High-lift rudders and improved boat handling

BY DAVE GERR

Wouldn't it be nice if your boat's steering — particularly in tight quarters, low-speed maneuvering — was crisp, precise, and predictable — if you felt confident and in command around the finger piers? Though they are little known, there are rudder designs and refinements that

Dave Gerr photos

can accomplish just this. Standard airfoil-section rudders stall and stop generating effective lift at rudder angles of 35 degrees or more.

There are ways to modify the standard airfoil-section shape to induce the rudder blade to create useful lift (turning side force) at higher angles. This can be a fixed rudder shape that doesn't change — often termed fishtail rudders (more properly hydrodynamic fishtail rudders) — or they can be rudders with movable flaps or other variable geometry — articulated rudders. Fishtail high-lift rudders are also called fixed-geometry high-lift rudders. All such high-lift rudders can be thought of as propeller slipstream diverters since they get their low-speed, high-angle lift by changing the direction of the slipstream radically. Though articulated rudders can work well, they have moving parts and are thus more complicated and expensive than fixed-geometry rudders.

A good example of a fishtail rudder is the MacLear Thistle rudder. This was invented by Frank MacLear. Frank was president and chief naval architect of MacLear & Harris, Inc. (where I once worked). MacLear had set out to improve low-speed maneuvering in close-quarters situations as well as enhancing steering response at speed. The reason for better performance at speed is clear enough — smashing into your neighbor's boat while docking can ruin your whole day.

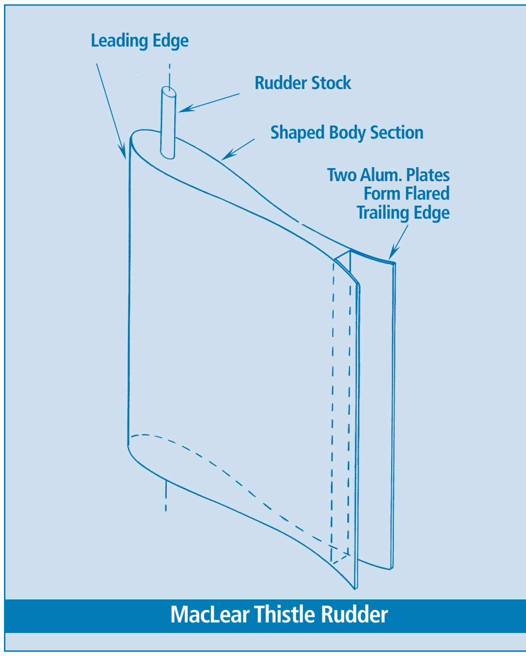
Naval architect Dave Gerr's design for the power voyager *Imagine*, above, called for a high-lift MacLear Thistle rudder, right, that gives the boat added maneuverability at low speed.

Increasing the useful helm angle

Most ordinary rudders are ineffective when the helm is put over more than 35 degrees. Turn a normal rudder further and it just acts like an unpredictable brake. It can even create eddies that throw the stern about randomly. But what if you could turn the helm over more, say, 40 degrees, and still get controlled positive helm response? Reasoning it through, MacLear came up with a new rudder-section shape. As you can see in the drawing, it starts off fattish and rounded swelling out as it runs aft, then thinning down at the middle, and — at the very end — flaring out again. Indeed, the shape is much like the bulb of a thistle, hence the name. The shape is also basically a standard airfoil rudder section flared out in a fishtail at the trailing edge, thus it's a typical fishtail rudder.

What does this shape accomplish? At normal cruising speed it doesn't have much effect, though it does increase steering response slightly at small course-keeping helm angles. But — when low speed maneuvering — you can turn the MacLear Thistle rudder over as much as 40 degrees. The waterflow is guided around the leading edge and midsection by the rudder's section shape, and then the flared-out end makes waterflow continue to do useful work at the higher angle. The result is that the rudder acts like a stern thruster, allowing tight turns at low speed.

Another plus is that the MacLear Thistle rudder's trailing edges can be made of aluminum plate and —



MacLear Thistle Rudder

Dave Gerr

optionally — left open and not welded together at the trailing edge. These are precurved about as you see in the drawing; however, you can adjust them by grabbing them with Vise-Grip pliers, or whatever, and bending them in or out, either evenly from top to bottom, or to varying degrees from top to bottom and differently port and starboard. The rather clever advantage of this is that you can adjust the flare-out on each side by trial and error until your boat's handling is exactly predictable and exactly as you want it. Having worked on the design of several boats fitted with the MacLear Thistle rudder, I can attest that it works as advertised.

The drawing shows the section proportions (along with the optional endplates). Note that — as the center of pressure is a bit further aft on the Thistle rudder — the rudder stock is at 20 percent chord, giving 20 percent balance.

Trying the Thistle rudder

On larger vessels the entire rudder is usually fabricated from aluminum or steel. For smaller vessels, you can make the forward three-quarters to seven-eights of the rudder blade in the usual way, with a stainless steel or bronze stock through a wood/fiberglass blade. Add the flared-out trailing edges of simply curved aluminum plate, let in flush to the body of the rudder blade. You can retrofit almost any standard rudder installation this way. Even at the normal range (35 degrees hard-over-to-hard-over) steering is more precise and predictable. The only improvement I've made to the MacLear Thistle rudder is — where possible — to build on end plates over the top and bottom of the entire rudder. These are fastened to the body of the rudder blade, but project aft over the curved flared ends, either attached or unattached. In this way you still have the endplate effect at the trailing edge, while retaining adjustability. Such endplates further improve the MacLear Thistle rudder's excellent helm response.

Thistle-rudder steering

A rudder like this gives unusually positive steering, and my office has installed them on most of our single-screw displacement cruisers. Though you can turn the MacLear Thistle rudder over to 40 degrees, all the installations I've done have only gone to the normal 35 degrees. At speed, somewhat less rudder angle is needed to get the same course correction you'd achieve with a standard rudder. During low-speed maneuvering, these rudders really shine. Steering response is both crisp and predictable. You can very quickly kick the stern of your boat around to exactly where you want it.

Here's what the skipper of one of my designs, *Imagine*, had to say about the boat's handling with the Thistle rudder:

"*Imagine* is doing wonderfully! To date, my strongest impression is how easily she handles in close quarters. We've been staying at quaint, but small, marinas that are quite challenging for even a twin screw to maneuver in. Two nights ago I was even forced to dock stern-to. I gave the harbormaster my length and he asked for my beam. I replied, '14 feet 6 inches,' and he said, 'Great. In that case, you can stay because I have one slip left with 16-foot width.' And then he told me I would have to follow marina custom and dock stern-to. I had 20 people watching, and I backed in with one try — *without using the bow thruster*. The response I got from the audience ranged from: 'You must have been handling her several years,' to 'Yep, I can always tell when a boat has twin screw.' Needless to say, I'm flattered."

Of course, *Imagine* is single screw. This Thistle rudder had endplates top and bottom, but it was set up only for the standard 35 degrees hard over. The one drawback to getting larger rudder angles is that the hydraulic steering gear needs to be somewhat customized to handle the added travel.

The MacLear Thistle rudder, with 20 percent balance as indicated, should be sized according to standard rudder area formulas; however, many companies size fishtail rudders as rectangles, with their height slightly greater than propeller diameter, and cord (fore-n-aft length) between 70 percent and 80 percent of propeller diameter. This should give good results as long as the propeller size and installation is in the normal range for the vessel it is driving. ■

Dave Gerr is the president of Gerr Marine, Inc. and the director of the Westlawn Institute of Marine Technology. He is the author of Propeller Handbook, The Nature of Boats, The Elements of Boat Strength, *and* Boat Mechanical Systems Handbook, *all published by International Marine/McGraw-Hill. This article is excerpted from* Boat Mechanical Systems Handbook.