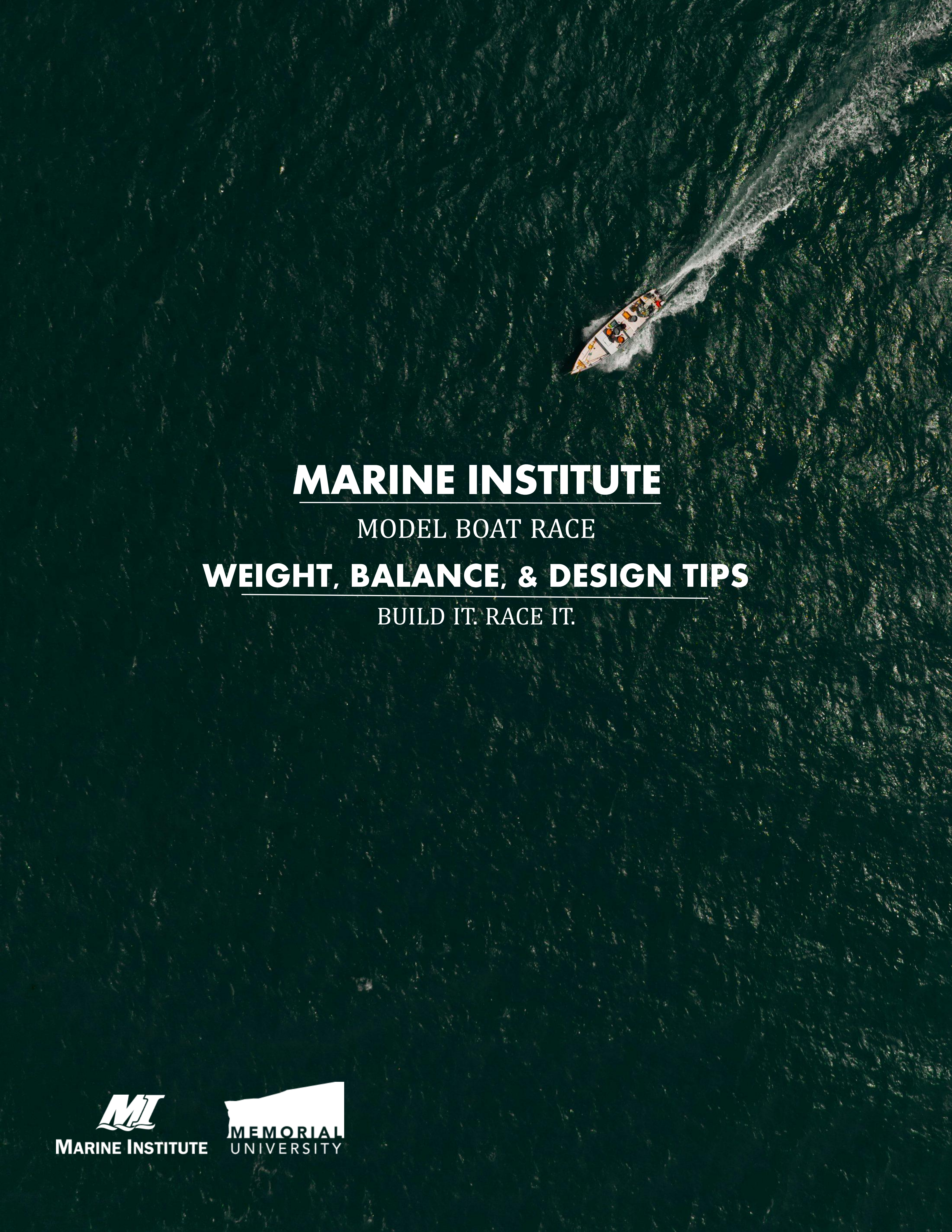

MARINE INSTITUTE

MODEL BOAT RACE

WEIGHT, BALANCE, & DESIGN TIPS

BUILD IT. RACE IT.

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What you will find in this document:

Note that the following document contains descriptions of buoyancy, stability, and associated principles that should be factored into the design of your hull and rudder as well as the positioning of all internal components.

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Weight & Balance

A critical quality of vessel design and construction is that which all components are designed and positioned around: **WEIGHT**.

You may note as well that the most important relation to your vessel's weight is its **BUOYANCY**, which allows it to float. Refer to the About Ships and Calculations booklet for more information on generating buoyancy.

NOTE that it is the relation between weight and buoyancy that creates **STABILITY**.

This correlation can be explained using the following definitions:

• Center of Gravity (CoG)

Point through which the combined weight of all vessel components acts (balance point). Should be positioned so that it passes through the **CENTER** when observed from the stern or bow and between **50% - 35%** of the total length measured from the stern in profile.

• Center of Buoyancy (CoB)

The center of the volume of water displaced by the portion of the vessel below the waterline. This is the point through which buoyancy acts. May shift as the boat tilts (waves, turns, e.g.).

• Metacenter (M)

The point on (or above) the boat that lies directly above the center of buoyancy. It is important for the center of gravity to exist below this point so that gravity and buoyancy may offset one another when the vessel is tilted.

Weight & Balance

With these definitions, we can understand what makes a boat stable:

When we say that weight and buoyancy 'act' through the CoG and CoB because they are the points where the **RESULTANT FORCE** of either action can be measured.

When the CoG & CoB are **OFFSET**, they may thus create a turning moment as they pull the hull in an attempt to align with one another.

This is used to our advantage when the CoG is centered below the metacenter as it will apply weight on the outside of any incline, making an upright attitude the equilibrium position.

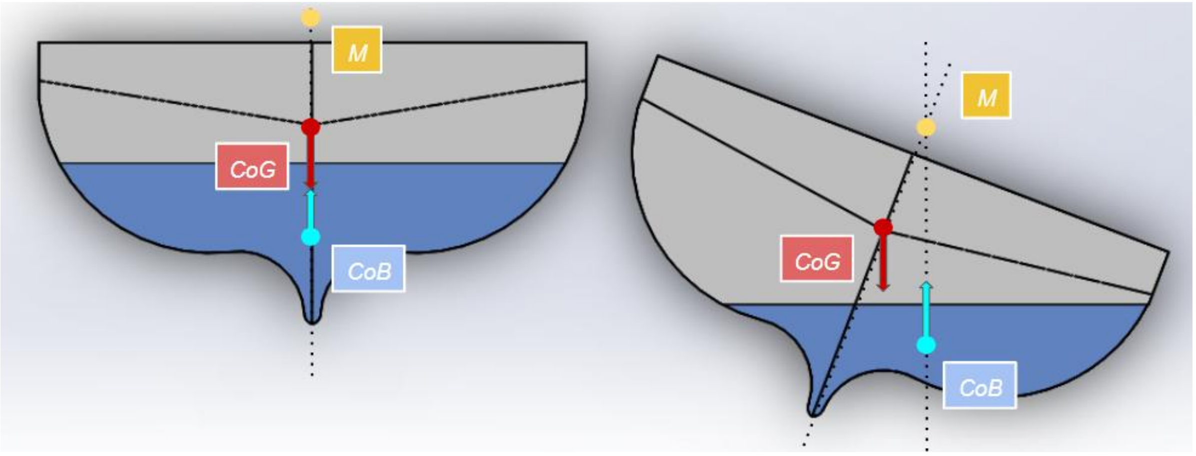

Figure 1: Self-correction Action Due to CoG & CoB

CONVERSELY, if the CoG falls above the metacenter, it will amplify the force through the CoB and cause your vessel to capsize.

FOR YOUR DESIGN, it is best to have a lower CoG to be sure that it is between the other key points.

Design Tips

Regardless of how the weight in the boat is distributed, the CoG & CoB will balance to reach a state of equilibrium.

With this in mind, the following are a series of design considerations that help to ensure that equilibrium leads to a high-performance vessel.

Consider

- Placing heavier components (battery, motor, e.g.) around water level to ensure the center of gravity is between the metacenter and center of buoyancy at rest.
- Placing heavier components within the range of distance from the bow for increased stability.
- Using a lightweight material (foam, e.g.) for the body to maximize static buoyancy (ballast can always be added).
- Ensuring all internal components are fastened in place so that your CoG does not shift in motion.
- Factoring in the shift in the CoG depending on the weight and position of your rudder.
- Testing and experimenting using sample weights (refer to the chart on Pg. 5) to map out component locations before implementing electronics. Your boat should be able to float, glide, and correct its orientation naturally with proper balance.

Mass & Dimensions Chart

Part	Description	Dimensions (mm)	Diameter (⌀mm)	Weight (g)
Traxxas 3875 Blast Water Cooling System		28	45	13
Dumas Complete Coupling 1/8" Bore No. 2008	Connects Shaft to Motor (Non Stiff Option)	20	9	37
Dumas 1/8" Shat/ Stuffing Box No. 323	Shaft	256	4	
Thrust Washer 1/8″ Kit #7019 (2X)	Washers	1	9	
Dynamite DYN1172 15 Turn Brush Motor (Hobby Hobby)	**Motor**	**83**	**37**	**218**
Pro-Boat Motor Coupler PRB286011	Connects Shatf to Motor (Stiff Option)	20	9	8
QUICRUN 1060 60A Waterproof Brushed ESC Speed Controller with 6V/3A BEC	Speed Controller	36 x 30 x 23	-	35
Miuzei 20KG Servo Motor High Torque Digital Servo Metal Waterproof Servo	Servo	55 x 50 x 20	-	71
Gens Ace 5000mAh 7 Cell 8.4V Nimh Deans Plug	**Battery**	**138 x 44 x 47**	**-**	**494**
Du-Bro 1/8" Plated Dura-Collar (4 Pack)	Collar	5	9	8
RC Boat Water Pump, 3-6V 370 Water Cooling Pump JR Plug RC Boats Motor & ESC	Pump for cooling	60	24.4	70

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