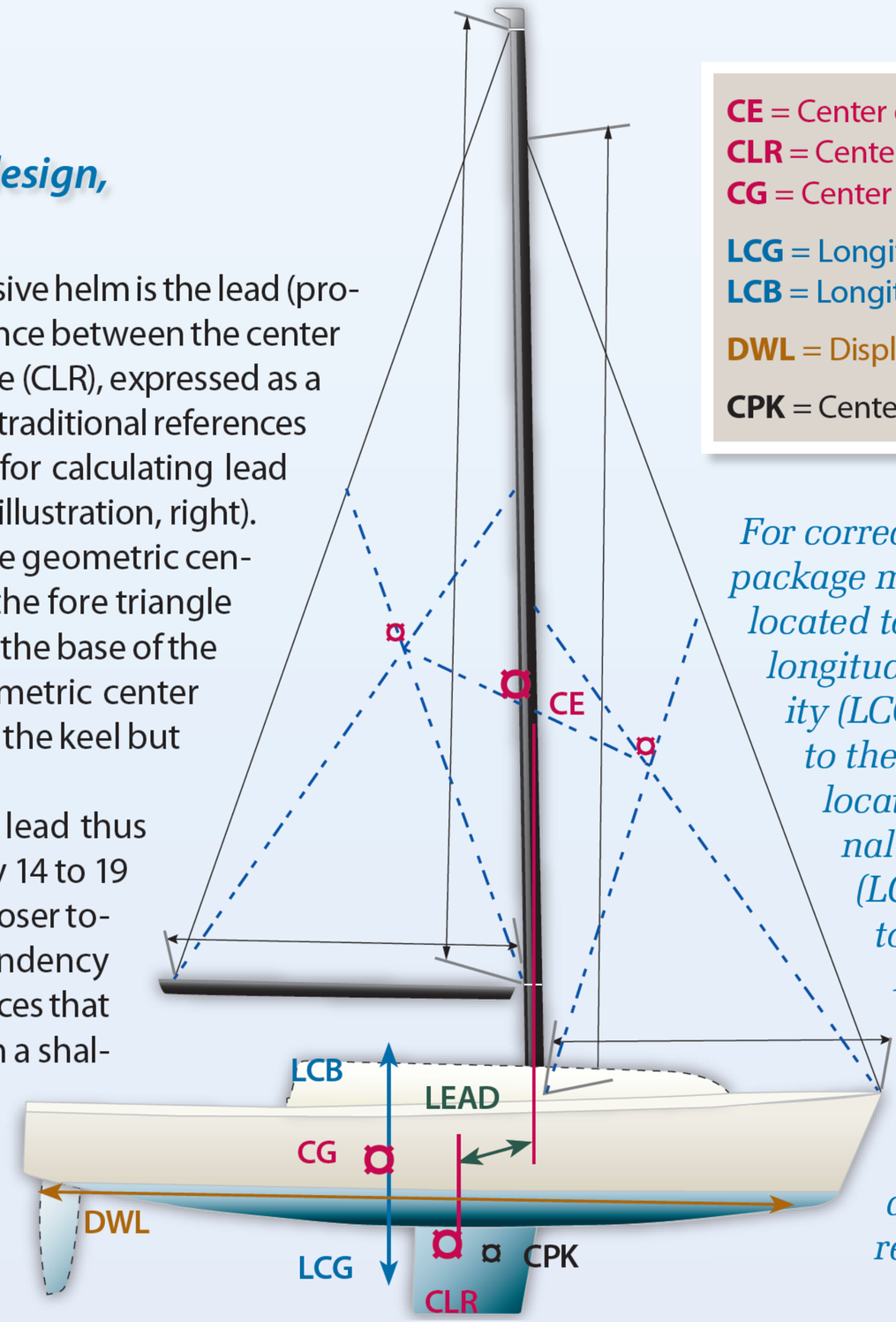
The Balancing Act

Even in the age of computerized design, quantifying lead is an art.

Fundamental to a balanced and responsive helm is the lead (pronounced "leed"), the fore and aft distance between the center of effort (CE) and center of lateral resistance (CLR), expressed as a percentage of waterline length (DWL). The traditional references for yacht design provide rules of thumb for calculating lead from the sailplan and the hull profile (see illustration, right).

For a sloop, the CE is usually taken as the geometric center of the mainsail (excluding roach) and the fore triangle (the area enclosed between the headstay, the base of the mast, and the stem). The CLR is the geometric center of the hull's underwater profile, including the keel but usually not the rudder.

A conventional range for the value of lead thus produced places CE forward of the CLR by 14 to 19 percent of DWL. Moving the CE and CLR closer together—reducing lead—increases the tendency to weather helm. Moving them apart reduces that tendency. On a modern fin-keel boat with a shallow canoe underbody, the keel makes a proportionately larger contribution to lateral resistance, emphasizing the importance of proper keel placement and a balanced sailplan.



CE = Center of effort
CLR = Center of lateral resistance
CG = Center of gravity

LCG = Longitudinal center of gravity
LCB = Longitudinal center of buoyancy

DWL = Displacement waterline

CPK = Center of pressure on the keel

For correct trim, the ballast package must be designed and located to bring the combined longitudinal center of gravity (LCG) of hull and ballast to the same fore-and-aft location as the longitudinal center of buoyancy (LCB). At the same time, to maintain a balanced helm, the keel must promote sufficient lead—the fore-and-aft distance—between the center of effort (CE) and the center of lateral resistance (CLR).