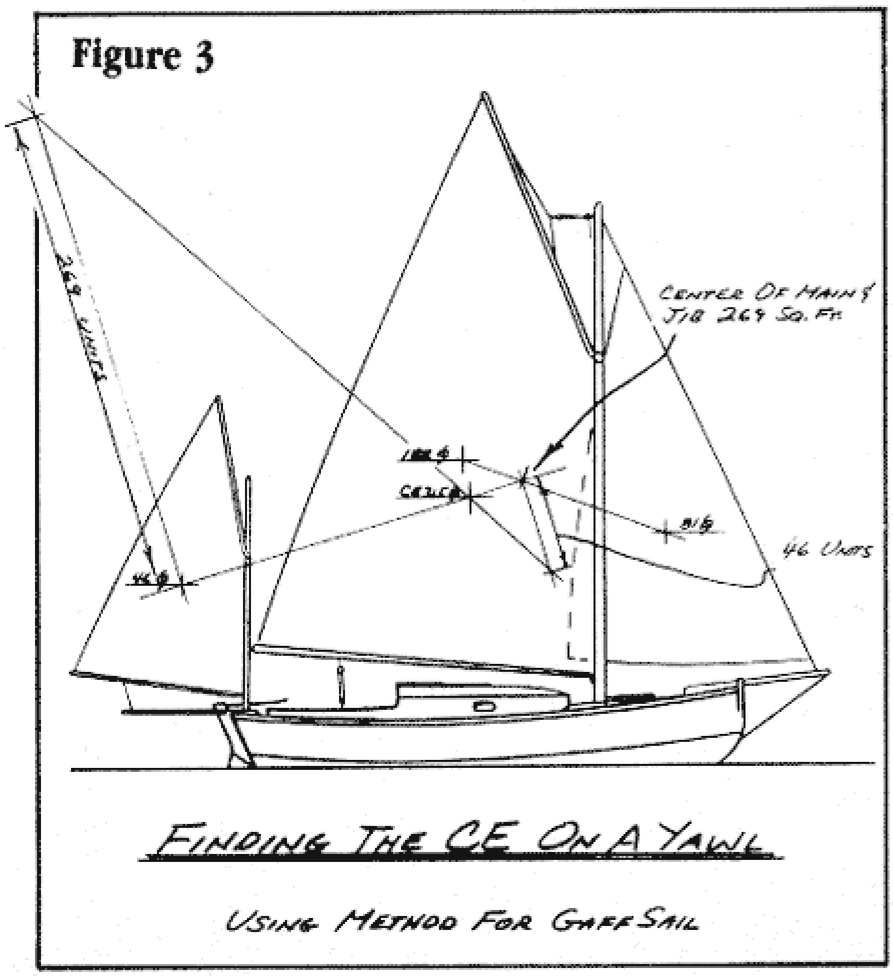


Figure 2

For estimating the hull's center of pressure, most designers use the following simple method. Trace the profile (side view) of your *Jaunty Jane's* hull underbody — every part of the boat below the waterline, including rudder and centerboard — and cut this shape out on a piece of cardboard. Balance the cardboard cut-out across the edge of a ruler perpendicular to the waterline. Naval architects call this imaginary center the *center of lateral plane* (CLP), also known as the center of lateral resistance.

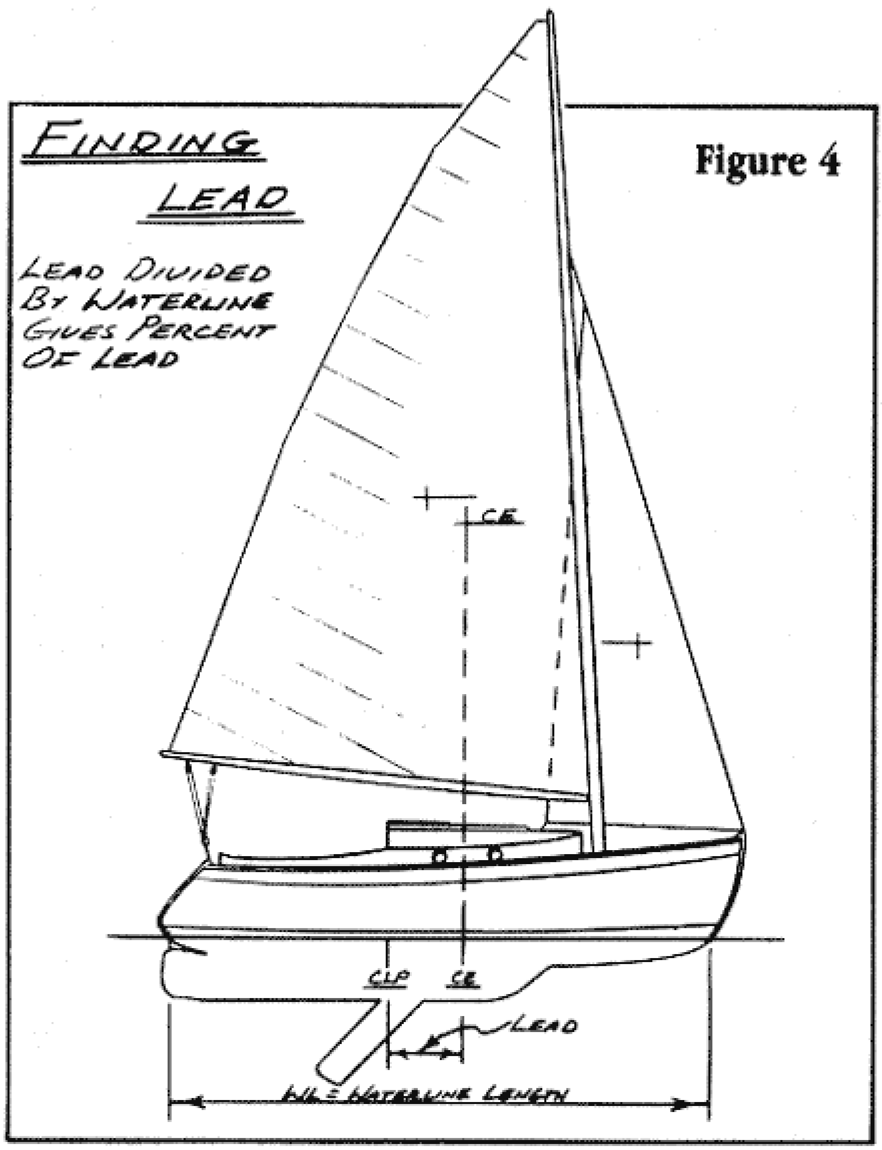
The next step is to figure the areas and centers of effort (CE) of the various sails and combine them to locate the total center of effort of the entire sail plan. Let's say Jaunty Jane is a catboat with a leg-o-mutton sail. Ignore the roach, and her sail is an ordinary triangle. The area is then one-half the base times the height of the triangle. To find the center of effort, make a tick mark exactly half way down the luff and halfway down the imaginary leach (the straight line between clew and head). Draw lines from these tick marks across to the corners of the sail directly opposite — luff to clew, leach to tack. The center of effort of this sail is where these two lines cross (Fig. 1).



Gaff Calculations

If *Jaunty Jane* were a gaff-rigged catboat, draw a line from the clew to the throat, dividing the sail into two triangles. You can then find the area of each triangle and the center of each triangle, just as before. Adding the areas gives the total area.

Finding the combined center of effort is a bit more complicated. Draw a line connecting the two center points of each triangle. Then from the center point of each triangle, draw another line perpendicular to the first (Fig. 2). These two lines should project from the center points in opposite directions. The lengths of these perpendicular lines are proportional to the area of the opposite triangle. For instance, if the lower triangle was 55 square feet and the upper triangle was 46 square feet, you could measure off 55 eighths of an inch (6-7/8 inches) on the upper perpendicular and 46 eighths of an inch (5-3/4 inches) on the lower perpendicular. Now, draw a line connecting the ends of the two perpendiculars. The point at which this line crosses the original line — the line directly between the two triangle centers — is the center of the full gaff sail.



Keep in mind that this is just an approximation used by designers to estimate the true center of pressure of the wind on the sails. As with the center of pressure on the hull, the actual center of pressure on the sails changes with the angle of heel, sail shape and trim, wind speed, and many other factors. The most powerful computer known wouldn't be able to reliably pinpoint it.

This same approach, determining the total center of effort, works for any combination of sails. If *Jaunty Jane* had been a sloop, the second triangle would be the area of the foretriangle* instead of the top half of a gaff sail. If you were figuring a ketch or yawl, simply find the combined area of the main and foretriangle and then, taking their total area and total center, combine them with the area of the mizzen using the same method (Fig. 3). In fact, you could go on with this method
to figure the areas and center of effort on any boat, with any number of sails, right up to a ftill-rigged ship.

> **By convention, the area of the foretriangle is the area of the triangle made by the headstay, the forward face of the mast — up to the intersection of the headstay — and the distance from the forward face of the mast along the deck to the headstay fitting at the bow.*

Once you have the location of the center of lateral plane and the center of effort, the last step is to see how they relate to each other. To do this, drop a vertical line from the CE down to the waterline. Measure the distance between them and divide that distance by the full waterline length (Fig. 4). Designers call this the lead (pronounced "leed").

The confusing thing here is that almost every boat ever built should have the CE ahead of the CLP. Why is this? Well, remember the CE and CLP are only imaginary approximations on flat surfaces of the true centers of pressure on the sails and on the hull underbody. The real centers, if we could find them, are much different. Fortunately, experience over the years has provided designers with guidelines for estimating the amount of lead (where these imaginary centers should be in relation to one another) so that their boats will behave properly:

Percent of Lead

Schooner	7%-12%
Ketch	11%-l4%
Yawl	12%-15%
Sloop	13%-17%

If, for example, *Jaunty Jane* had an 18 foot waterline and was an average sloop, her lead should be about 13 percent, or her CE should fall 2.7 feet ahead of her CLP (15% x 18 feet = 2.7 feet). These
numbers are average ranges for most vessels, and with a little judgment, you won't go wrong using them, provided you take into account other considerations.

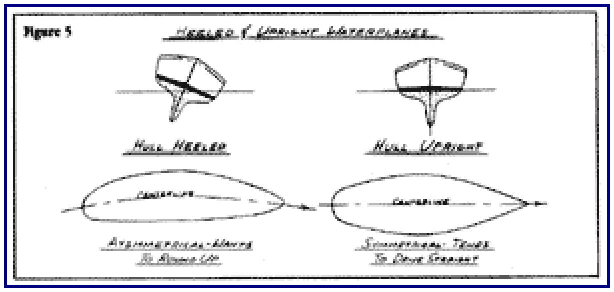


Figure 5 (click image to enlarge)

Hull Factors

First, hull shape can greatly affect the amount of weather helm a boat has when heeled. This is because the hull presents an asymmetrical shape to the water as it heels, tending to make the boat round up even more than the simple fore and aft location of the centers of pressure alone would indicate (Fig. 5). In generaly, anything that tends to increase hull form stability increases weather helm when the boat heels. For instance, a wide hull with a broad transom and hard bilges will become very asymmetrical and cause more weather helm when heeled. On the other extreme, a narrow double ender with slack bilges will maintain its symmetry and cause less weather helm. If *Jaunty Jane* were a sloop with a wide hull and hard bilges, you'd be wise to use the larger amount of lead called for in the table to compensate for the additional weather helm generated by the heeled hull shape.

Similarly, a tall rig creates more weather helm than a short one. This is because the center of the sails is actually way out over the water to leeward when the boat is heeled over. The pressure of the wind is, for all intents and purposes, acting at this point as if a giant caught hold of a long lever (the mast) and twisted the boat to windward (Fig. 6). Again, for any of the above lead categories, you would choose from the higher end of the recommended leads for tall-rigged craft and from the lower end for shorter-rigged vessels.

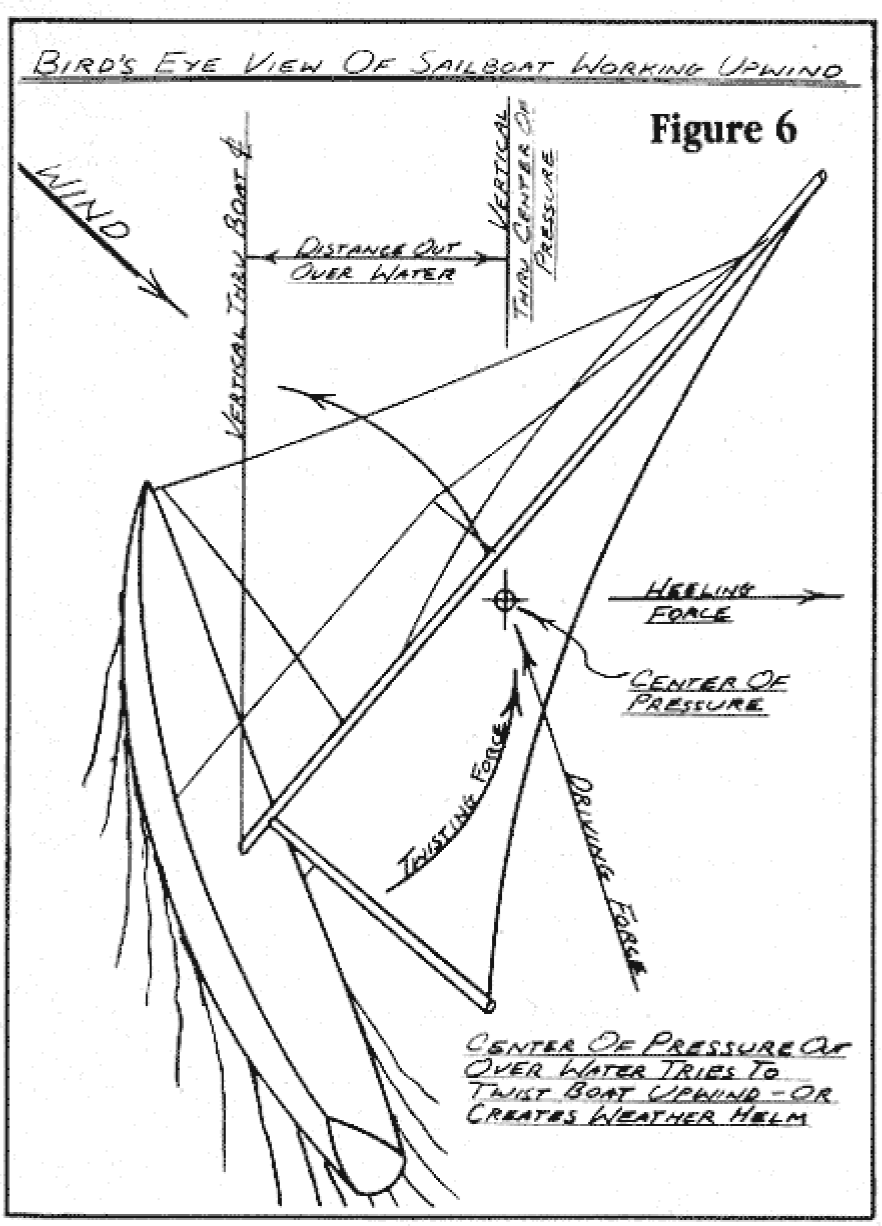


Figure 6

In fact, if all the factors indicated it, you might drop down a bit or go up a bit from the recommended leads. Say your *Galloping Gazelle* was a narrow slack-bilged double-ended sloop with a low rig. These factors all indicate that her hull will not generate much additional weather helm due to heel. Thus, for a boat like this, you ought to consider using not the 13 percent lead indicated on the low end of the table's recommendations for sloops but perhaps even 12 percent.

Put this all together and you can determine the effect of adding more sail area, how to change your boat from, say, a sloop to a yawl without adversely affecting performance, and where to locate a centerboard or leeboards in a boat being converted to sail. Plus, you can gain insight into the delicate balance of factors that affect the way your boat sails, and your helm feels.

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