THE APPRENTICE SCHOOL STUDENT SECTION OF
THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS

Boat Design Competition Illustrated Glossary

Newport News Shipbuilding
A Division of Huntington Ingalls Industries

TABLE OF CONTENTS

Abeam

At right angles to the fore-aft centerline. See Ship Directions.

Aft

Toward, at, or near the stern. See Ship Directions.

Aft Perpendicular (AP)

For the purposes of the Boat Design Competition, a vertical line at the aftermost portion of the buoyant hull. In actuality, the AP is normally at the rudder stock or at the intersection of the design waterline and the hull. See Ship Dimensions.

Amidships

At or near the midship section (middle portion) of the boat. See Ship Directions.

Appendages

Items or features outside the outline of the hull (e.g. rudder).

Athwartships

See Abeam.

Awash

Level with the surface of the water so as to be covered due to wave action.

Ballast

Any weight(s) used to keep the boat from becoming top heavy or to change its draft or trim.

Baseline (BL)

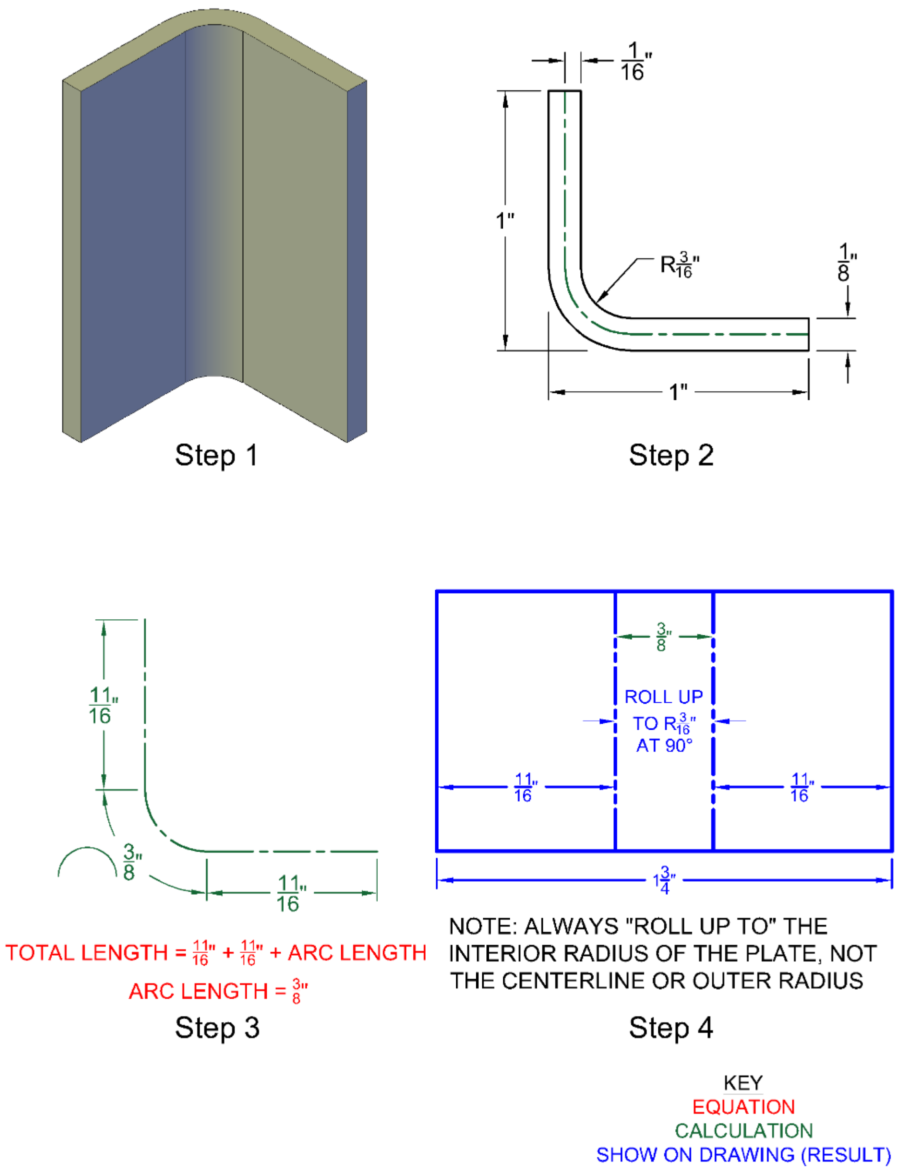
A horizontal line through the lower point of a boat's hull from which all vertical measurements are taken. See Ship Dimensions.

Beam or Breadth

Maximum width of the boat's hull. See Ship Dimensions.

Bending

Curvature is not a requirement. Different types of hull forms can be accomplished without using curved plate, which has many benefits for designers and naval architects. The greatest benefit of using flat plates is the ease of locating the center of gravity of each plate. However, using multiple flat plates to accomplish a geometric form that can be accomplished by bending plates is superfluous. This not only increases welding, but greatly increases the difficulty in lofting and construction. The more complicated the design, the more difficult the calculations, construction, and other aspects of shipbuilding become. Curvature can be accomplished by rolling the plate to a dimensioned radius and angle.



Body Plan

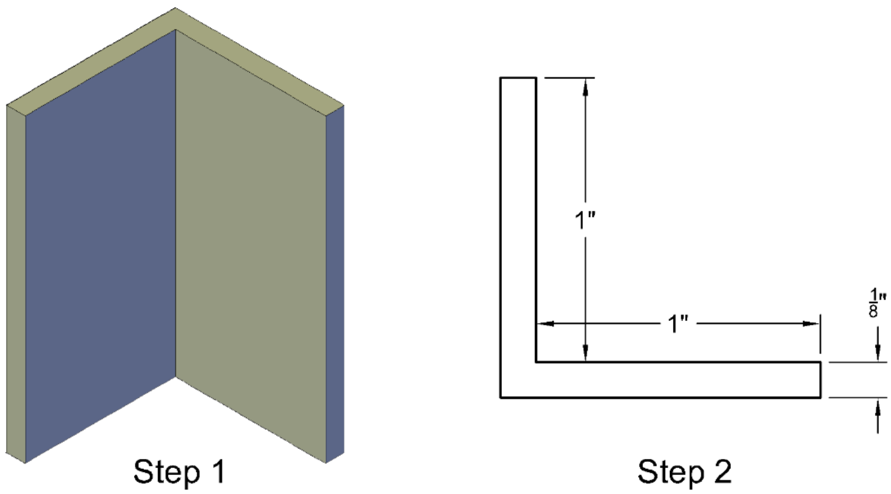
See Views.

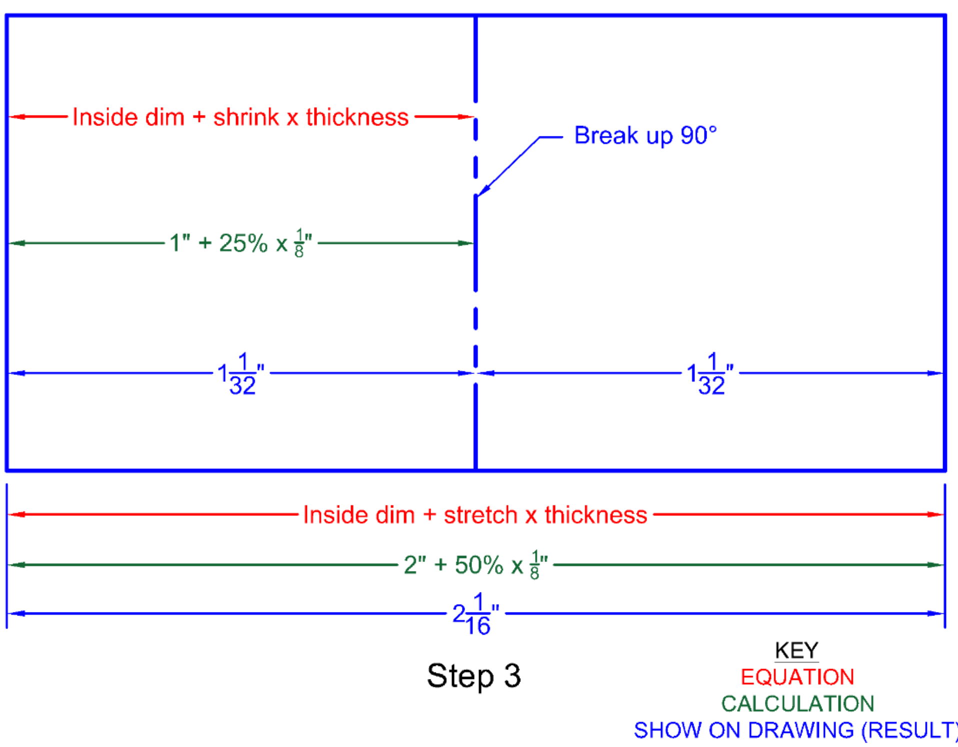
Bow

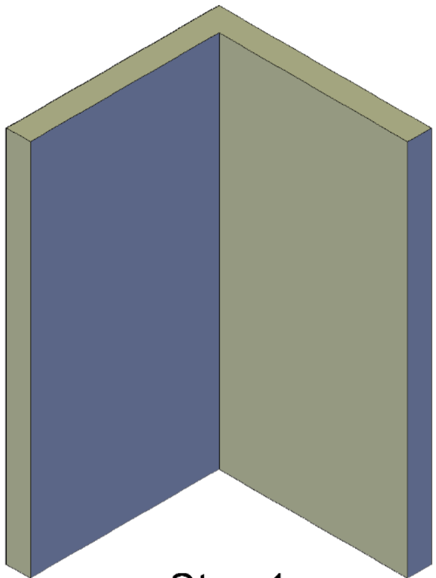
Forward end of boat. The length of the bow is arbitrary. See Ship Directions.

Breaking

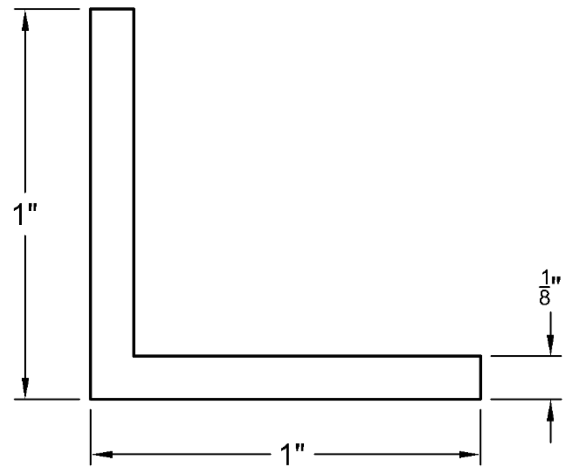
When a ninety degree bend is required, a square break should be considered. A typical location for a square break would be the turn-of-the-bilge (the transition between the bottom plating and the side plating). Square breaks require extra dimensions on the drawings to accurately fabricate (depending on whether inside or outside breaks are used).



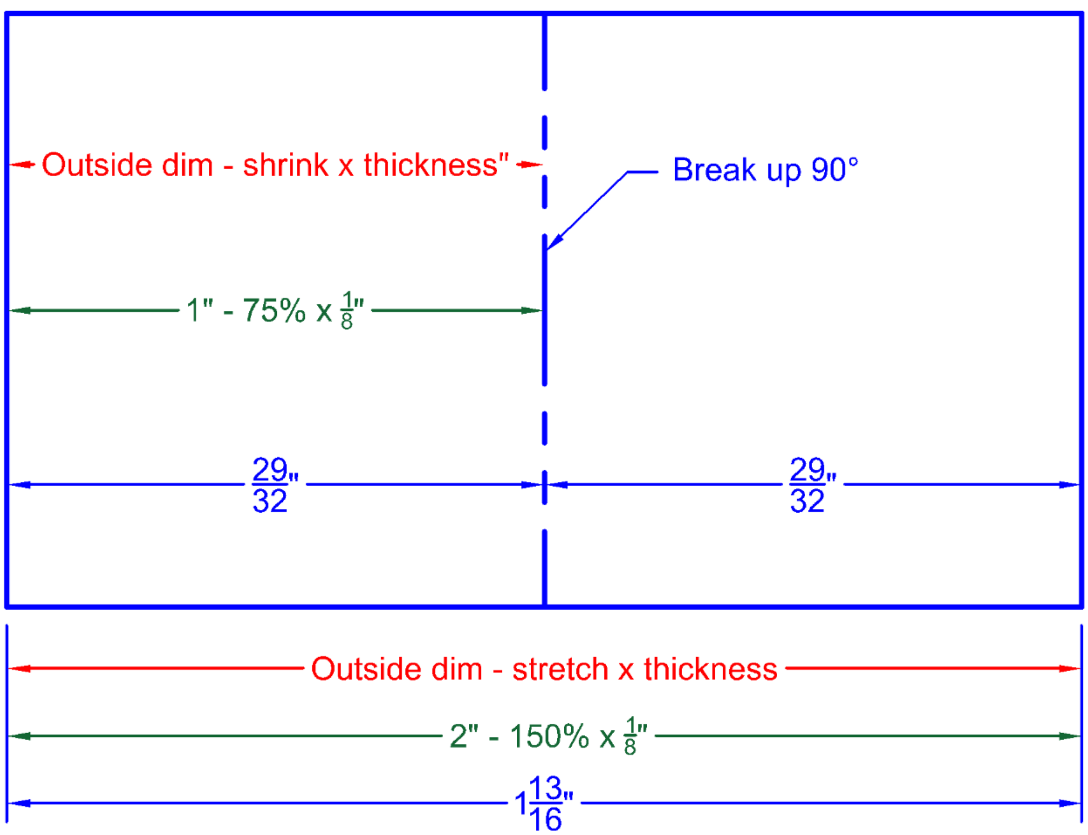




Step 1



Step 2

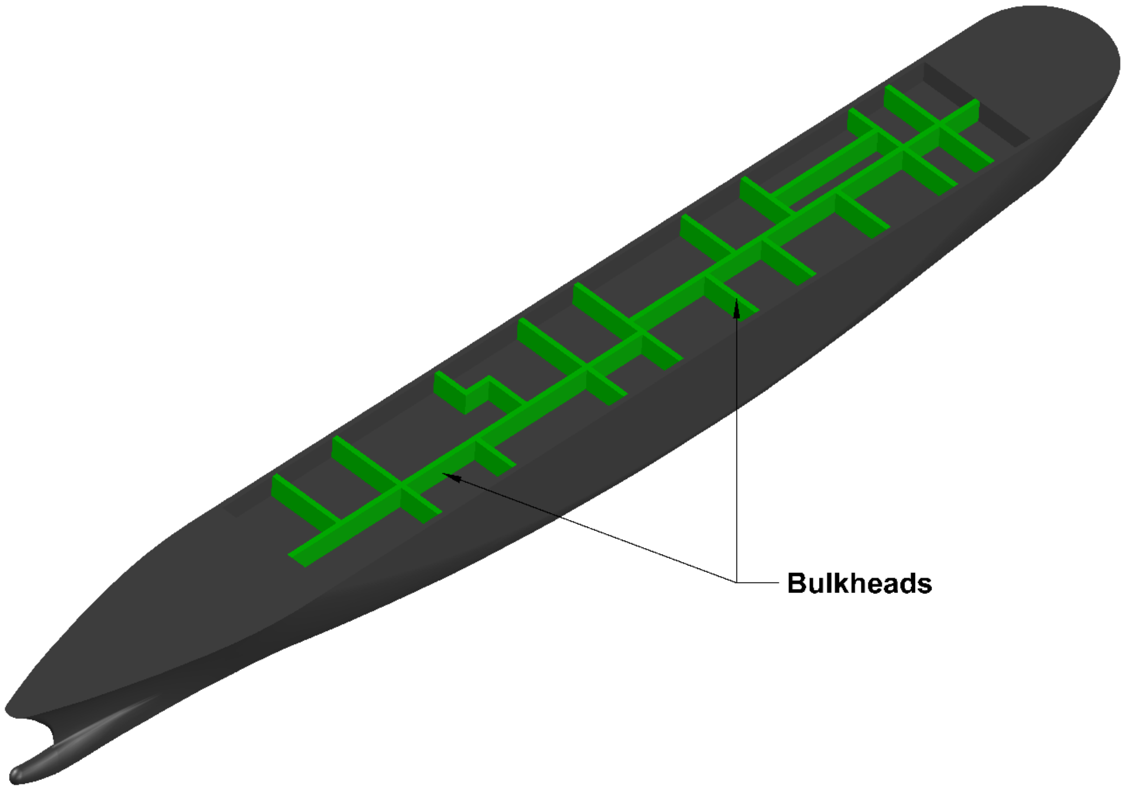


Step 3

KEY
EQUATION
CALCULATION
SHOW ON DRAWING (RESULT)

Bulkhead

Partition or wall.

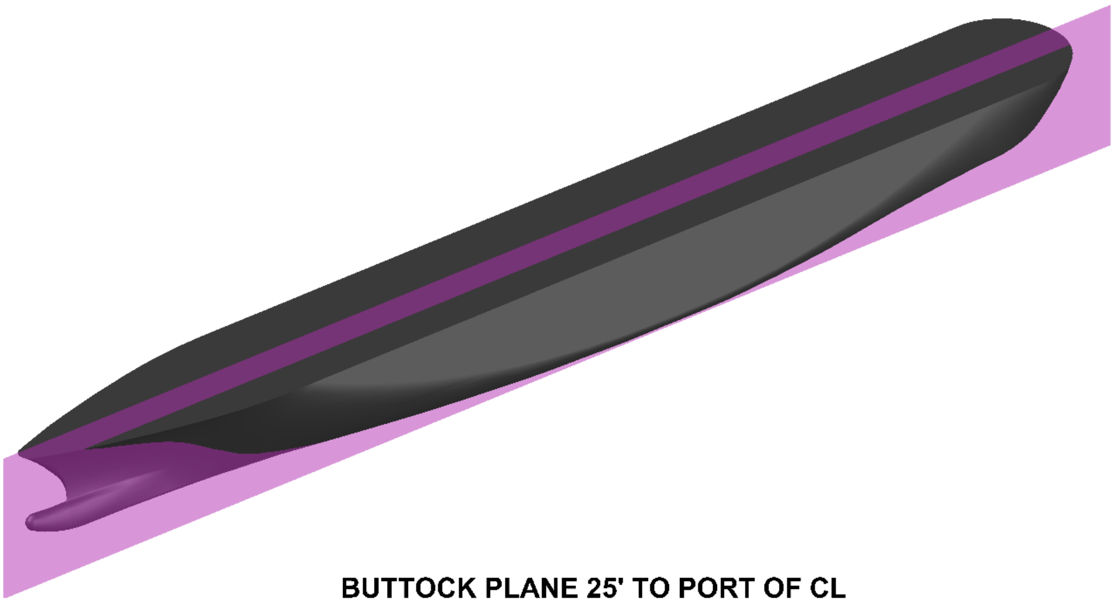


Buoyancy

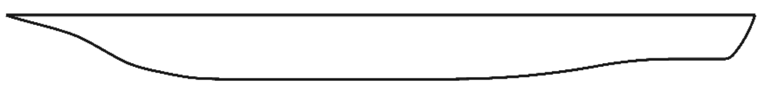
Ability to float. For a boat to float, the weight of the boat and the buoyant force being imposed on the boat from the water must be equal. The amount of buoyant force on the boat is determined by the amount of water the boat displaces, which is equal to the immersed volume of the hull (volumetric displacement).

Buttock

Vertical longitudinal section planes. The intersections of these planes with the hull create buttock lines. In combination with waterlines and stations, buttocks define the curvature of the boat's hull.



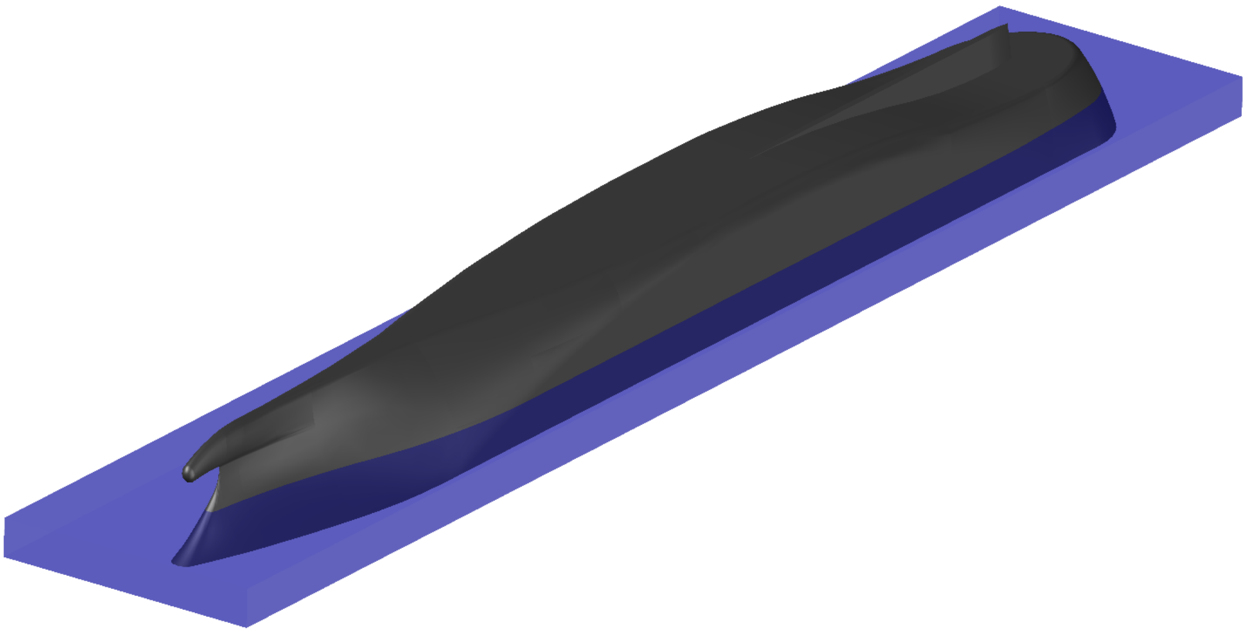
BUTTOCK PLANE 25' TO PORT OF CL



BUTTOCK LINE 25' TO PORT OF CL

Capsize

To overturn; turtle.

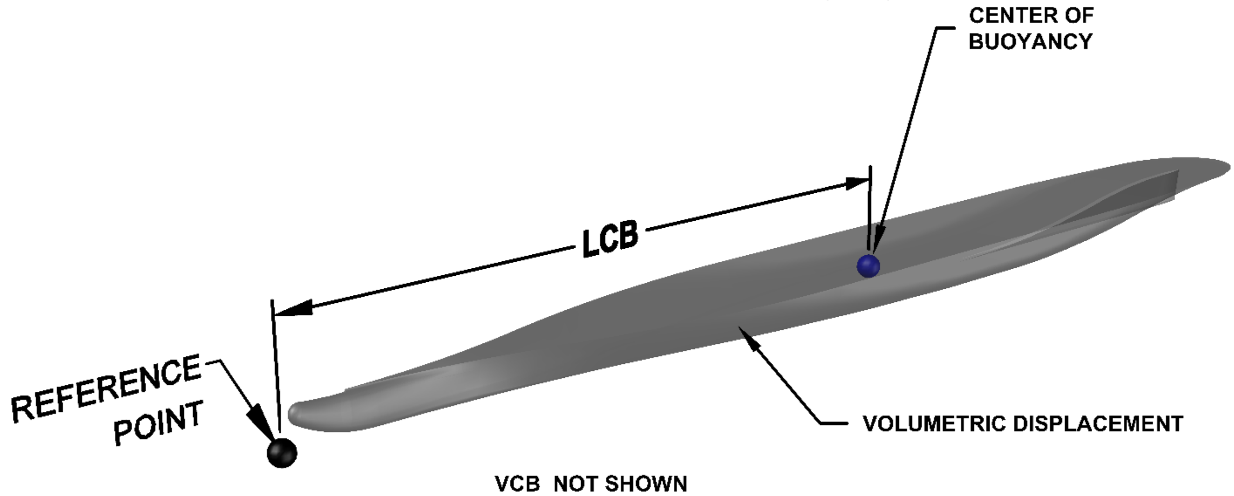


Catamaran

A boat with two parallel hulls or floats joined by a deck or other structure. See Design Process Parameters for construction issues with catamarans.

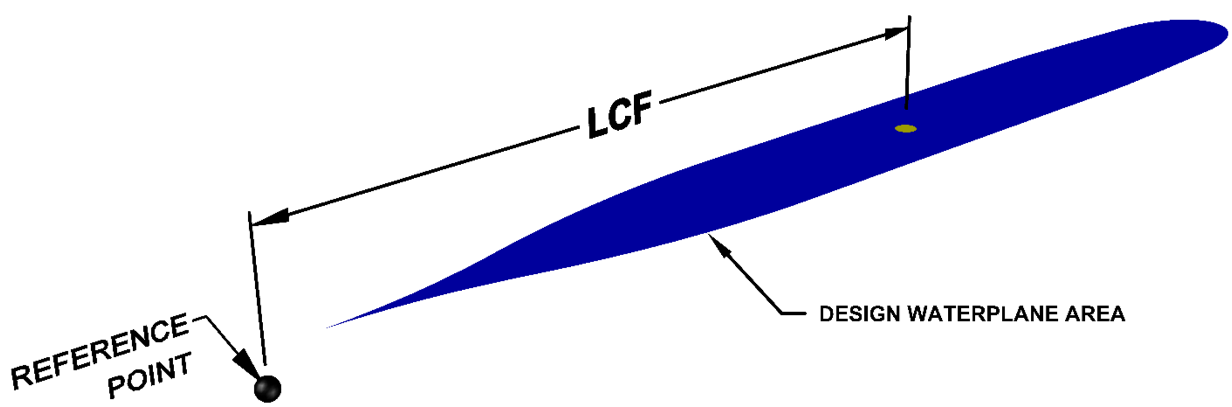
Center of Buoyancy (CB)

The point about which the boat floats; determined as the geometric center of gravity of the immersed volume of the displaced water. Determined solely by the shape of the immersed body of the boat. The center of buoyancy changes depending on the boat's motions (except pure surge and pure sway) and conditions (e.g. list, trim, etc.). Even in these conditions a transverse component (TCB) is not normally defined. The distance KM is the same as the vertical center of buoyancy, VCB.



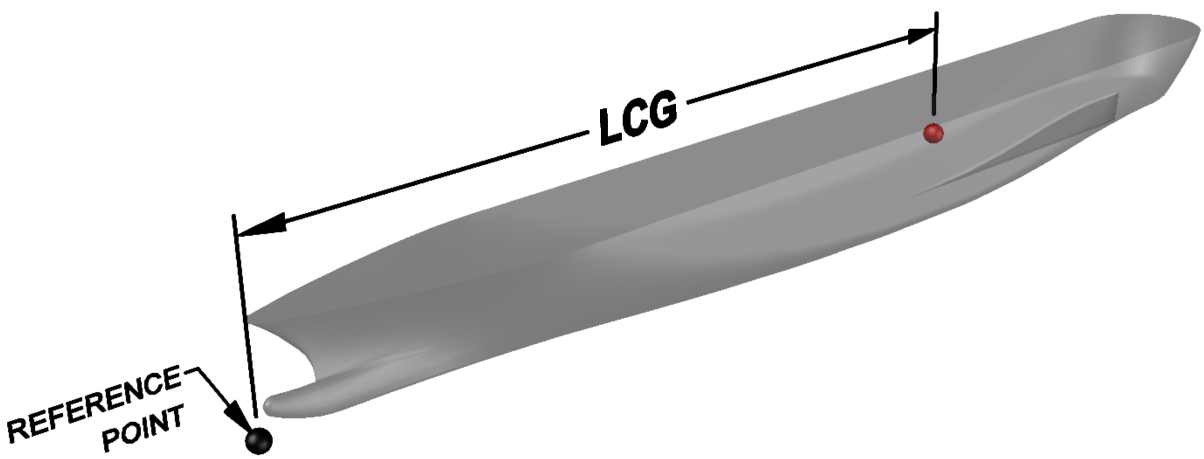
Center of Flotation (CF)

The geometric center of the waterplane at the design waterline. When a boat trims, it inclines about the CF. Weight added directly above or below the CF will increase the mean draft, but will not change trim. The CF is usually just referred to as the Longitudinal Center of Flotation (LCF) since the vertical component is zero (since the waterplane is an area at the design draft) and the transverse component is almost always nonexistent due to the waterplane being symmetrical. The LCF is located midship when the boat has longitudinal symmetry (e.g. rectangular waterplane).



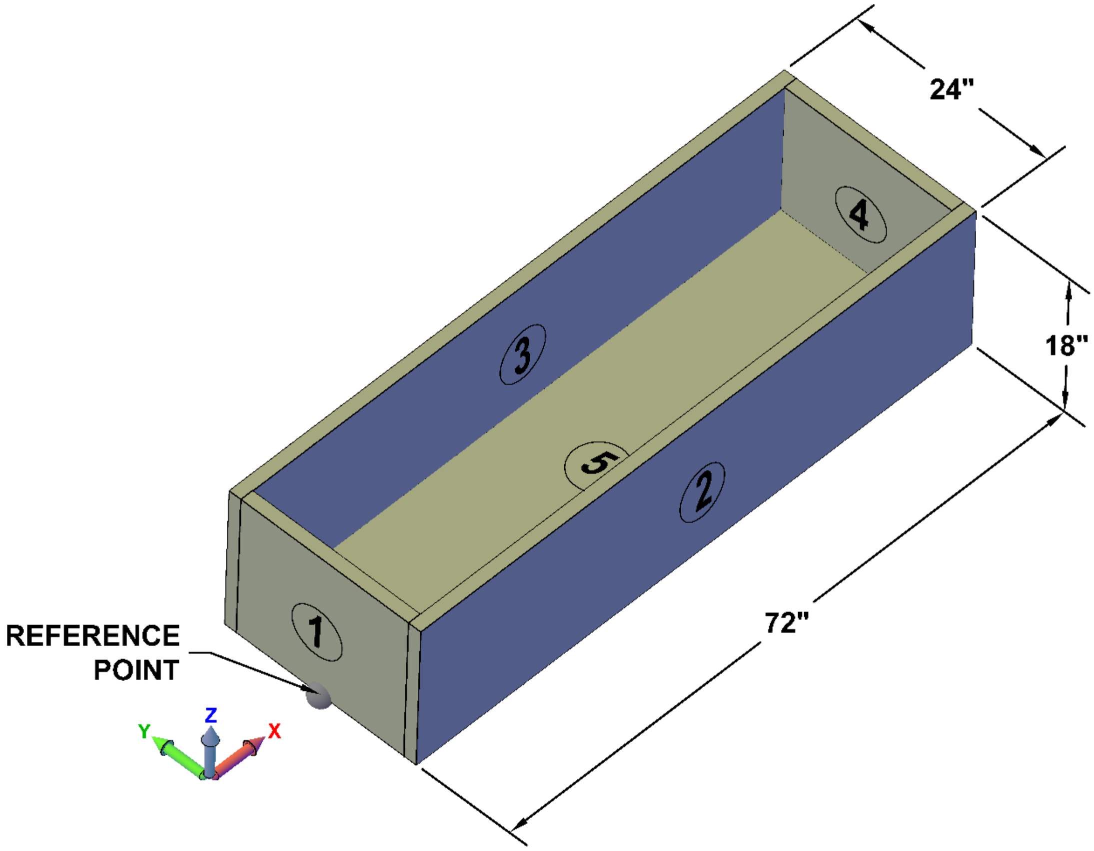
Center of Gravity (CG)

The point at which the combined weight of all the individual items may be considered as concentrated. Center of gravity is a geometric property of an object and is independent of the material used (unless the material is of varying density, nonhomogeneous). The center of gravity can change due to shifting weights (e.g. passengers moving about, liquids in tanks, sliding cargo, etc.). The distance KG is the same as the vertical center of gravity, VCG. Unlike center of buoyancy, center of gravity does have a transverse component, TCG, since a boat is not always symmetric in regards to weight/cargo distribution.



VCG & TCG NOT SHOWN

Center of Gravity Example



The following tables assume that the reference point is located at the front of Plate 1 and the bottom of Plate 5. Plate weight density is 5.1 lbs/ft^2.

Item	Dimensions (in)	Area (in^2)	Weight (lb)	LCG (in)	LMOM (in·lb)	VCG (in)	VMOM (in·lb)	TCG (in)	TMOM (in·lb)
Bow Plate (1)	22" x 18"	396	14.025	0.5	7.0125	9	126.225	0	0
Port Plate (2)	72" x 18"	1296	45.9	36	1652.4	9	413.1	-11.5	-527.85
Starboard Plate (3)	72" x 18"	1296	45.9	36	1652.4	9	413.1	11.5	527.85
Stern Plate (4)	22" x 18"	396	14.025	71.5	1002.79	9	126.225	0	0
Bottom Plate (5)	70" x 22"	1540	54.54	36	1963.44	0.5	27.27	0	0
Total			174.4		6278		1106		0

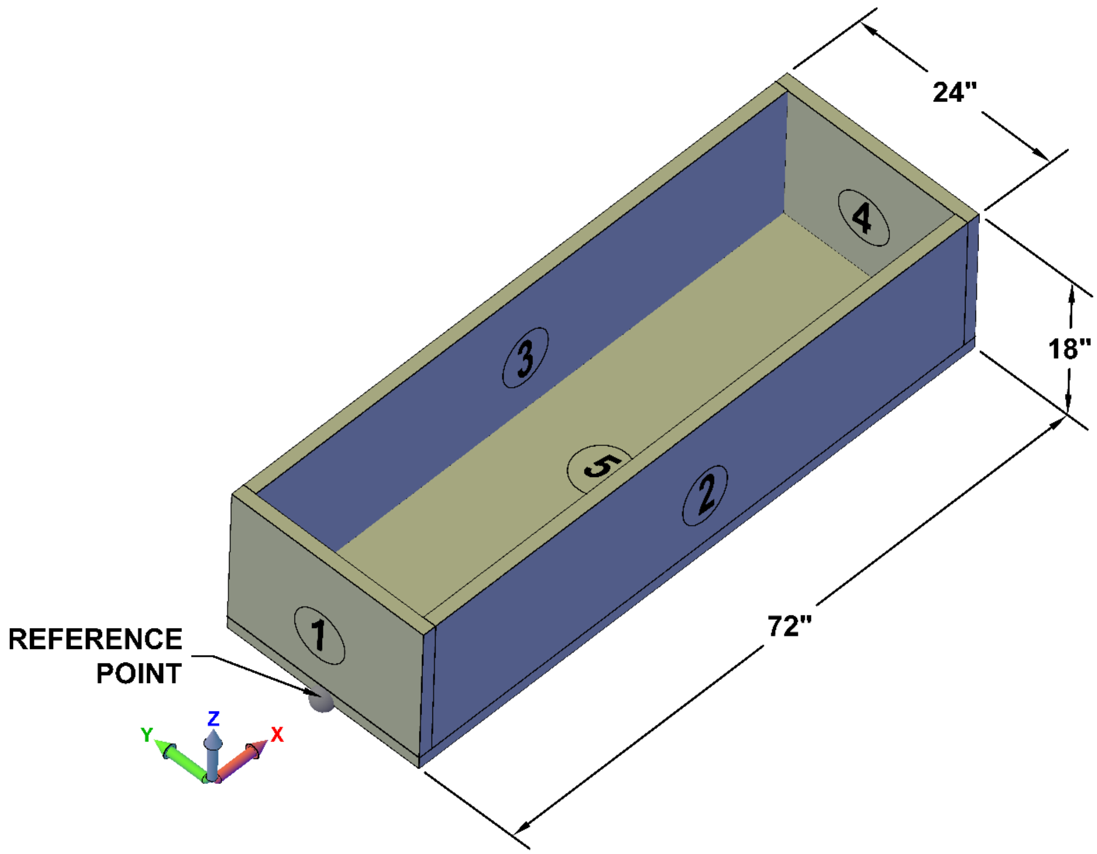


Plate thickness is 1"

Item	Dimensions (in)	Area (in^2)	Weight (lb)	LCG (in)	LMOM (in·lb)	VCG (in)	VMOM (in·lb)	TCG (in)	TMOM (in·lb)
Bow Plate (1)	24" x 17"	408	14.45	0.5	7.225	9.5	137.28	0	0
Port Plate (2)	70" x 17"	1190	42.14	36	1517.04	9.5	400.39	-11.5	-484.61
Starboard Plate (3)	70" x 17"	1190	42.14	36	1517.04	9.5	400.39	11.5	484.62
Stern Plate (4)	24" x 17"	408	14.45	71.5	1033.18	9.5	137.28	0	0
Bottom Plate (5)	72" x 24"	1728	61.2	36	2203.2	0.5	30.6	0	0
Total			174.4		6278		1106		0

Notice that even though the plates of the two examples are different sizes (and therefore the center of gravity dimensions differ), the weight and the moments are the same. If the reference point is moved, the moments would change, though the composite center of gravity would remain at the same point in the barge.

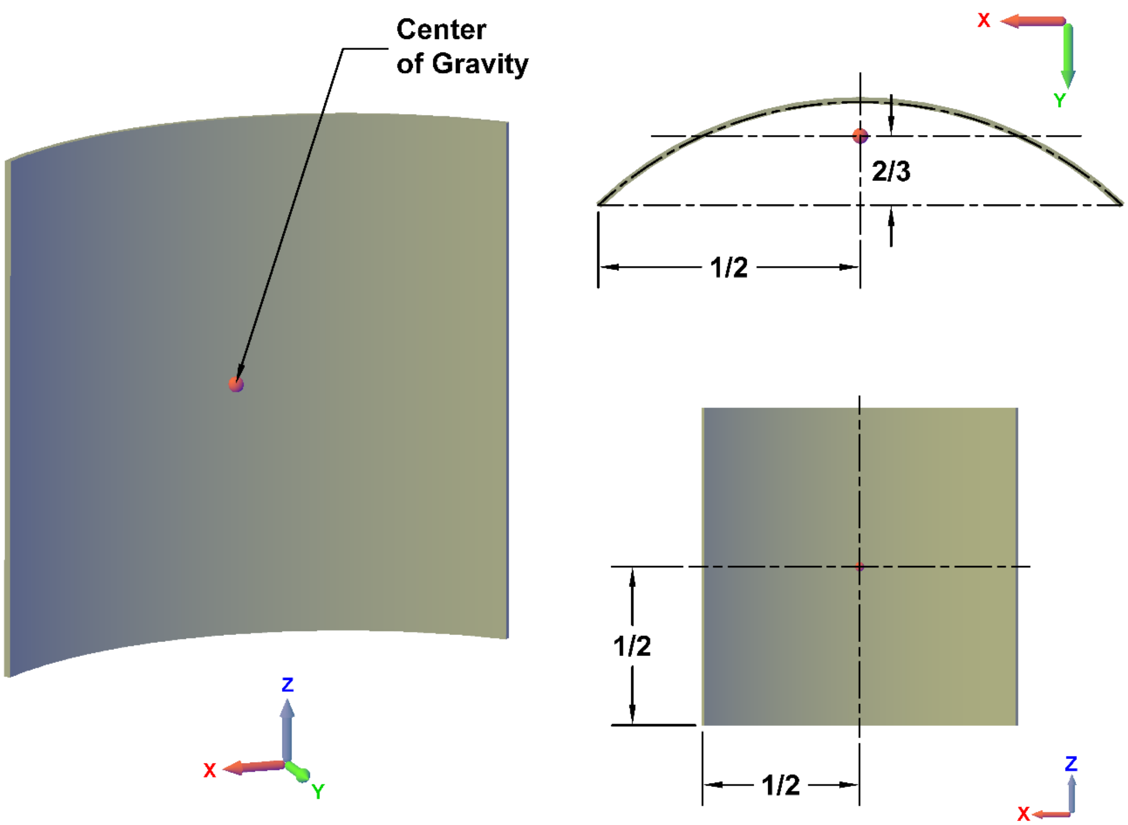
The composite center of gravity is:

- LCG = 36 inches aft of reference point (6278/174.4)
- VCG = 6.34 inches above reference point (1106/174.4)
- TCG = 0 inches aside reference point (0/174.4)

Center of Gravity Techniques

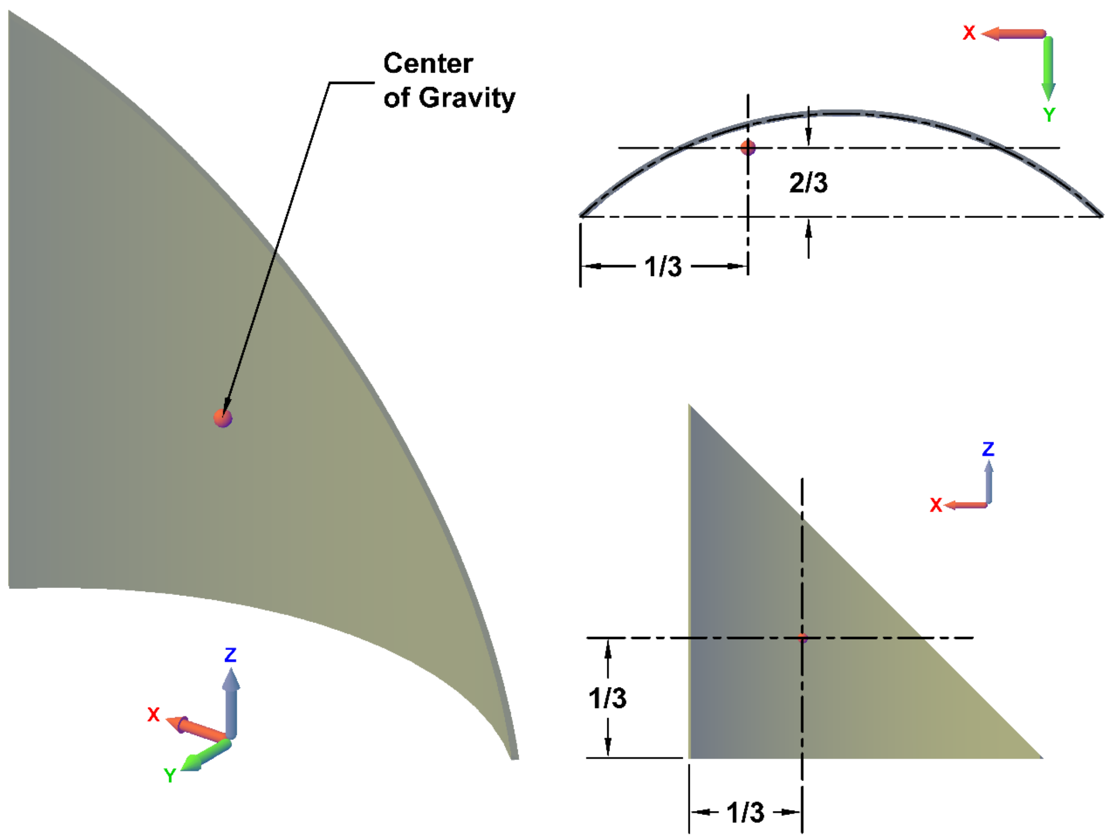
Some plates do not have centroids that are easily defined, as in the center of gravity example. This makes it difficult to find the LCG/VCG/TCG to the plate's centroid/center of gravity. If the plate is of a regular two-dimensional shape, the centroid should be relatively easy to find, even if the plate is rotated in space. Use the internet to find formulas for finding the centroid of a two-dimensional shape.

The technique below is for finding the centroid of a bent rectangular plate. Since the plate is a rectangle, the centroid is located halfway between its length and height, as shown in the xz-plane diagram. However, as the plate is bent, the centroid moves outward (in the y-direction), as shown in the xy-plane diagram. Therefore, bent plates have composite center of gravities that are not actually on the plate. A horizontal line (in the y-direction) drawn at the 2/3 dimension would illustrate that the same amount of material is above the line as below the line. Therefore, that is how far the center of gravity moves away from the plate to compensate for the bend.



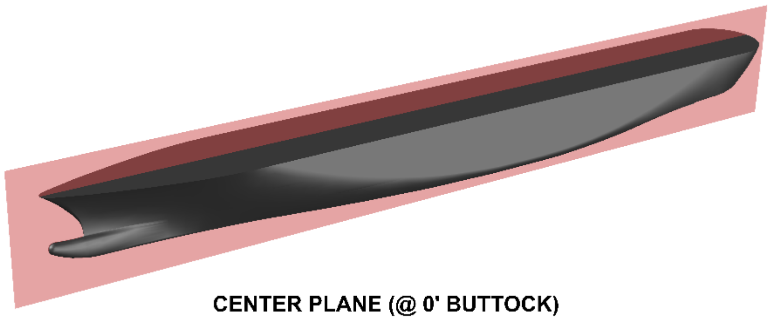
Center of Gravity Techniques (Continued)

If the bent plate is triangular, as opposed to rectangular of the previous technique, then the center of gravity is found in a different manner. Whereas a rectangle has its centroid midway along its length and height, a triangle's centroid is located at 1/3 of its length and height. This length moves the centroid over to the bulkier side of the plate, as shown in the xy-plane diagram. Otherwise, the movement due to the bend is the same.

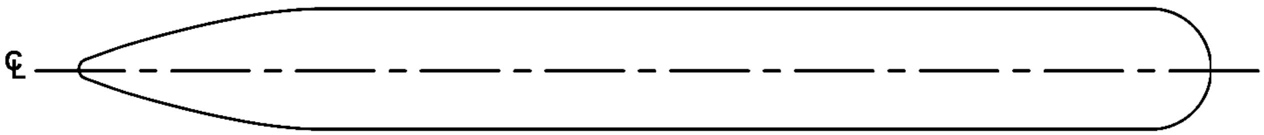


Centerline (CL)

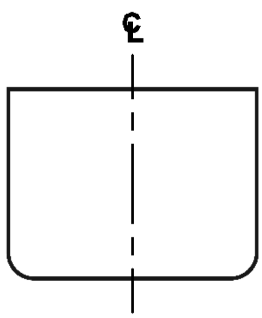
A line created by taking a vertical plane down the center of the boat, extending from bow to stern. All transverse dimensions are taken from the centerline.



CENTER PLANE (@ 0' BUTTOCK)



CENTERLINE (MAIN DECK WATERLINE)



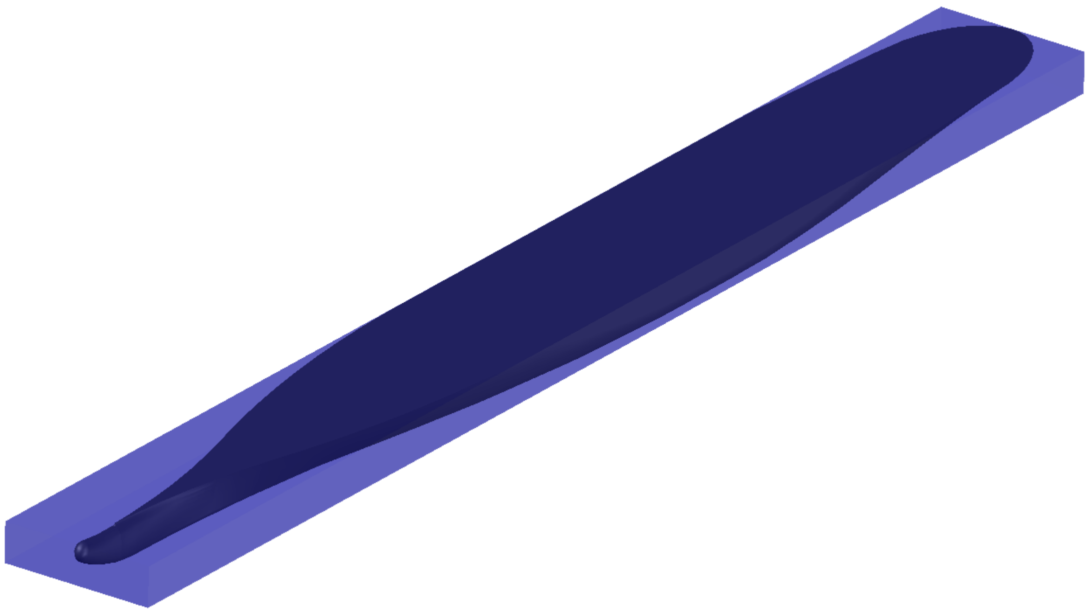
CENTERLINE (MIDSHIP SECTION)

Coefficients

Coefficients help determine the efficiency of the hull.

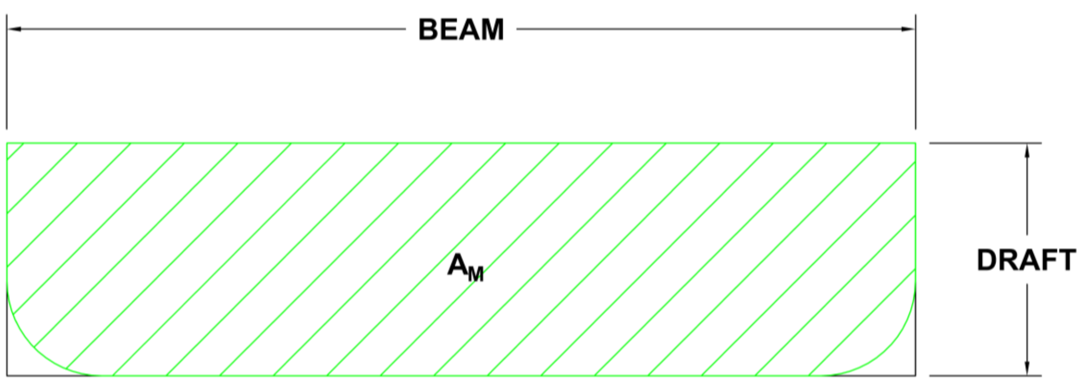
Block Coefficient (C_B) – the ratio of the volumetric displacement of the hull to a prism equal to the waterline length, beam, and draft of the hull (i.e. how much of a prism is occupied by the hull)

$$C_B = \frac{\nabla}{LWL * B * T}$$



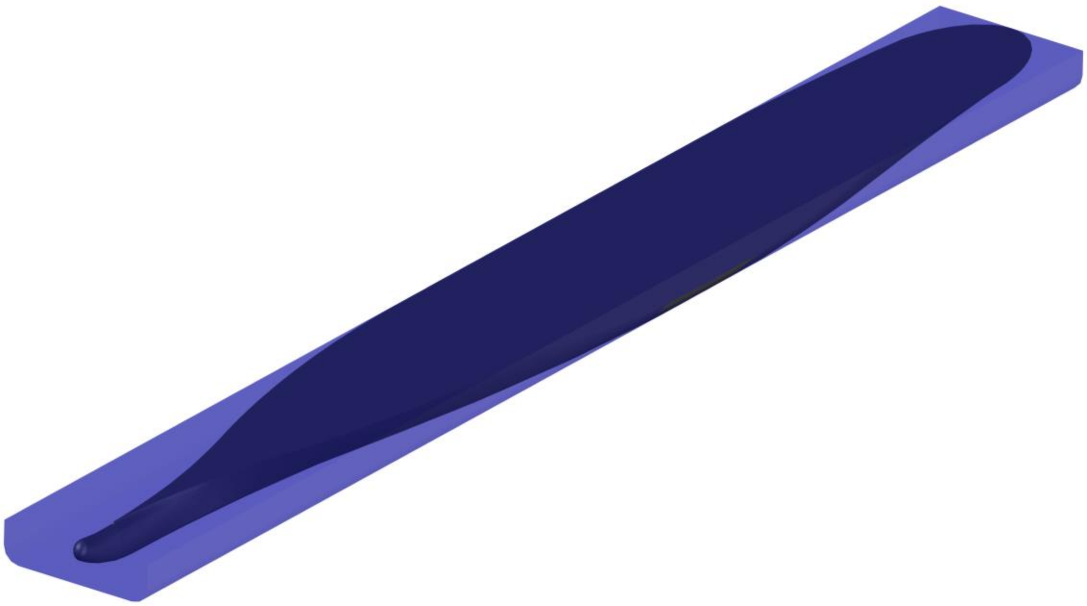
Midship Coefficient (C_M) – the ratio of the midship area of the hull to a rectangle equal to the beam and draft of the hull (i.e. how much of a rectangle is occupied by the midship area)

$$C_M = \frac{A_M}{B * T}$$



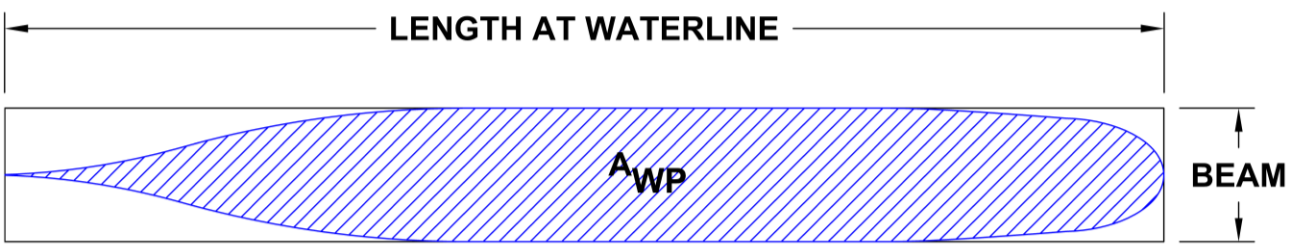
Prismatic Coefficient (C_P) – the ratio of the volumetric displacement of the hull to a body equal to the waterline length and midship area of the hull (i.e. how much of a body is occupied by the hull)

$$C_P = \frac{\nabla}{LWL * A_M}$$



Waterplane Coefficient (C_W) – the ratio of the waterplane area of the hull to a rectangle equal to the waterline length and beam of the hull (i.e. how much of a rectangle is occupied by the waterplane area)

$$C_W = \frac{A_{WP}}{LWL * B}$$

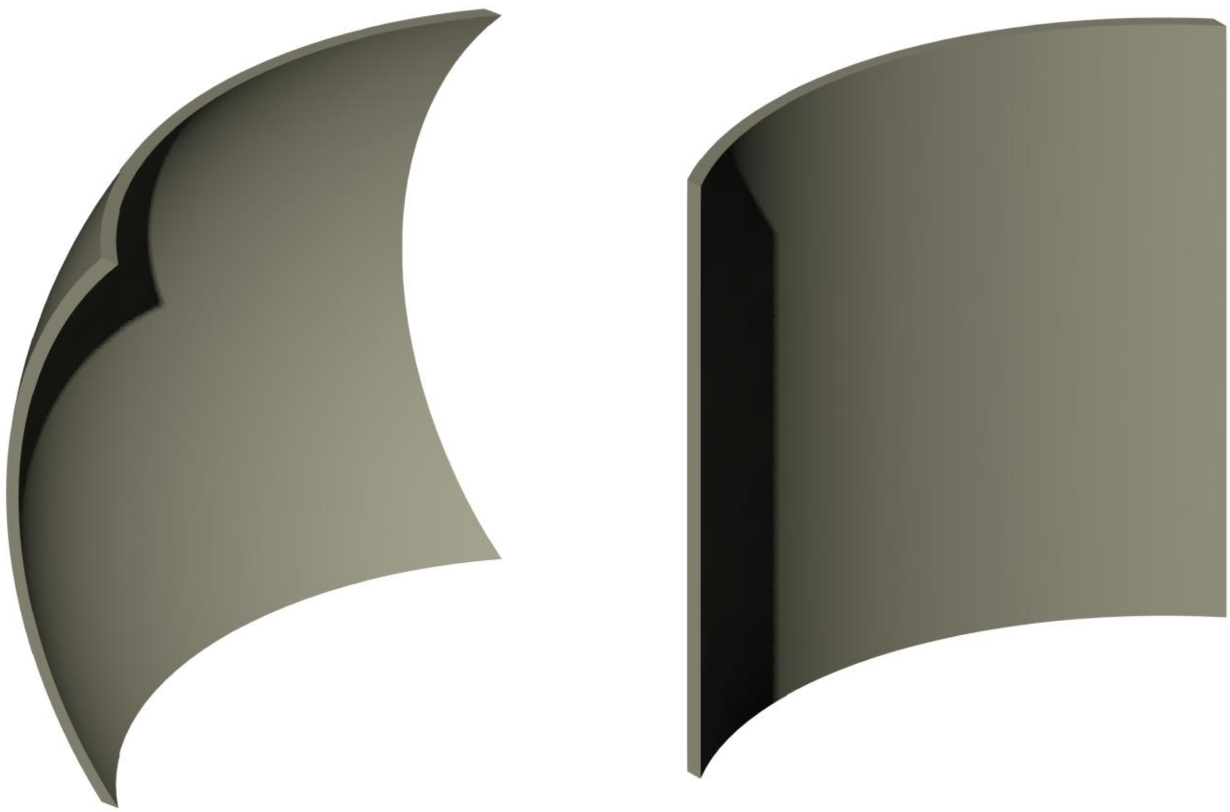


Compartment

A confined space (a room in a boat).

Curvature

Complex Curvature – bending a plate in two planes
Simple Curvature – bending a plate in one plane



Complex Curvature Curvature

Density

Mass per unit volume (ρ) or a weight per unit volume (weight density, specific weight, γ). For the purposes of the Boat Design Competition, material density is in units of lb/ft^2 for several reasons:

- Steel plate and plywood areas, not volumes, are calculated
- Steel plate in the shipyard is referred to by unit weight, which correlates to thickness
- In conjunction with the above, the thickness dimension is removed from the denominator so that the units reduce to lb/ft^2
- All teams utilize the same thickness of steel plate and plywood

Depth (D)

Vertical distance from the top of the hull to the baseline. See Ship Dimensions.

Displacements

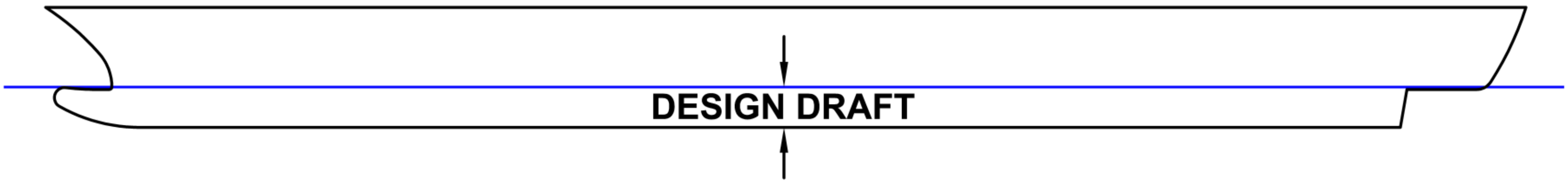
The amount of water that a boat displaces; measured by weight or by volume:

Displacement (Δ) – total weight of the boat when afloat including everything on board.
Volumetric Displacement (∇) – displacement in terms of volume.

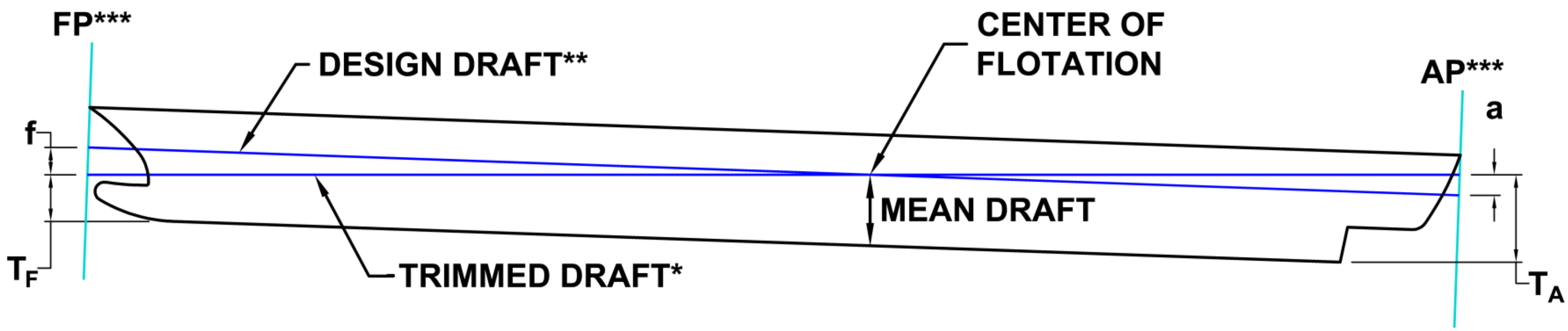
Drafts

Draft – vertical distance from the waterline to the baseline.
Mean Draft – draft measured at the center of flotation. It is the average of the draft at the bow and the draft at the stern. For purposes of the Boat Design Competition, the mean draft is taken as the design draft since they are approximately the same.
Draft at Bow – draft measured at the forward perpendicular.
Draft at Stern – draft measured at the after perpendicular.
Design Draft – draft that the boat is expected to operate at.

See illustration on the next page.



DRAFT ILLUSTRATION WITH NO TRIM



*DRAFT ILLUSTRATION WITH EXAGGERATED TRIM BY THE STERN
**DWL DEEPENED FOR CLARITY
***MOVED FOR THE PURPOSES OF THE BOAT DESIGN COMPETITION

Elevation View

See Views.

Forward or Fore

Near, at, or toward the bow of the boat. See Ship Directions.

Forward Perpendicular (FP)

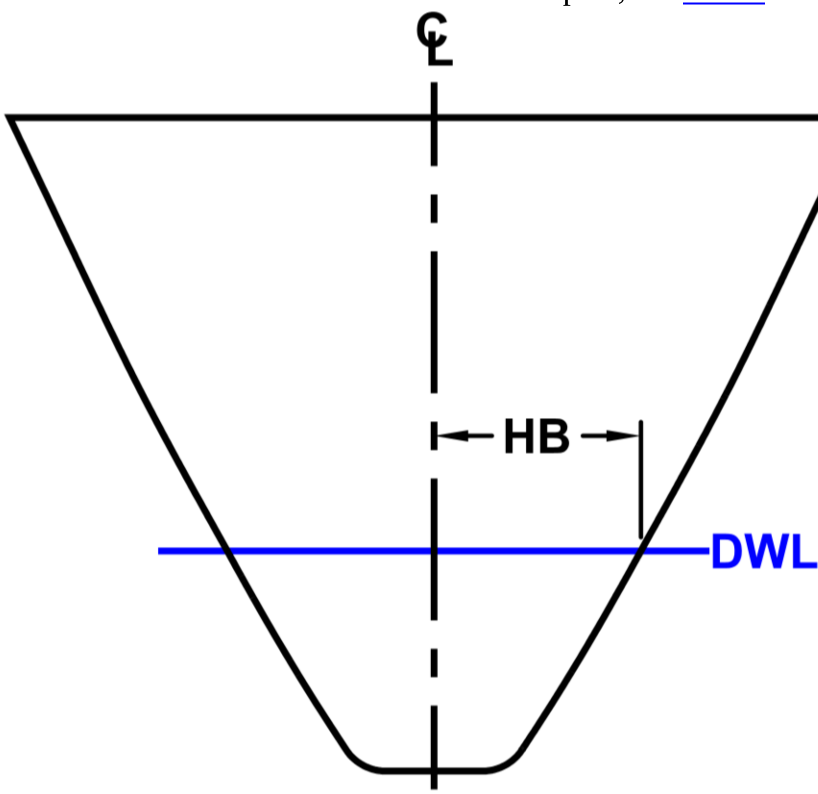
For the purposes of the Boat Design Competition, a vertical line at the forward most portion of the buoyant hull. In actuality, the FP is at the intersection of the design waterline and the stem. See Ship Dimensions.

Freeboard

Depth minus the draft and therefore a measurement of the boat's hull above the waterline. See Ship Dimensions.

Half-Breadth (HB)

A distance from the centerline to the hull. For half-breadth plan, see Views.



HALF-BREADTH AT INTERSECTION OF STATION 2 AND DWL

Heave

See Ship Motions.

Heel

A semi-permanent condition where a boat leans to port or starboard due to effects on the hull. Not to be confused with rolling, the continuous side-to-side motion.

Hull

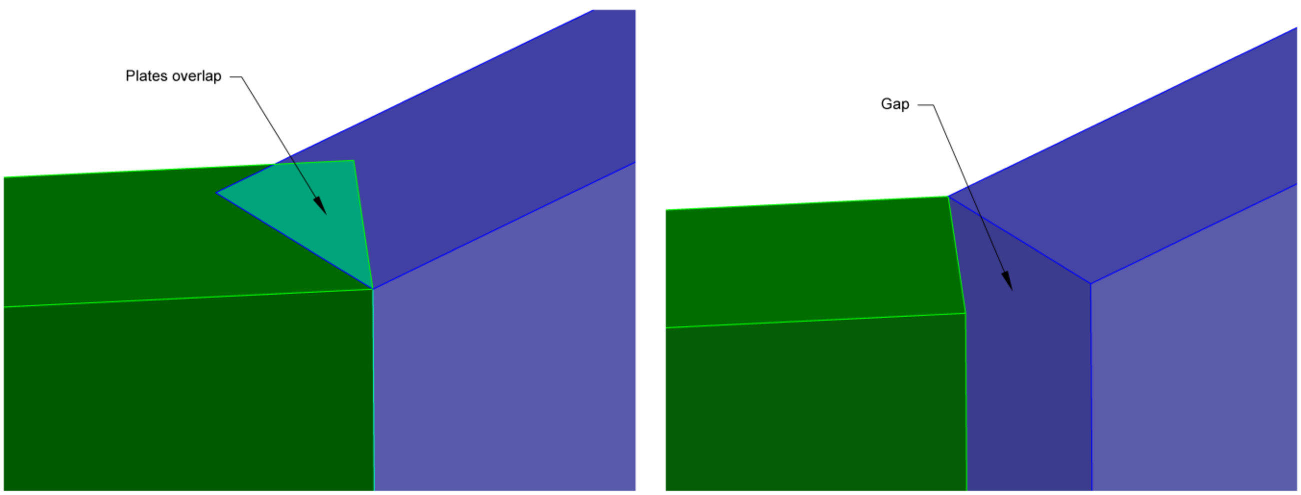
For the purposes of the Boat Design Competition, the main structurally buoyant portion of a boat, including the decks, bulkheads, etc., but excluding the superstructure or appendages. See Superstructure.

Inboard

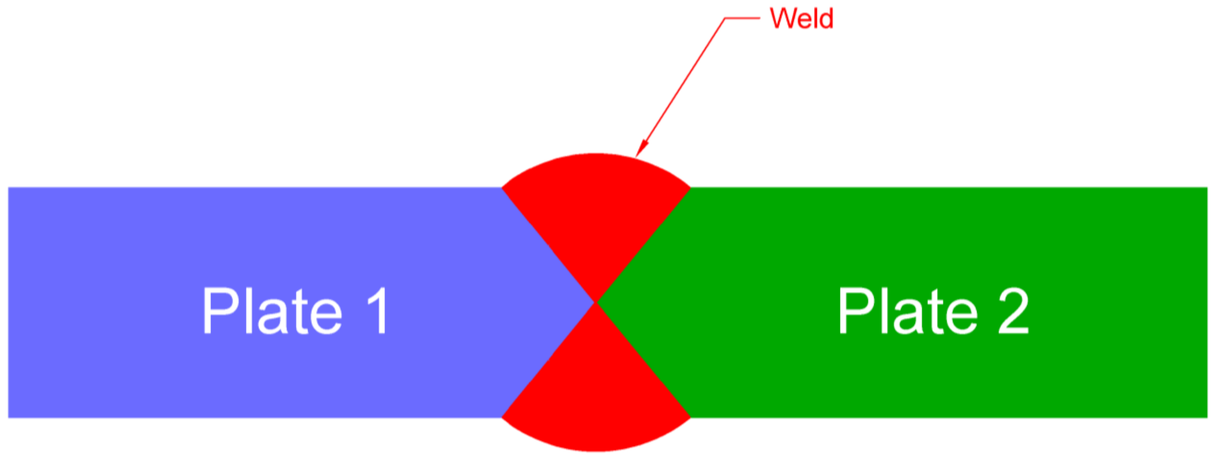
Toward the centerline. See Ship Directions.

Joints

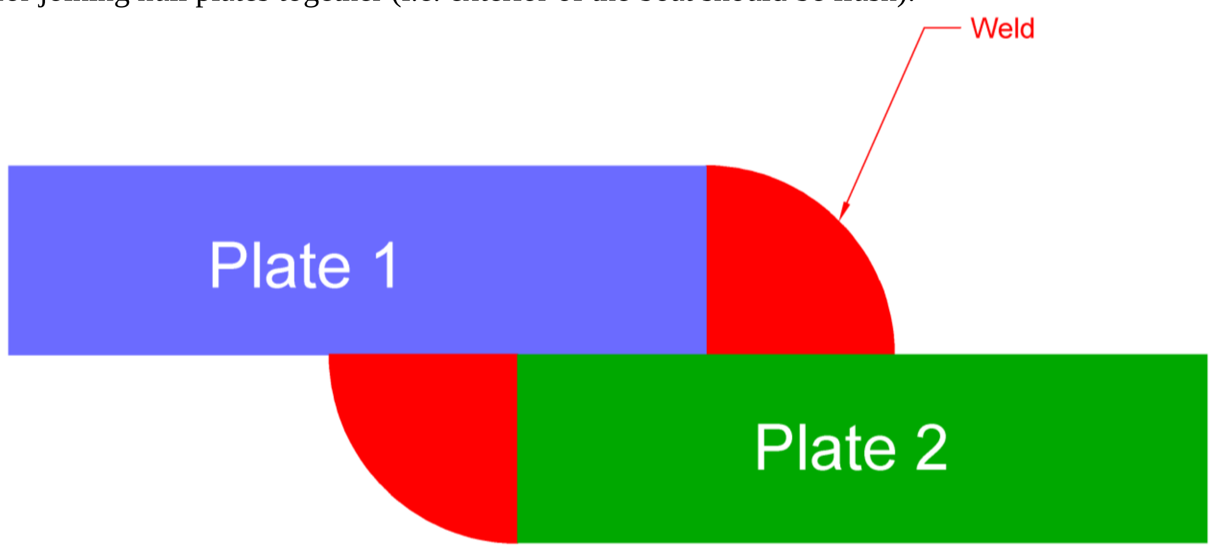
When two plates meet at an angle, an option exists to either meet them at an exterior edge, which can result in an overlap, or meet them at an interior edge, which can result in a gap. To make a joint of the overlapping plates, one plate's end needs to be modified across the thickness to make a flush joint. To make a joint of the gapped plates, weld metal will fill the gap. For the purposes of the Boat Design Competition, the cuts across the thickness/gaps between plates does not need to be specified in the construction drawings. Experienced shipyard workers will handle these small nuances in the construction. Instead, teams should focus on accurately dimensioning and weighing the plates' major dimensions.



A butt joint is a connection between two pieces by joining their ends together. Butt joints should be used in the Boat Design Competition.



A lap joint is a connection between two pieces by overlapping their ends. Lap joints should not be used for joining hull plates together (i.e. exterior of the boat should be flush).



Keel

The principal fore and aft member of a boat's hull (the boat's backbone) that runs along the bottom centerline.

Lengths

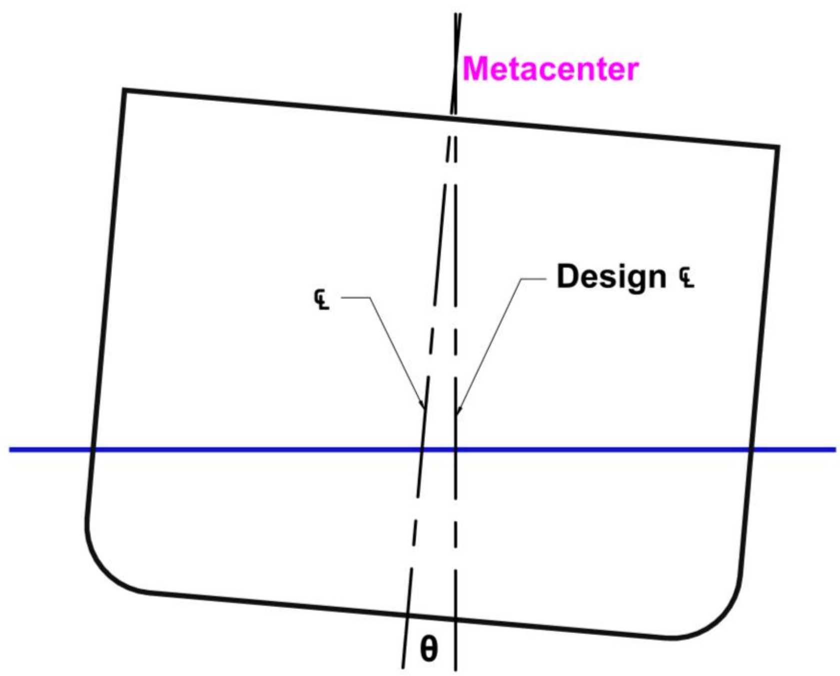
Length Between Perpendiculars (LBP) – distance between the FP and the AP.
Length Overall (LOA) – distance from structural tip to structural tip.
Length at Waterline (LWL) – distance between the forward draft and the aft draft. In some instances, there may be two LWLs; one that defines only the buoyant portion of the boat and one that defines an actual length.

For some boats of the Boat Design Competition, the LBP, the LOA, and the LWL may all be the same value (e.g. vertical-sided), may all be different values (e.g. a monohulls with cantilevered appendages), or may a combination of the aforementioned (e.g. majority of boats).

See Ship Dimensions.

List

A permanent condition, until corrected, of a boat to lean to port or starboard. Not to be confused with rolling, the continuous side-to-side motion. In contrast to trim, which is the permanent condition forward and aft.



Load Waterline (Design Waterline) (DWL)

Same as Design Draft.

Longitudinal

Parallel with the boat's centerline. See Ship Directions.

Longitudinal Center of Buoyancy (LCB)

See Center of Buoyancy.

Longitudinal Center of Flotation (LCF)

See Center of Flotation.

Longitudinal Center of Gravity (LCG)

See Center of Gravity.

Longitudinal Metacentric Height (GM_L)

See Longitudinal Stability.

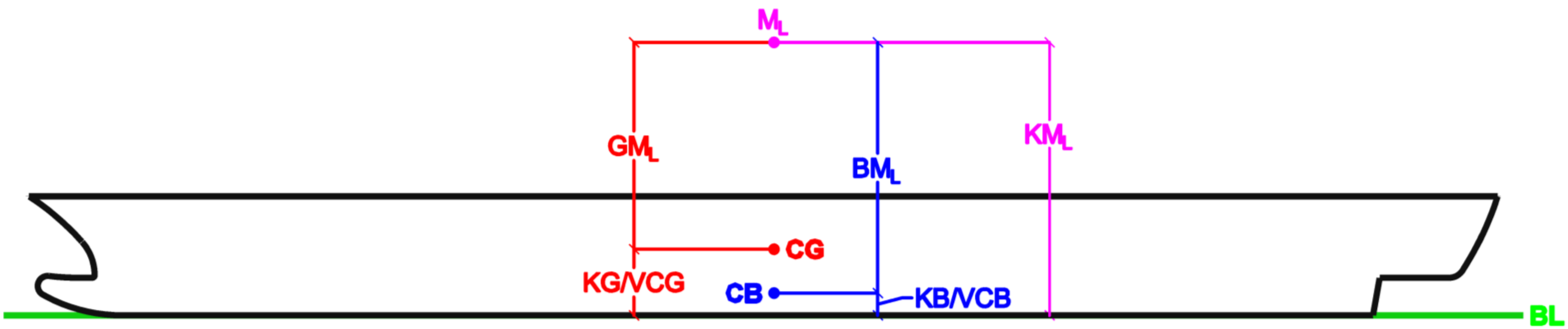
Longitudinal Metacentric Radius (BM_L)

See Longitudinal Stability.

Longitudinal Stability

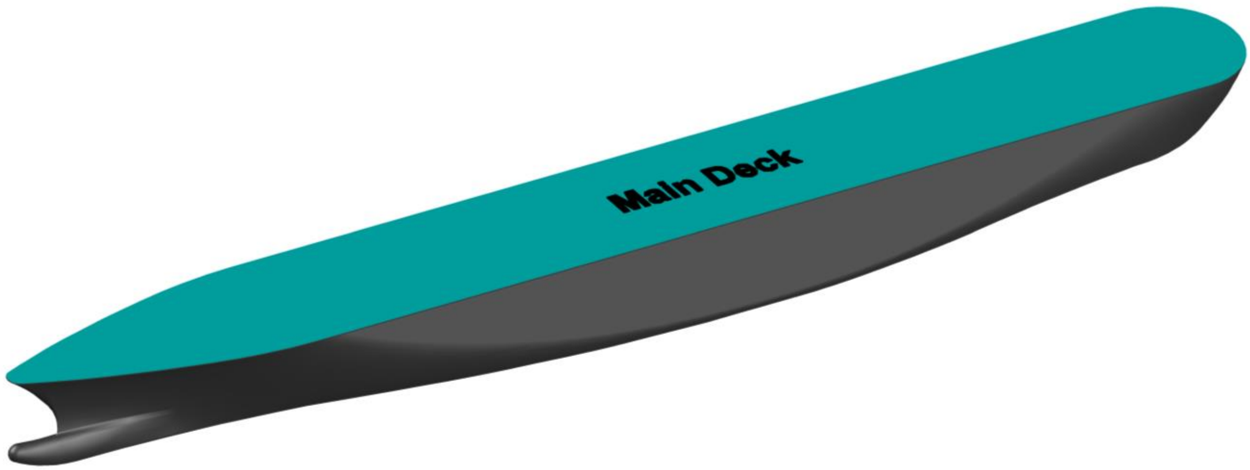
The tendency of a boat to resist a change in trim. Longitudinal stability shares the same KB and KG as transverse stability and therefore only the measurements to the metacenter (KM, BM, GM) change.

See illustration on the next page.


M_L
GM_L
BM_L
KM_L
CG
KG/VCG
CB
KB/VCB
BL

Main Deck

For the purposes of the Boat Design Competition, the plane forming the top boundary of the hull (since a deck would enclose the hull and is not allowed per the Design Process Parameters)



Mean Draft (T_M)

See Drafts.

Metacenter

Fixed point in space above a boat about which it rotates. See Transverse and Longitudinal Stability.

Metacentric Height (GM)

A vertical distance between the center of gravity and the metacenter. A measure of stability: if M is above G, the metacentric height is positive and the boat is stable. If M is below G, the metacentric height is negative and the boat is unstable. If GM is large, the boat resists rolling/pitching and is said to be stiff. If GM is small, the boat rolls/pitches slowly and is said to be tender. Therefore, a large GM is desirable for resistance to the flooding effects of damage, but a smaller GM is desirable for passenger comfort, accurate gunfire, etc. See Longitudinal and Transverse Stability.

Metacentric Radius (BM)

A vertical distance between the center of buoyancy and the metacenter. So termed because for small angles of heel, the center of buoyancy can be traced by a circle. See Longitudinal and Transverse Stability.

Moment

Force times a distance.

Moment to Trim 1”

Measure of a boat’s ability to resist a one inch change in trim. Units do not simplify; instead they remain a moment (force x distance) over a 1” trim (distance) [i.e. $^{(in \cdot lb)}/_{in}$].

$$\text{MT1"} = \frac{\Delta * GM_L}{LWL}$$

Monohull

A boat with only one hull, as opposed to a catamaran or trimaran.

Origin

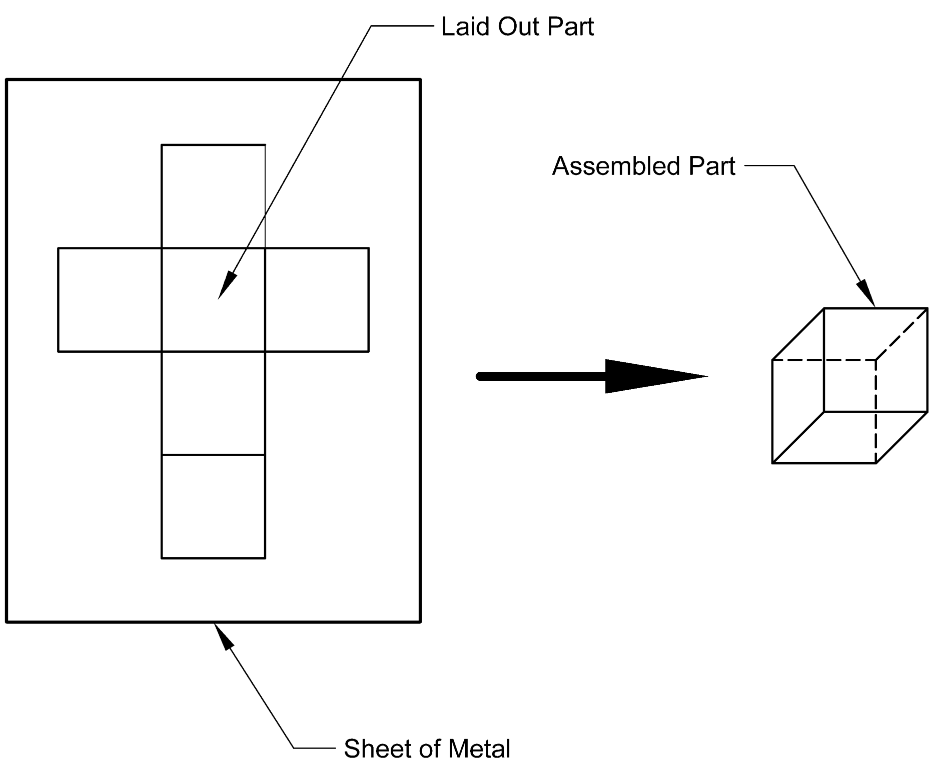
See Reference Point.

Outboard

Away from the centerline.

Nesting

Layout of parts to be cut from a sheet of material.



Payload

The total weight of cargo that a boat is designed to carry.

Pitch

See Ship Motions.

Plan View

See Views.

Port

The left side of the boat when looking forward. See Ship Directions.

Pounds Per Inch (PPI)

The number of pounds of additional weight required to immerse a boat one additional inch of draft. In the industry, this is referred to as Tons Per Inch (TPI) since pounds are relatively small for ships. Like MT1", PPI is somewhat misleading since it is calculated from the design waterplane area, which theoretically changes size as the boat's draft changes. However, since a boat's waterplane area does not change drastically in such a small increment, PPI/TPI is only used to determine small changes in draft from loading/discharging small weights.

$$\mathrm{PPI} = \frac{A_{WP}}{27.7\,{}^{in^3}/_{lb}}$$

Reference Point

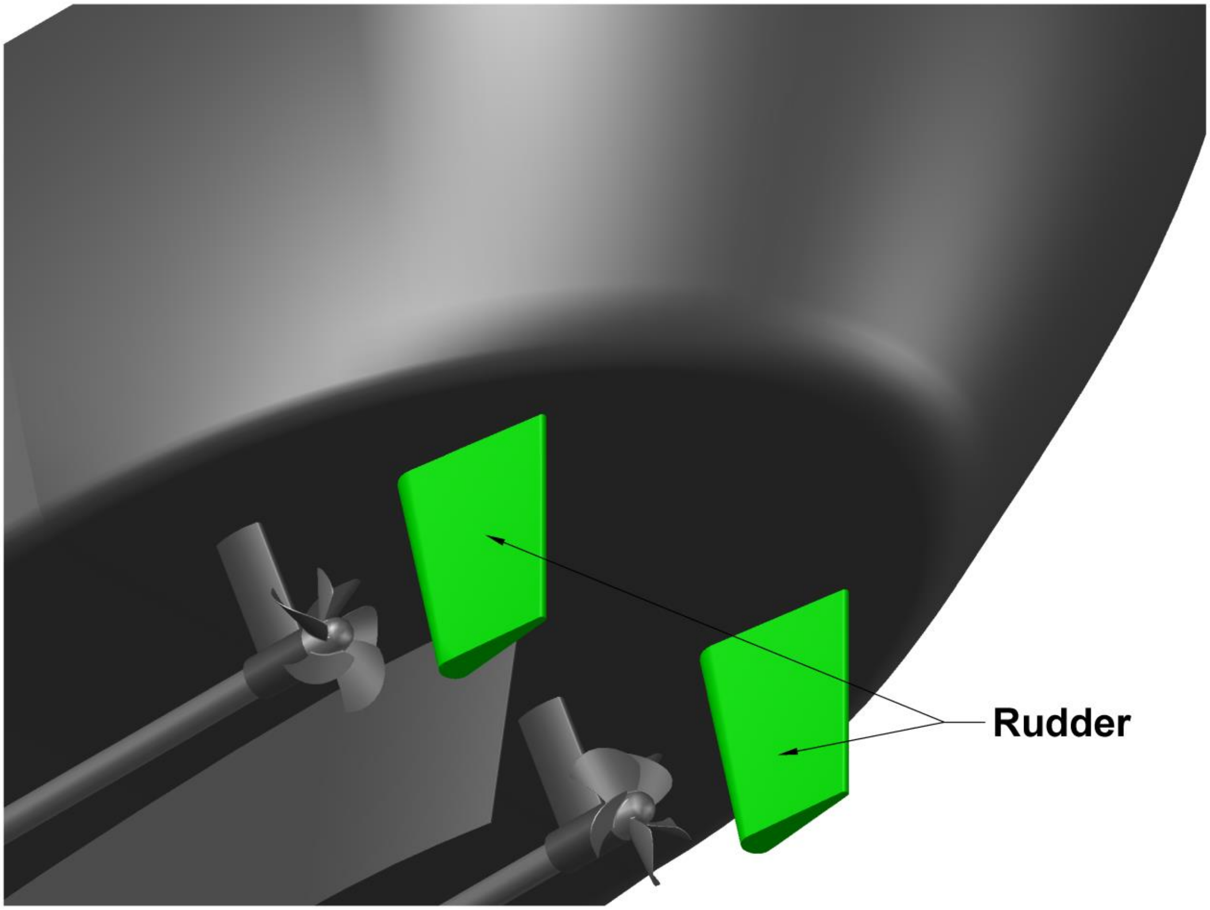
For consistency, the reference point will be located at the same place for all teams. This point is located at the intersection of the forward perpendicular and baseline. This holds true for all types of hulls (monohulls/catamarans/etc.). See Ship Dimensions. The proper sign convention must be used in conjunction with the reference point.

Roll

See Ship Motions.

Rudder

Blade-shaped device used to steer the boat.



Rudder Stock

Vertical shaft that connects the rudder to the steering mechanism.

Seams

See [Joints].

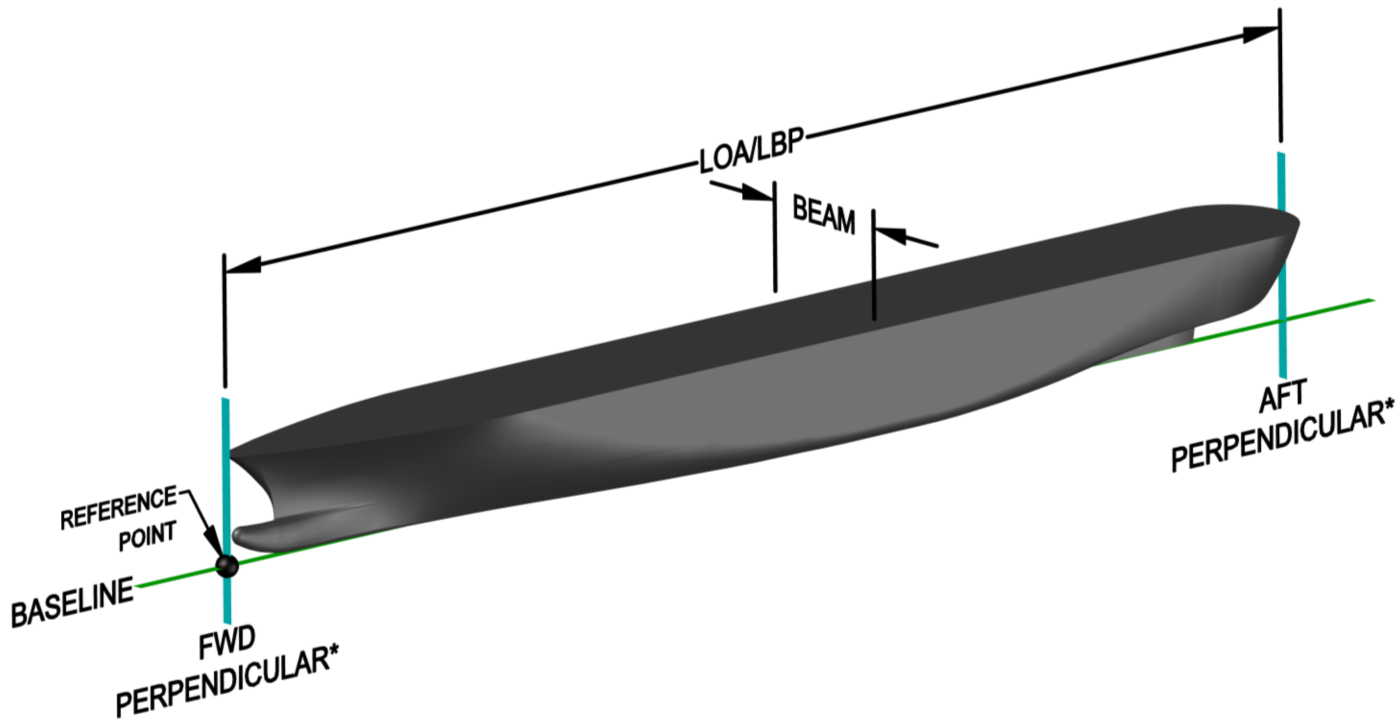
Section View

See [Views].

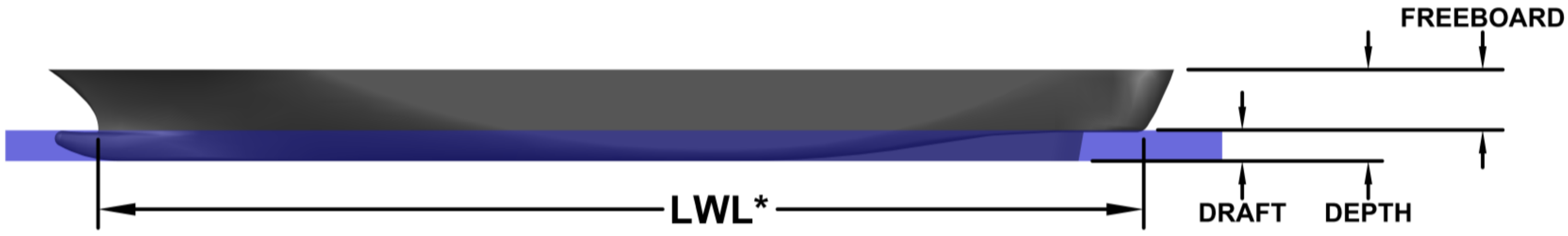
Sheer Plan

See [Views].

Ship Dimensions

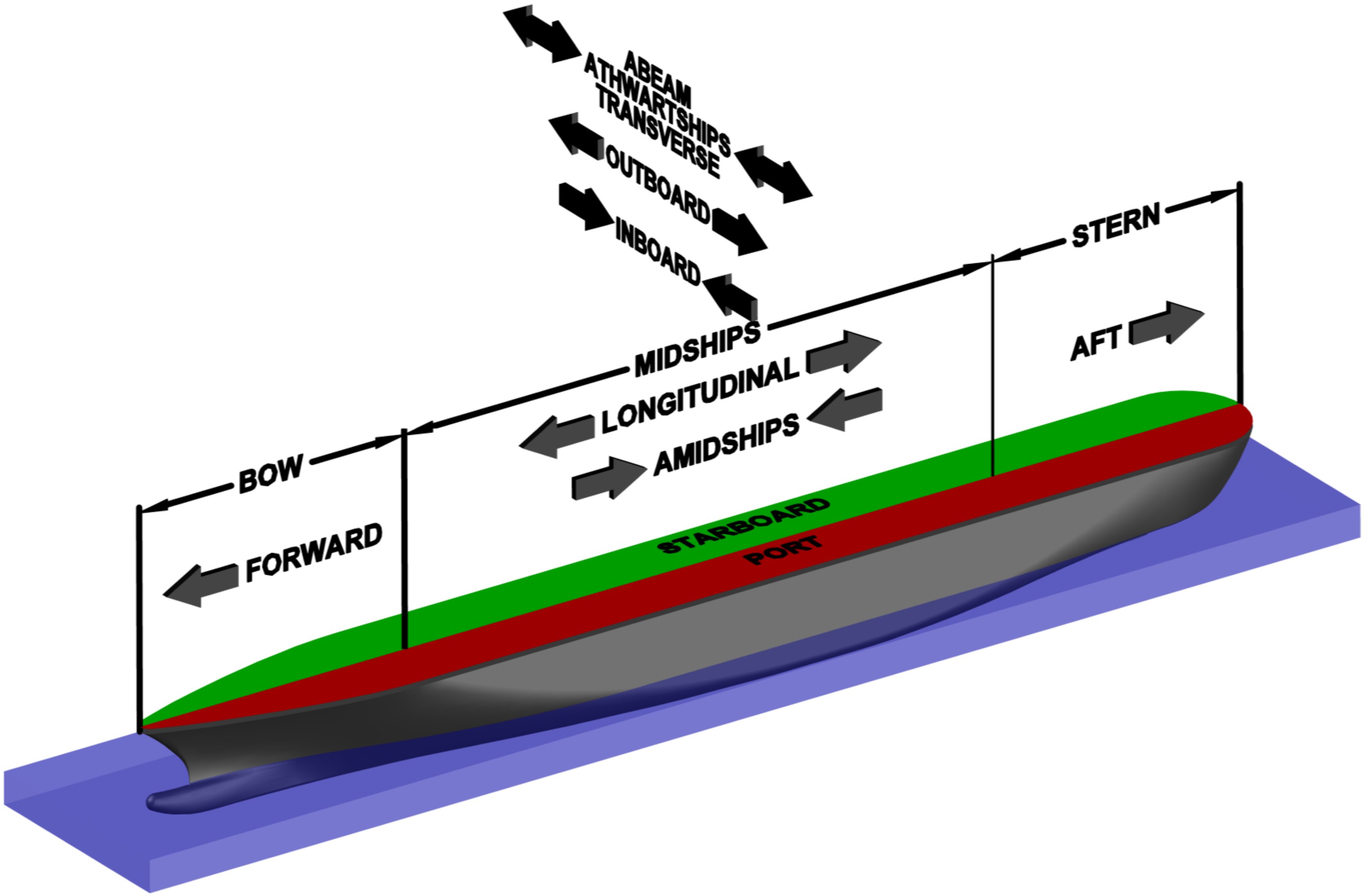


*moved for purposes of the Boat Design Competition



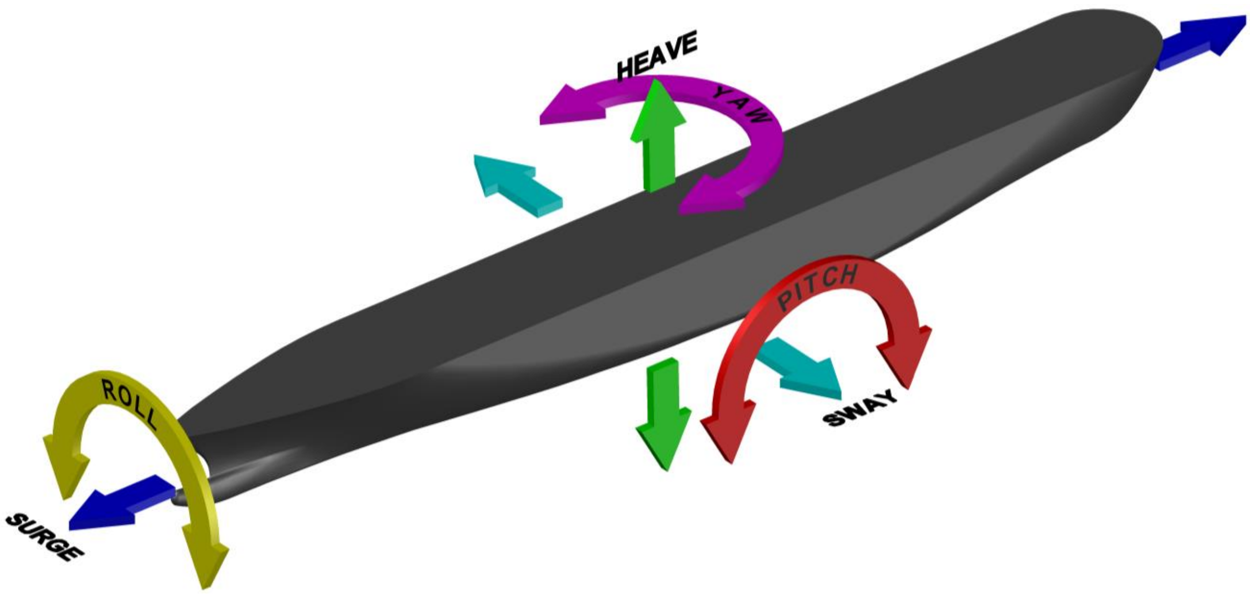
*bulbous bow omitted for the purpose of this illustration

Ship Directions



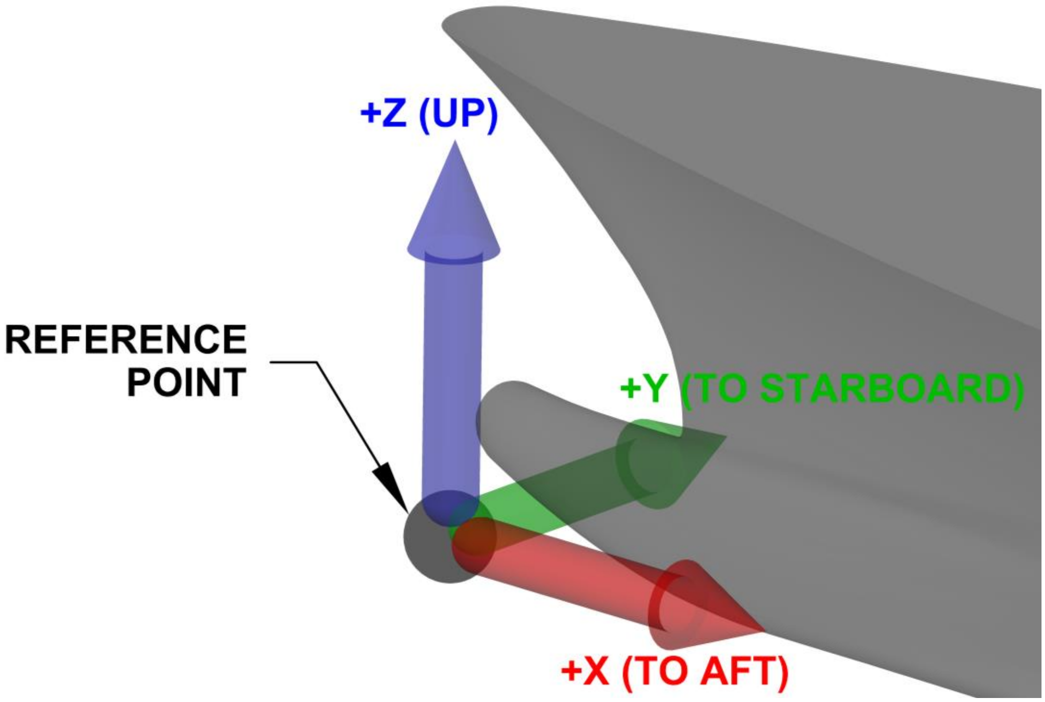
Ship Motions

Six degrees of freedom that a boat experiences. Composed of three rotational motions (pitch, roll, yaw) and three linear motions (heave, sway, surge).



Sign Convention

Distances aft, to starboard, and up are positive. Distances in front of the boat, to port, and below the boat are negative.



Simpson's Rule

Simpson's Rule is a technique used in naval architecture to closely approximate areas and volumes through numerical integration (if distances are known, then areas are calculated; if areas are known, volumes are calculated). For Simpson's Rule to work, an even number of intervals is used.

Specifically, Simpson's First Rule will be used. It assumes that the shape of the curve follows a second-order polynomial. The basic formula for Simpson's Rule for calculating a volume (∇) is:

$$\nabla = \frac{h}{3}(1 * A_0 + 4 * A_1 + 2 * A_2 + 4 * A_3 + 1 * A_4)$$

where h is the spacing between the intervals and A is the area. This formula would work for four intervals since there are five areas. This is the basic formula that will be used in conjunction with station and waterplane areas in the next section. The result will find the volumetric displacement and verify the draft.

For increased precision, Simpson's Rule may be modified. If the hull is more uniform, less areas are required. If the hull changes shape significantly, more areas are recommended. For seven areas, the formula would look like this:

$$\nabla = \frac{h}{3}(1 * A_0 + 4 * A_1 + 2 * A_2 + 4 * A_3 + 2 * A_4 + 4 * A_5 + 1 * A_6)$$

The values in front of the areas (1, 4, and 2) are called Simpson's Multipliers. Notice that in the middle of the equation for 7 areas, Simpson's Multipliers go back and forth between 4 and 2 (as opposed to 1 and 4 for five areas). The pattern for the multipliers is:

for 3 areas	1…4…1
for 5 areas	1…4…2…4…1
for 7 areas	1…4…2…4…2…4…1
for 9 areas	1…4…2…4…2…4…2…4…1
for 11 areas	1…4…2…4…2…4…2…4…2…4…1

The areas of the stations and the areas of the waterplanes are allowed to come from the CAD program. If preferred (or unable to pull the areas from the CAD program), then the formula can be modified to find the areas by hand:

$$\mathrm{A} = \frac{h}{3}(1 * D_0 + 4 * D_1 + 2 * D_2 + 4 * D_3 + 1 * D_4)$$

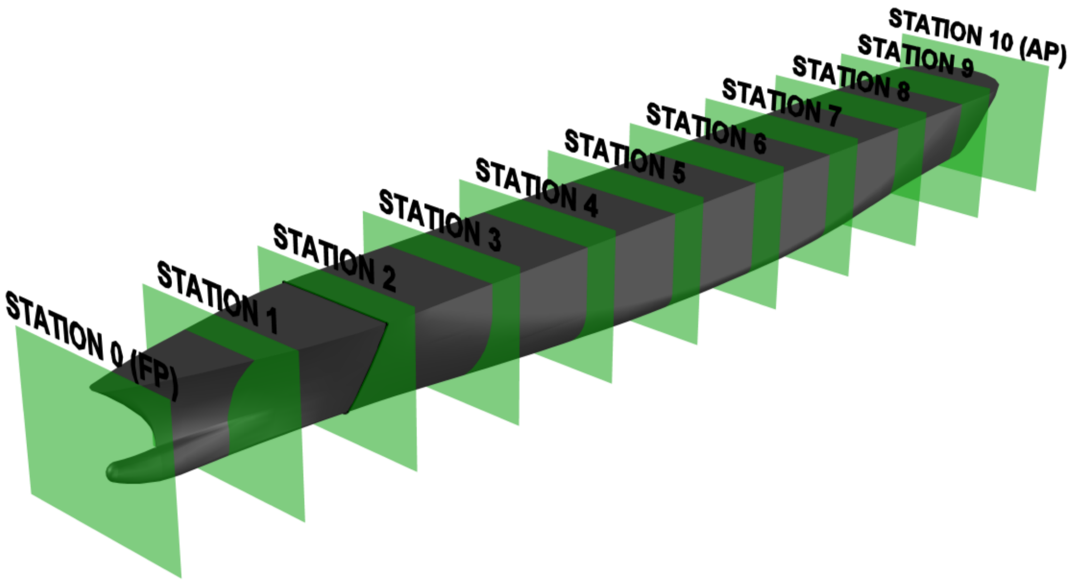
where D is the half-breadth distance (do not forget that this only calculates the area of one side). Obviously, some station and waterplane areas may be more easily found by geometric formulas than by Simpson's Rule.

Starboard

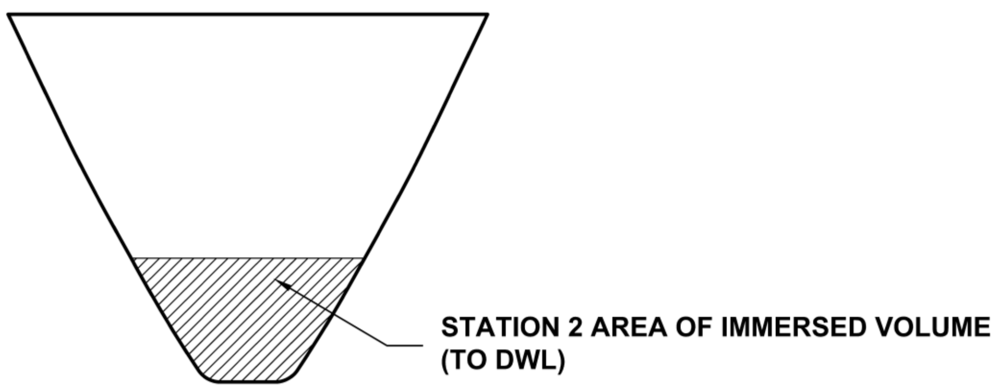
The right side of the boat when looking forward. See Ship Directions.

Station

Vertical transverse section planes. The intersections of these planes with the hull create curved lines also called stations. In combination with buttocks and waterlines, stations define the curvature of the boat's hull.



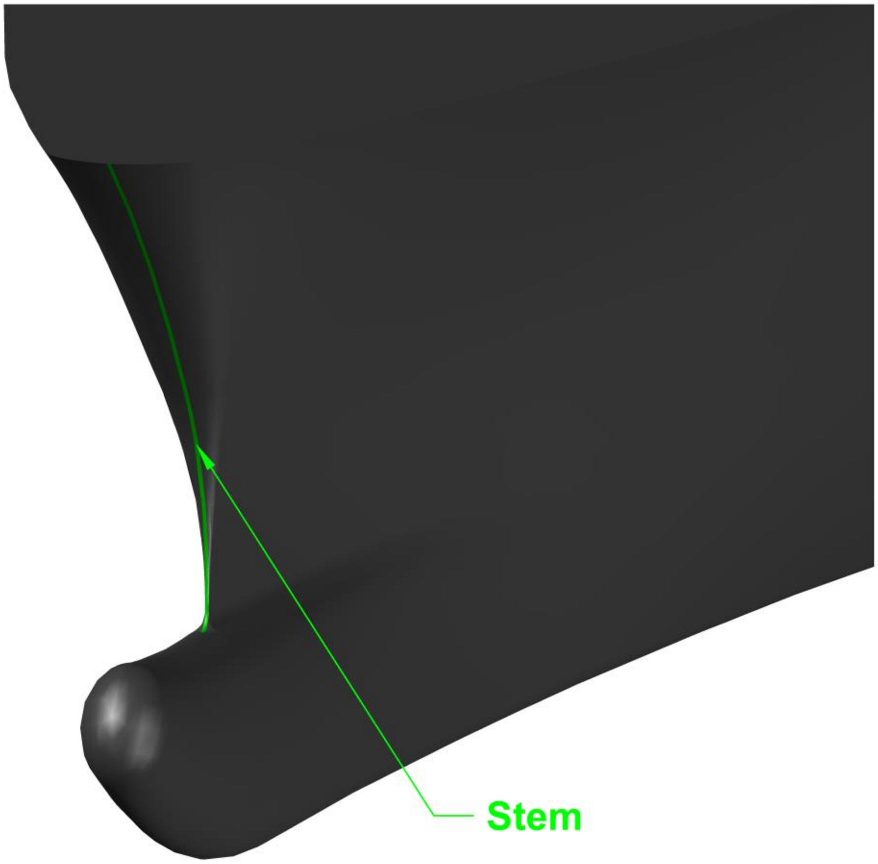
ODD NUMBER OF STATIONS (STATION AREA @ 0 AND 10 ARE ZERO)



STATION 2 AREA

Stem

Edge composing the forward part of the bow.

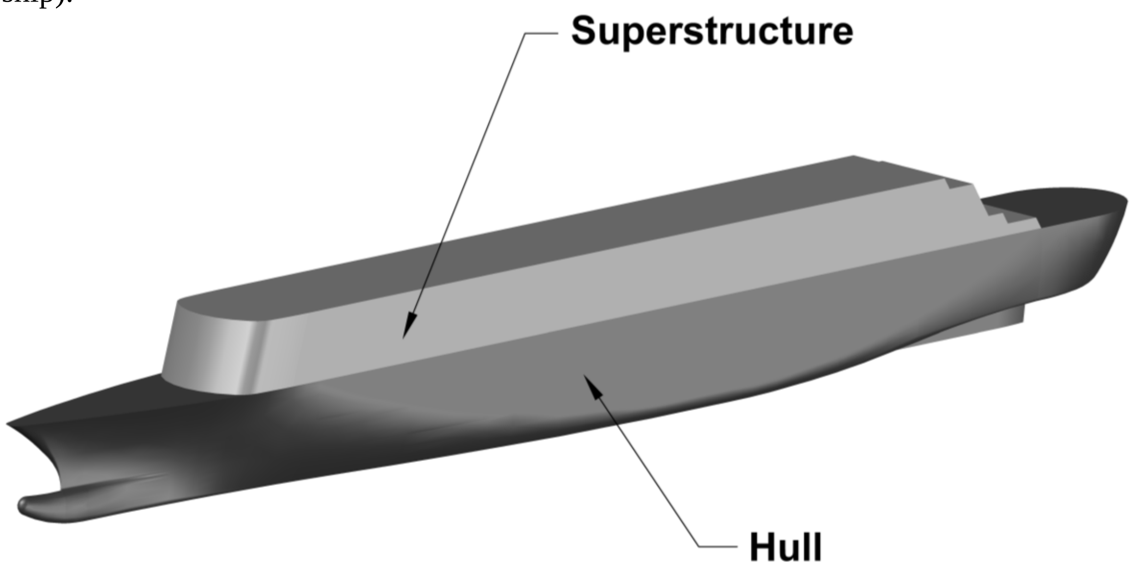


Stern

Aft end of the boat. The length of the stern is arbitrary. See Ship Directions.

Superstructure

Structure that sits on top of the hull (e.g. deckhouses of cargo ships or the accommodation decks of a cruise ship).



Surge

See Ship Motions.

Sway

See Ship Motions.

Transverse

At right angles to the boat's centerline. See Ship Directions.

Transverse Center of Gravity (TCG)

See Center of Gravity.

Transverse Metacentric Height (GM_T)

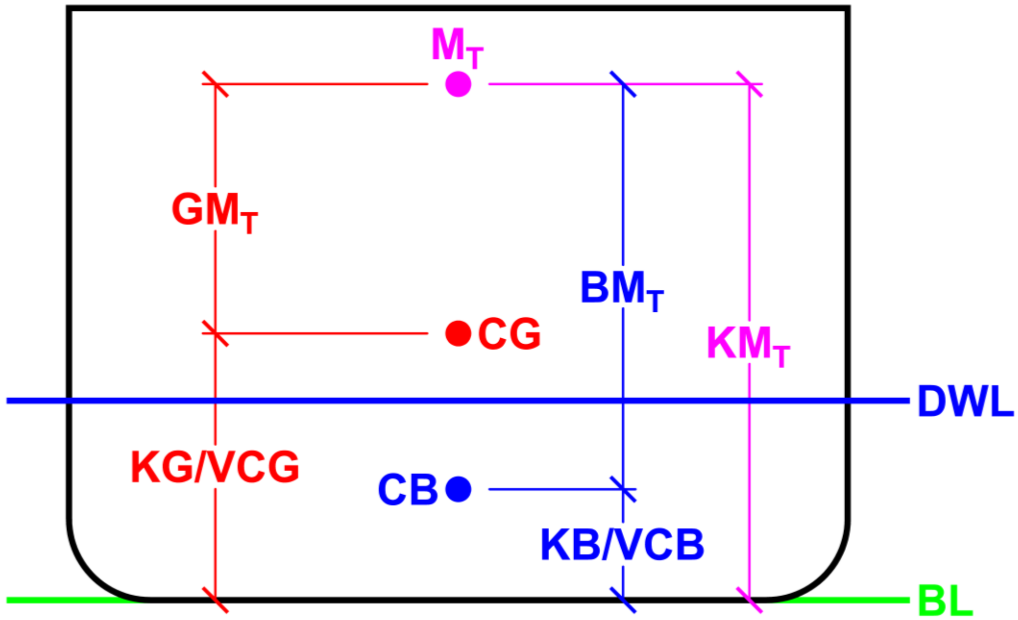
See Transverse Stability.

Transverse Metacentric Radius (BM_T)

See Transverse Stability.

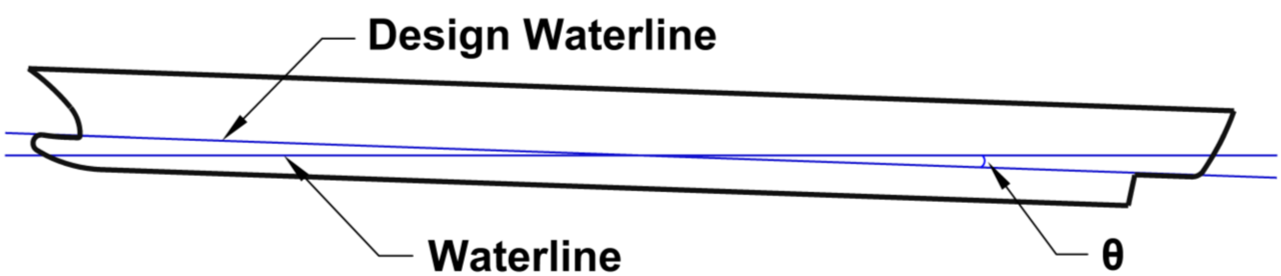
Transverse Stability

The tendency of a boat to resist a change in list. Transverse stability shares the same KB and KG as longitudinal stability and therefore only the measurements to the metacenter (KM, BM, GM) change.



Trim

A difference between the forward and aft drafts. A permanent condition, until corrected. Not to be confused with pitching, a continuous rocking motion. In contrast to list, which is the permanent inclination to port or starboard. See Drafts.



Trimaran

A triple-hulled boat, the center hull usually being larger than the others. See Design Process Parameters for construction issues with trimarans.

Vertical Center of Buoyancy (VCB)

See Center of Buoyancy.

Vertical Center of Gravity (VCG)

See Center of Gravity.

Views

Body – a view vertically and transversely forward of the boat with port to the right showing beam and depth and the front view of the boat. In actuality, curves would be shown at designated stations to show the curvature of the hull. Due to the symmetry of the hull, stations forward of midships would be shown on the right side of the view and the stations aft of midships would be shown on the left side. For the purposes of the Boat Design Competition, a traditional view is all that is required.

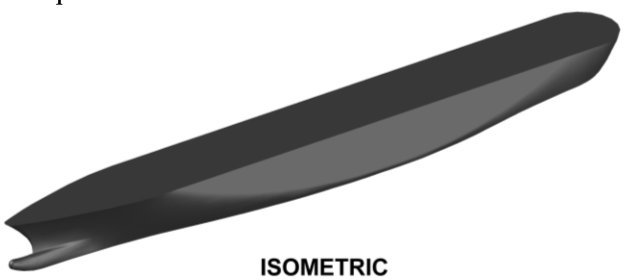
Isometric – a three-dimensional view represented two-dimensionally by projection

Plan – a view horizontally and longitudinally above the boat with the bow to the right showing length and beam and the top view of the boat. In actuality, curves would be shown at designated waterplanes to show the curvature of the hull. Due to the symmetry of the hull, only one side would be shown (called a half-breadth plan). For the purposes of the Boat Design Competition, a traditional plan view is all that is required.

Section – a view cut through the boat to show an area hidden in another view

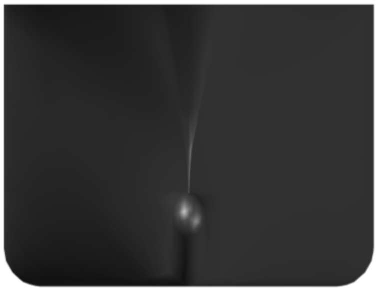
Sheer – a view vertically and longitudinally abeam of the boat with the bow to the right showing length and depth and the elevation of the boat. In actuality, curves would be shown at designated buttock planes to show the curvature of the hull. For the purposes of the Boat Design Competition, a traditional side view is all that is required.

PLAN (TOP VIEW OF SHIP)



ISOMETRIC

SHEER (ELEVATION) (SIDE VIEW OF SHIP)



BODY (FRONT VIEW OF SHIP)

PLAN VIEW

SECTION A-A
FACING AFT

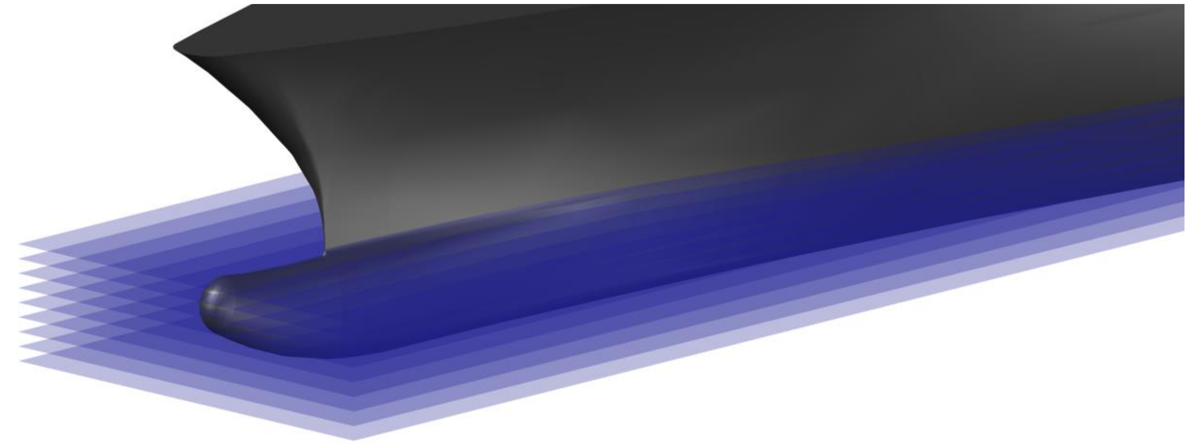
VIEWS ARE SHADED FOR PURPOSES OF THESE ILLUSTRATIONS

Volumetric Displacement

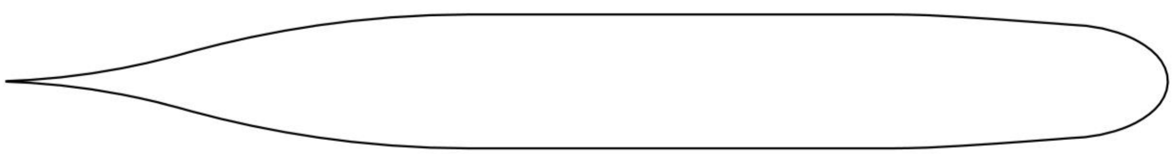
See Displacements.

Waterline/Waterplane

Horizontal section planes. The intersections of these planes with the hull create waterlines. In combination with buttocks and stations, waterlines define the curvature of the boat's hull.



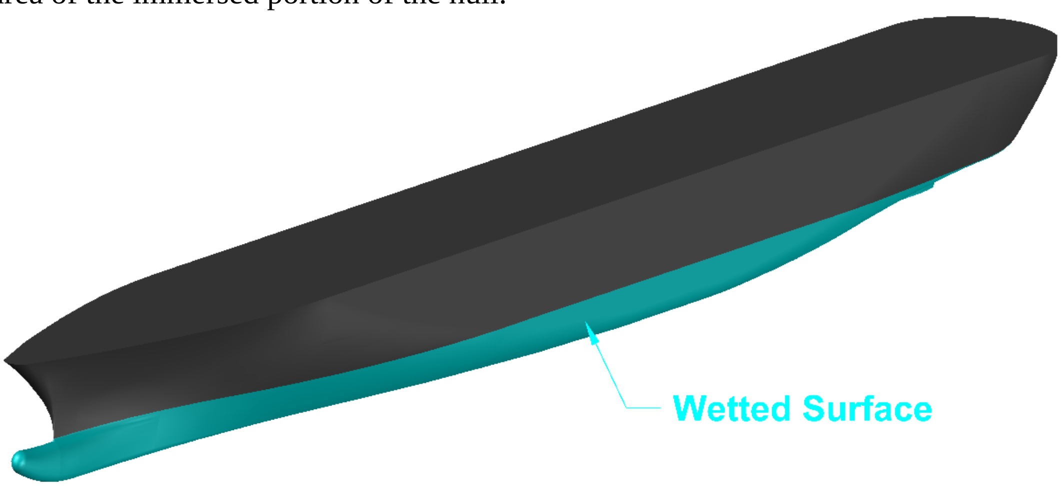
WATERPLANES AT 0' (BL), 4', 8', 12', 16', 20', 24', 28', 32' (DWL)
ODD NUMBER OF WATERPLANES



WATERPLANE AREA AT DWL

Wetted Surface

Surface area of the immersed portion of the hull.



Yaw

See Ship Motions.