POTENTIA INNOVATIONS

MISSION

To design a dynamic In-Board Boat

that can change from Ski-boat to Wake-board boat and back.

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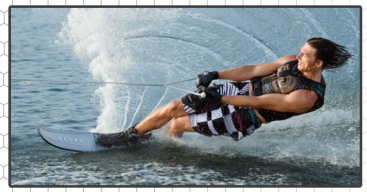
Types of Skiing



In tournament slalom skiing, a course is set up with buoys and water skiers are expected to navigate through and around six buoys using only one ski. A skier's score is based upon the number of successful buoys cleared, the speed of the boat, and the length of the rope. The faster the speed and the shorter the rope adds difficulty to the task. A slalom ski rope for competition is always the standard 75’ long segmented rope.

Trick skiing is based on using a smaller, oval-shaped waterski that is smooth on the bottom in order for it to be able to turn over the surface of the water. This ski gives the skier a lot more freedom to perform tricks. Trick skiers can use either one or two skis. In trick skiing tournaments, skiers complete either one or two 20-second runs during which they perform a series of their chosen tricks. The tricks are assessed and scored by judges, and the skier with the most points wins the tournament. The tricks are scored based on the difficulty of the trick and the way it is executed. They are also scored based on if they use one or two skis.

The ski jump is performed on two long skis and skiers are towed behind a boat at fixed speed, using a ramp. This technique is used in competition skiing. In this category the skier must ski up and over a wooden ramp. The ramp can be a height of 5 or 6 feet tall. The speed of the boat varies but the maximum speed is 58 kilometers per hour. Professional ski jumpers can travel up to 250 feet (76 m) and hit the ramp at speeds up to 70 mph.[6]

A Barefoot skier skies behind the boat however without the use of skis. The plane on the water using the soles of their feet which requires higher speed because the bare footprint is much smaller, providing less lift. A general rule of thumb for barefoot waterskiing speed is (X/10)+Y= Barefooting MPH, where X equals your weight (divided by 10) and Y equals 18.

Types of Watersports

Wakeboarding is a water sport which involves riding a wakeboard over the surface of a body of water. It was developed from a combination of water skiing, snow boarding and surfing techniques. The rider is usually towed behind a motorboat, typically at speeds of 17-24 miles per hour, depending on the water conditions, board size, rider's weight, type of tricks, and rider's comfort speed. This speed could also depend on the year, make, and model of the boat because some boats, which are not designed for wakeboarding, create a different size wake which the rider may not feel comfortable with.

Wakeskating is a water sport and an adaptation of wakeboarding that employs a similar design of board manufactured from maple or from fibreglass. Unlike wakeboarding, the rider is not bound to the board in any way, which gives the sport its own unique challenges. Instead, the top surface of the board is covered with griptape, (in a similar fashion to a skateboard) or a soft, high-traction, foam, usually referred to as EVA foam, covering that is kinder to riders in the inevitable crashes and also allows a rider to ride barefoot. Riders usually wear shoes while riding to afford themselves extra purchases on the board, similar to skateboarding.The speed at which riders wakeskate behind a PWC (Personal Water Craft: Jet ski), boat, cable system, or winch is generally 16 – 22 miles per hour. However, this depends on water conditions, the weight of the rider, their proficiency in the sport as well as a preference matter of the rider.

Water ski racing consists of a number of water skiers who race around a set course. A team consists of a boat driver, an observer and one to two skiers, depending on the race. The driver will tow the skier behind a powerboat, varying the speed as different conditions are encountered, according to the driver's knowledge of the skier, the observer's ability to read the skier and the signals which the skier gives to the driver.

WHAT DO THE PRO'S WANT FROM THEIR BOATS?

Cale Burdick

Tyler Lorenz

Sergio Uribe

Unanimously; The perfect wake

Trick: Steep, Skinny, Hard

Slalom: Shallow, Wide, Soft

Jump: As little as possible

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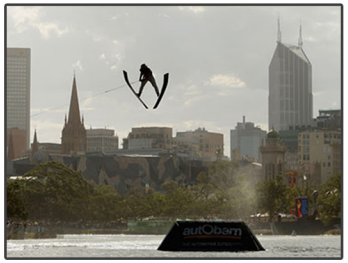
THE INDUSTRY LACKS SPECIALIZATION AND VARIABILITY



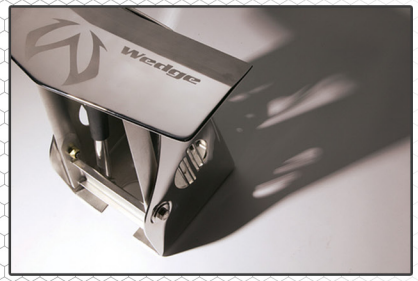
Currently everyone from watersport enthusiasts to the weekend skier have to make a choice: Get a boat with a wake that is great for one sport and not as good for others OR purchase a boat that is well rounded but with a noticable sacrifice at either end of the wake spectrum.

There are Slalom boats and at the other end of the spectrum are Wakeboard boats. Modifications can be made to either style of boat to better accomdate sports that prefer the opposite wake style however they come at a sacrifice to the original sport.

A Jumper experiencing “Ski-Hop” due to the wake interrupting their cut.

CURRENT WAKE MODIFICATION PRODUCTS THAT JUST DON'T CUT IT...

Fat Sac - SLOW to fill and drain, bulky. Modifies wake by adding extra weight to increase displacement.



The Wedge - Fast, unobtrusive. Uses a hydrofoil to pull boat deeper increasing displacement. Damages boat if used over 34 MPH by cracking the hull.

The Wake Gate - Fast, unobtrusive. Uses a drop plate to permit or deny water to flow through a trough along the bottom. This allows the boat to sit higher or lower in the water by a few inches. (Not as effective

WHAT CURRENT WAKE MODIFIERS AIM FOR

All these products seek to change the wake by lowering the stern of the watercraft to increase displacement.

Weight and it's placement makes a huge difference in the how the wake formed. The mere weight of one man can change the lean of the hull left and right or tilt fore and aft, in turn effecting great amounts of change on the wake, like the man in this photo is doing to create a larger wake on one side for the wakesurfer.

MISSION

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GENERAL BOAT AND HULL TERMS

Bow	is the frontmost part of the hull
Stern	is the rear-most part of the hull
Port	is the left side of the boat when facing the Bow
Starboard	is the right side of the boat when facing the Bow
Waterline	is an imaginary line circumscribing the hull that matches the surface of the water when the hull is not moving.
Midships	is half-way from the forwardmost point on the waterline to the rear-most point on the waterline.
Baseline	is an imaginary reference line used to measure vertical distances from. It is usually located at the bottom of the hull.
Skeg	is a stabilizing fin or hull element to increase stability. Usually on the keel.
Keel	is the center spine of a ship giving it greater directional control and stability. the keel helps the hull to move forward.
Rudder	is a device used to steer a boat or other conveyance that moves through a medium (generally air or water).
Chine	is a sharp angle in the hull, as compared to the rounded bottoms of most traditional boat hulls.
Strake	is a part of the shell of the hull which, in conjunction with the other strakes, stabilizes the boat.
Pad	is a usually 10-12” flat portion on the keel of a Vee hull to assist in planing out.

The Recreational boat industry features a wide range of boat hulls.

The ski boat industry most often uses a Vee bottom with pad and strakes.

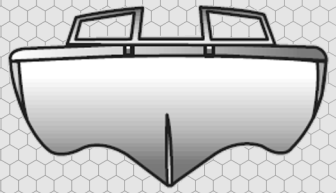
However any of these four hull types have been used in the sking industry in the past.

The hulls to the right make very messy and unstable wakes

Vee bottom

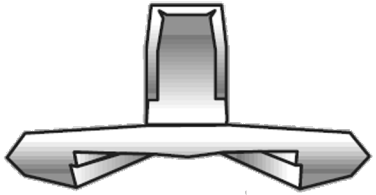
Vee bottom with strakes

Tri-hull

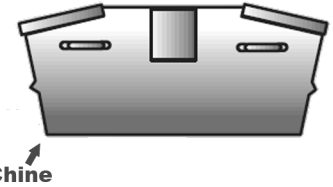


Vee bottom with pad and strakes

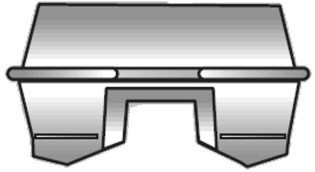
Tunnel Bottom



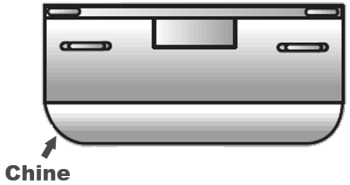
Flat bottom with hard chines



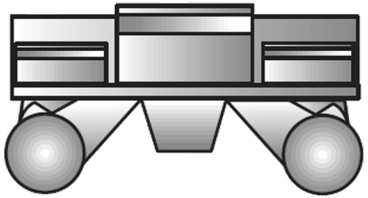
Catamaran



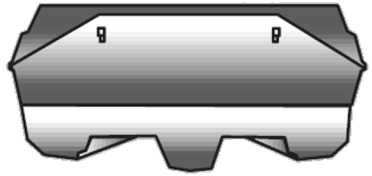
Flat bottom with soft chines



Pontoon



Tunnel Vee



ERS MAIN COMPANIES INDUSTRY LEADERS

MasterCraft
HELD TO A HIGHER STANDARD

NAUTIQUE

malibu
BOATS

MASTERCRAFT WATERSKING

	ProStar 190	ProStar 197	ProStar 214
Length of boat	19' 8"	19' 8	21' 4"
Width Amidship	91"	91	96"
Boat Weight	2,620 lbs.	2,800 lbs.	3,100 lbs.
Length of Boat w/Platform	21' 6"	21' 6	23' 8"
Fuel Capacity	28 Gallons	28 Gallons	40 Gallons
Total Weight Capacity	7 Persons or 1,087 lbs.	7 Persons or 1,087 lbs.	11 Persons or 1,525 lbs.
Depth at Transom	20"	20'	22.5"

MASTERCRAFT WAKEBOARDING

	X-1	X-Star	X-15
Length of boat	20' 7"	22' 3"	21' 8"
Width Amidship	90	100"	100"
Boat Weight	3,200 lbs.	4,250 lbs.	3,575 lbs.
Length of Boat w/Platform	22' 6"	24' 5"	23' 9"
Fuel Capacity	33 Gallons	53 Gallons	45 Gallons
Total Weight Capacity	11 Persons or 1,615 lbs.	12 Persons or 1,770 lbs.	14 Persons or 2,325 lbs.
Depth at Transom	23.5	28"	28"

MARKET RESEARCH MARKET RESEARCH MAR

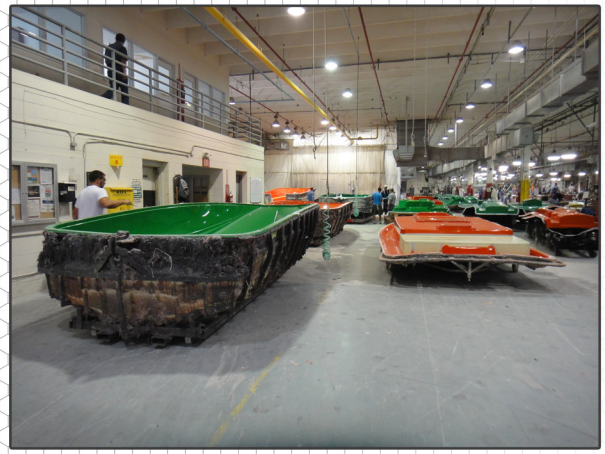
NAUTIQUE

	Ski Nautique - 200	Sport Nautique - 200	Super Air Nautique - 230
Length of boat	20' 0"	20' 0"	23'
Width Amidship	7' 11"	7' 11"	8' 5"
Boat Weight	2,850 lbs	2,850 lbs	2,850 lbs
Length of Boat w/Platform	21' 10"	21' 10"	25' 5"
Fuel Capacity	29 Gallons	30 Gallons	51 Gallons
Total Weight Capacity	1,450 lbs	1,600 lbs	2,300 lbs
Depth at Transom	22"	23.5"	29"

MALIBU BOATS

	Response TXI	Ride 21v	Wakesetter 247 LSV
Length of boat	20' 6"	21' 7"	24' 7
Width Amidship	9' 5"	8' 2"	8' 2"
Boat Weight	2,900 lbs	3,500 lbs	4,000 lbs
Length of Boat w/Platform	22' 6"	23"	26"
Fuel Capacity	40 Gallons	48 Gallons	84 Gallons
Total Weight Capacity	1,265 lbs	1,654 lbs	2,400 lbs
Depth at Transom	22"	24"	27"

ASSEMBLY PROCESS



Each boat has 3 hull pieces: an outer base, a skeleton and a deck.

Each hull piece has a mold (Each model has a different color mold).

The hulls are painted main-color first with accent color zones taped off. Accent colors are applied underneath the main coat.

The white main-color is applied via spray hose. Dry time is 45 minutes.

The masks are pulled off. White is where hull will be and green is where the next color will show through.

After all layers of Gel-coat are applied and dry, a Barrier coat is applied to prevent blisters from occuring under the Gel-coats.

ASSEMBLY PROCESS

Fiberglass is cut into specific puzzle pieces specific to the shape of the hulls.

The pieces of fibreglass for a single boat are organized into bins.

Resin is sprayed onto the Barrier coat and then the fibreglass sheets are applied by hand.

Structural elements for where people walk are fibreglassed into the hull.

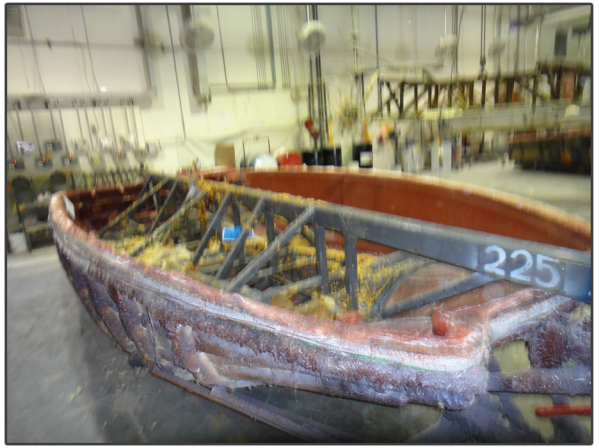
After each layer a worker using a 2 inch long roller makes sure not a single bubble exists between the layers.

Screw plates are glued to the fibreglass to provide a sturdy surface to bolt hardware and additional parts to.

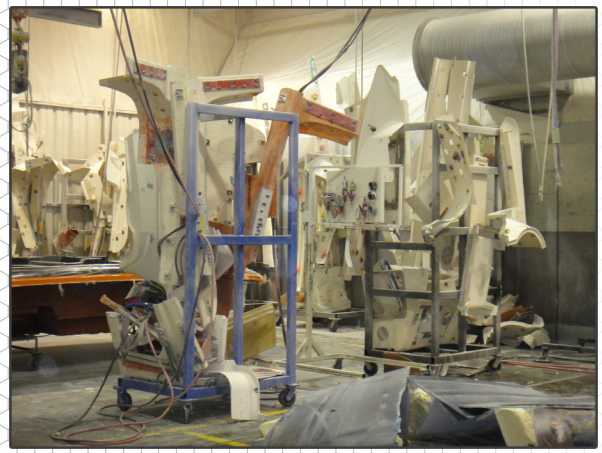
ASSEMBLY PROCESS

The inner structural hull is removed from its mold.

Adhesive is strategically layed on the inside of the bottom hull.



The inner structural hull is clamped down with one ton of pressure, while high pressure foam is injected into the



Using stencils, the hulls are cut to accomodate engine compartments exhaust storage and gagues etc.

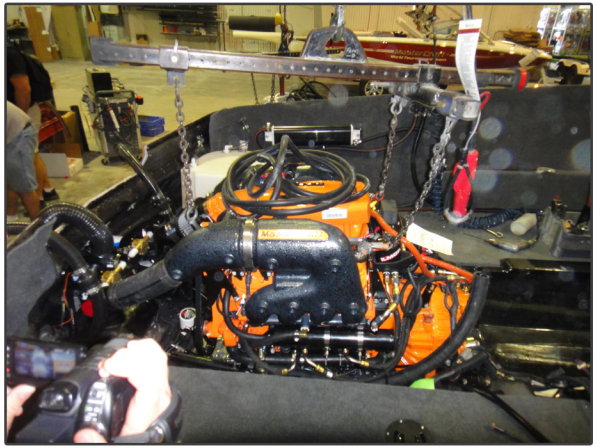
The top hull is lifted up to be placed on the bottom and inner hulls.

The hulls are buffed cleand and then inspected for quality control.

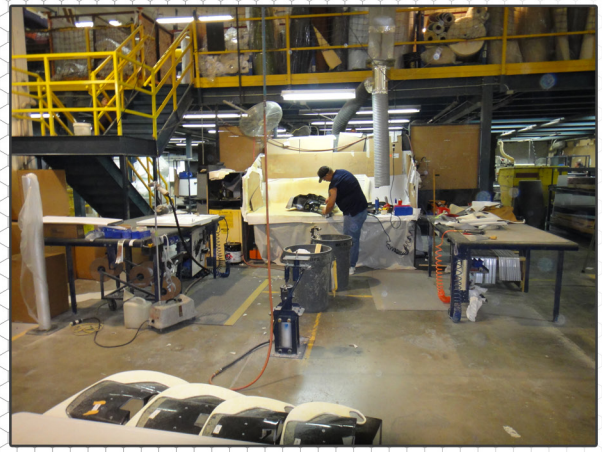
ASSEMBLY PROCESS

First the underwater hardware is installed.

Second the ornamental and upper hardware is installed.



The motor is is lowered into place and bolted down.



Foam is then apolstered with vinyl and then bolted and screwed down.

Decals are added and the boat is waxed.

The boat is launched for preformance testing and then cleaned and wrapped for shipping.

MATERIALS MATERIALS MATERIALS MATERIALS

Fibreglass

The current hull material of choice for recreational boat hulls. Strong, rigid, relatively lightweight, waterproof

Dragonskin Flexible Armor

Under descrepancy for being truely bulletproof however the scaled material provides extreme puncture protection while remaining flexible. Lightweight, flexible, waterproof.

1000+ Denier Nylon

The current hull material of choice for collapsable boat hulls. Strong, relatively lightweight, waterproof, flexable.

Rubber

Can be used on hovercrafts instead of Nylon and although heavy so not as prefered. Heavy, flexable or rigid, waterproof.

MICRO PROBLEMS MICRO PROBLEMS MICRO

A ski boat as a whole product has many featuresand systems that each have their own problems.

Constant refinement is required.

Some of the bigger refinements include

Water Drainage

Elderly/Injured entry

Silppery surfaces/wet carpet

Stern light annoyances

Bimini option/storage

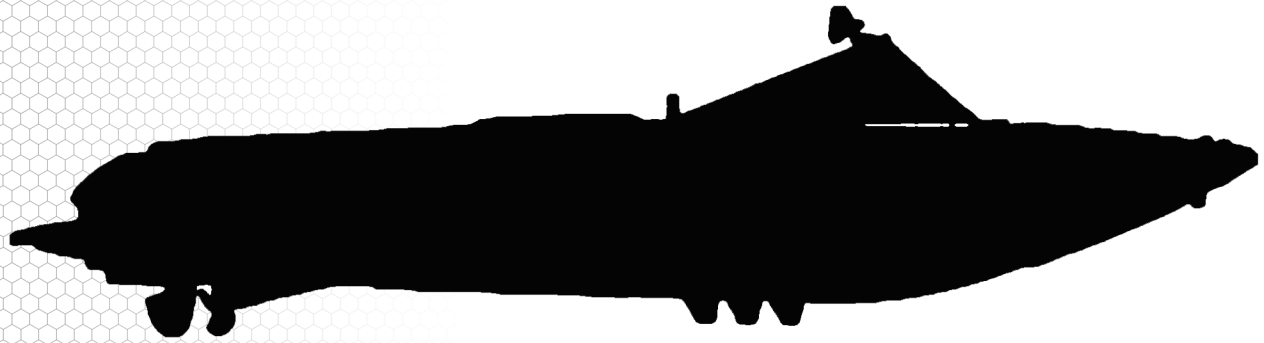
Dead battery

BREAKDOWN BREAKDOWN BREAKDOWN BREAKDOWN BREA

RESEARCH BREAKDOWN

IDEAL WAKES PER SPORT
BOAT HULL TYPES AND SPECS
MAIN BRANDS AND CURRENT MARKET
BOAT ASSEMBLY PROCESS
MATERIALS
GOALS

DESIGN GOALS



Create a mechanical system for changing the shape of the hull on the fly.

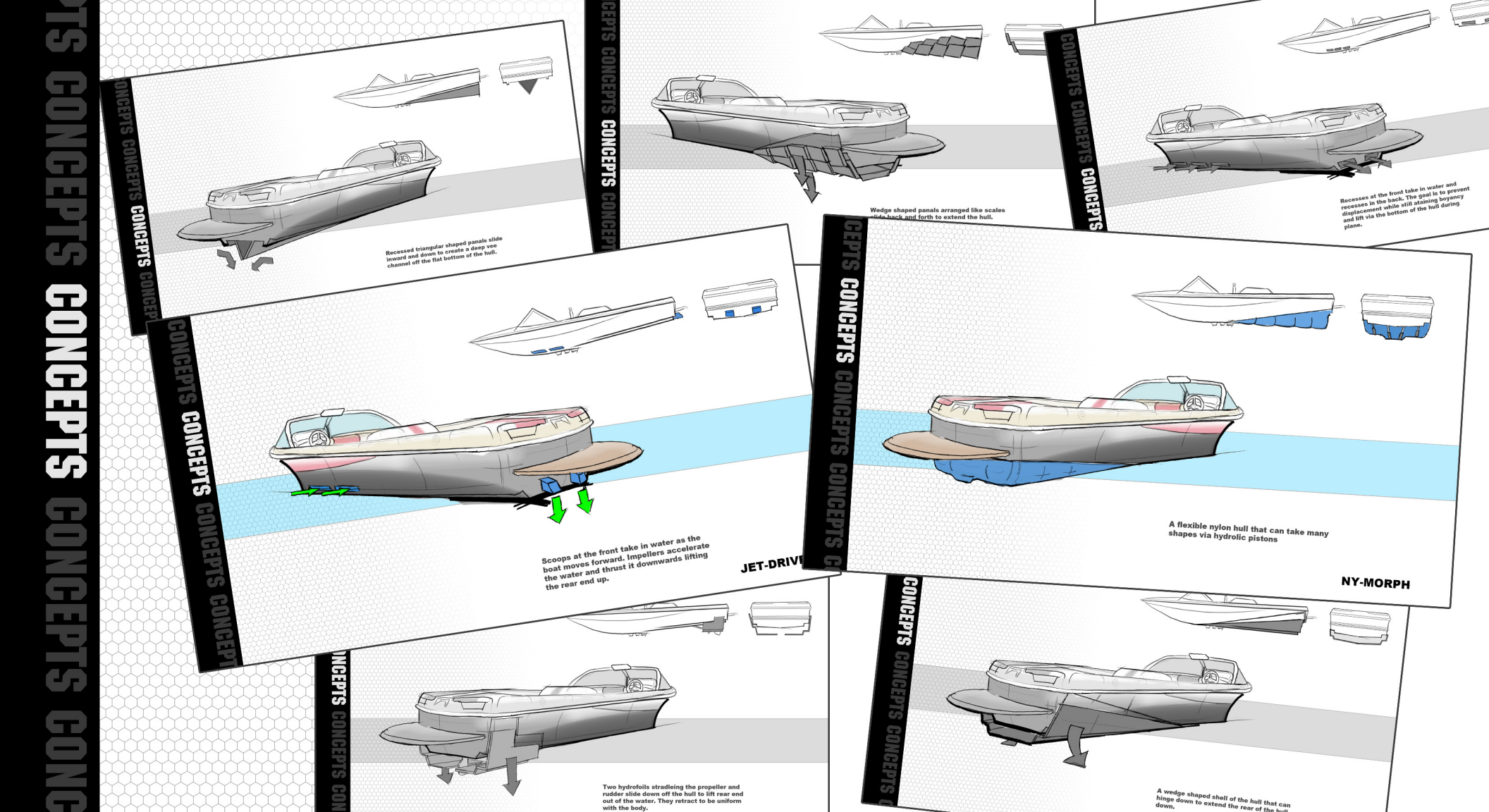
Solve and incorporate at least 3 of the micro problems

Keep within $10,000 of original cost.

Open bow and Closed bow models

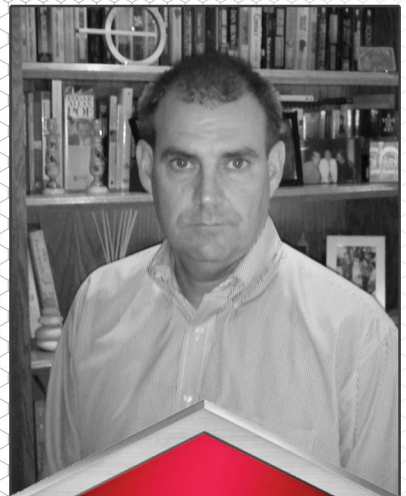
7-10 person capacity

DESIGN GOALS DESIGN GOALS DESIGN GOALS


CONCEPTS CONCEPTS CONCEPTS
Recessed triangular shaped panals slide inward and down to create a deep vee channel off the flat bottom of the hull.
Wedge shaped panals arranged like scales slide back and forth to extend the hull.
Recesses at the front take in water and recesses in the back. The goal is to prevent displacement while still ataining boyancy and lift via the bottom of the hull during plane.
Scoops at the front take in water as the boat moves forward. Impellers accelerate the water and thrust it downwards lifting the rear end up.
JET-DRIVE
A flexible nylon hull that can take many shapes via hydrolic pistons
NY-MORPH
Two hydrofoils stradleing the propeller and rudder slide down off the hull to lift rear end out of the water. They retract to be uniform with the body.
A wedge shaped shell of the hull that can hinge down to extend the rear of the hull down.

INTERVIEW INTERVIEW INTERVIEW INTERVIEW

Commodity Manager, Engine Power Products Group at Briggs & Stratton
Avid Slalom Skier
All-around Mechanical Guru



BRIGGS & STRATTON ®

PAUL MARCEAU

One thing you have to really think about is corrosion. Many recreational boats are used in salt water conditions which can cause significant wear and tear on mechanical systems.

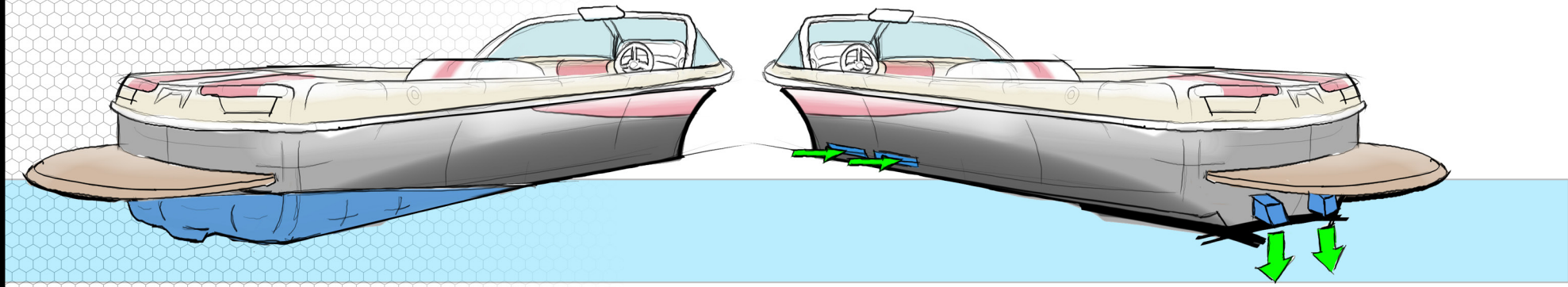
Hydrolics are good for somethings, but with them comes a whole slew of problems.

Although possible, especially with the introductions of smaller electric motors as opposed to V8's, you really do not want to change the position of the motor, driveshaft, propeller and rudder. Cost and complexity would most likely outweigh the benefits.

TESTING TESTING TESTING TESTING TESTING

SCALE TESTING

Through personal preference, professional insight and feasability, the top two concepts were chosen for scale testing.



A flexible nylon hull that can take many shapes via hydrolic pistons

NY-MORPH

Scoops at the front take in water as the boat moves forward. Impellers accelerate the water and thrust it downwards lifting the rear end up.

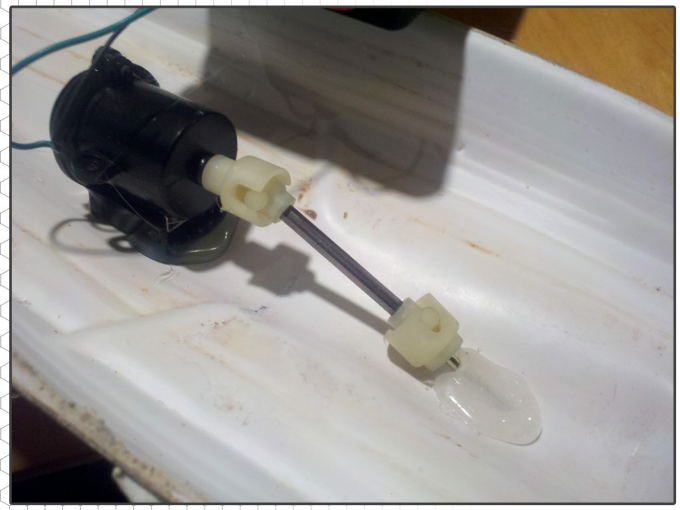
JET-DRIVE

TESTING TESTING TESTING TESTING TESTING

MODEL CONSTRUCTION

Testing of Concept 11 was fairly straight-foreward, create two very similar hulls but each with a distinct stern shape.

If I can produce a different wake using the same weight and size hull except for the stern portion, then the concept is validated.



Testing for Concept 4 simply required proof of the concept: Can a jet-drive system lift the stern of a watercraft.

When a Jet-ski is shifted into reverse the stern raises when at higher RPMs. Jet-ski manufactuers have limited the RPMs their watercraft can achieve while in reverse to counteract this.

CONCEPT TEST HULLS

Using two identical hulls that I vacuum-formed off of a scale model of a Mastercraft X-Star, used a heat gun and melted key areas to create distint but controlled changes. I created a flat sterned hull and a more vee sterned hull.

The goal was to make an achievable but dramatic change in the hull without affecting the drivetrain.

TESTING TESTING TESTING TESTING TESTING

RIVER TESTING CONCEPT 5

Due to uncontrolable variables, no conclusive data was obtained. However, I gained insight on how to better test the hulls.

TUB TESTING CONCEPT 5

Breaking apart video into comparable frames, the flat hull and Vee shaped hulls constructed are loaded with the same amount of coins and towed through still water at the same velocity.

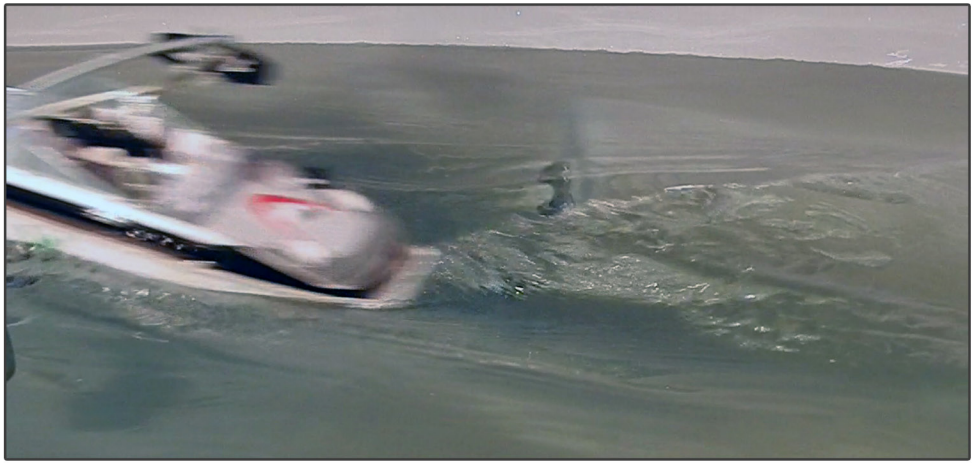
Although very similar, both these wakes have their own distinct qualities.

The most notable are wake height and crispness. The bottom wake is a harder cleaner formed wake that creates a crisp rise up to the wake table. The wake on the top, while it does have a slight rise up, does not form a crisp edge.

Also worth noting is the angle at which the hull sitis in the water. The Vee shape sits lower in the water instead of planeing. This is lower transom depth combined with the hull shape create larger wake.

The bottom wake would be better suited for wakeboarding and trickskiing, while the top wake is more tailored to a skier.

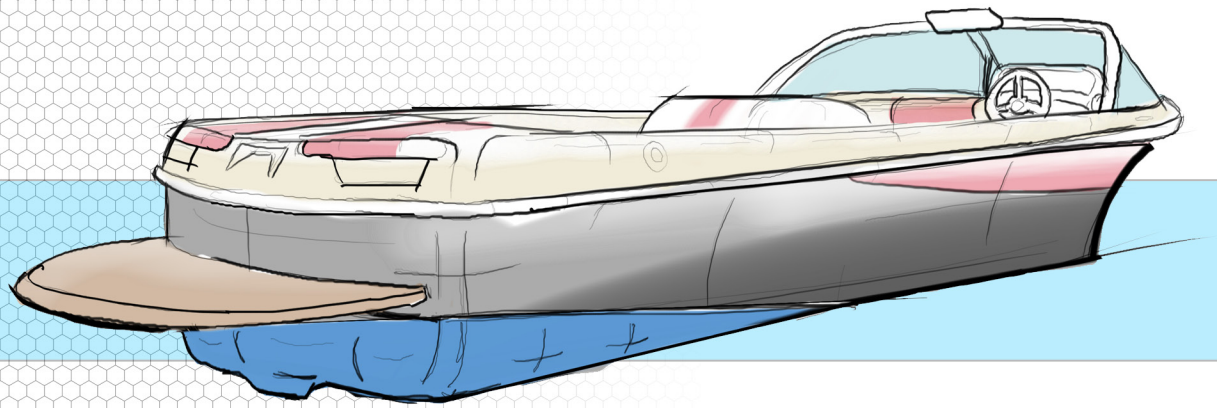
The flat hull on top skims across while the vee hull below digs down and displaces



FINAL DIRECTION

Knowing that both concepts in theory work, I had to decide which achieved my goal the best.

While concept 4 would change the “weight” of the hull on the water by lifting it out of the water and the changing how much it displaced, it did so in an energy inefficient way.



The NY-MORPH held truest to the idea of combining two boats into one and did so in the most energy efficient and simplest way.

FINAL DIRECTION FINAL DIRECTION FINAL DIRECTION

HIGH DENSITY POLYURETHANE COATED BALLISTIC NYLON

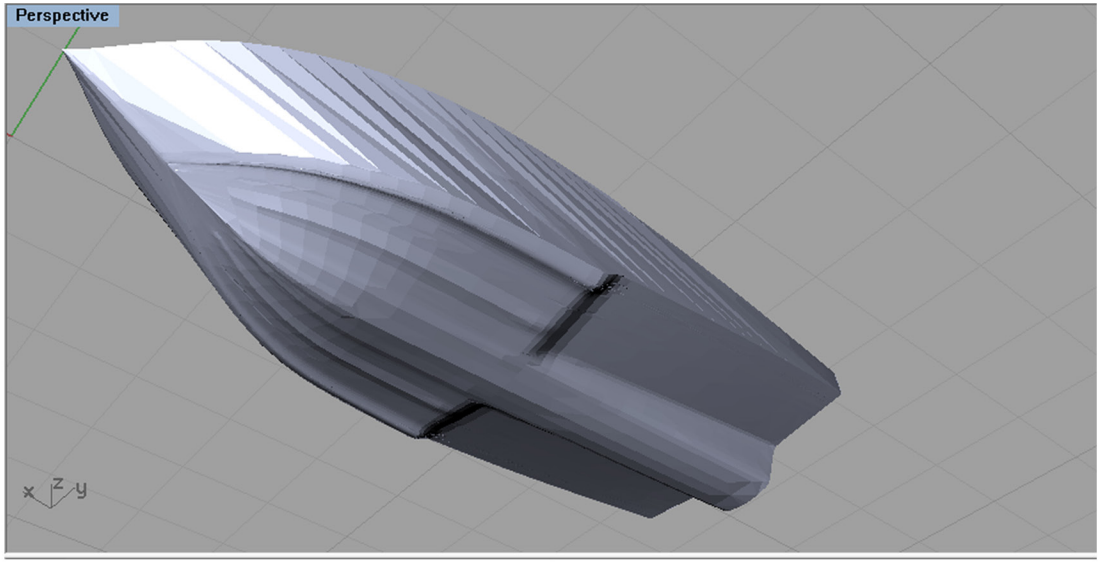
Highly puncture and abrasion resistant, Polyurethan coated nylon is currently used by the United States Military in many of their watercraft.

- Superior **Abrasion Resistance**
- Superior **U/V Resistance**
- Superior **Puncture & Tear Resistance**
- **Highly Inert** Resists Chemicals
- Compatible with Both **Heat and R/F Welding**

CAD CONSTRUCTION

Orca3D

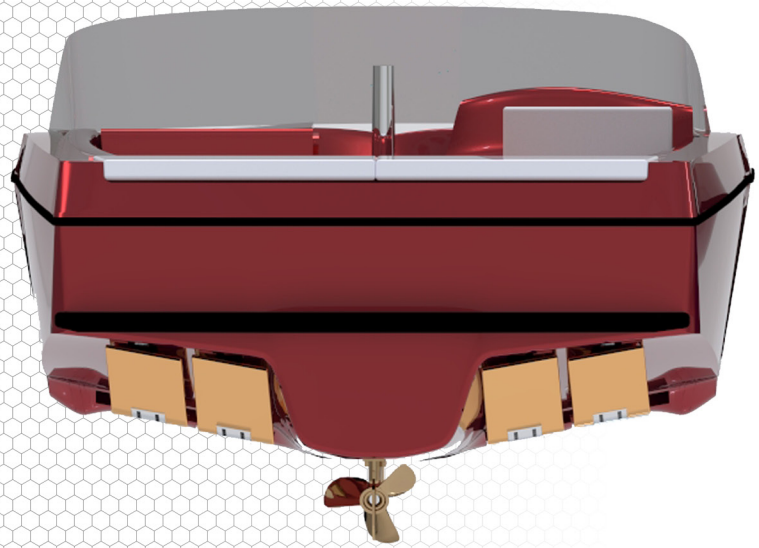
Rhinoceros®
NURBS modeling for Windows

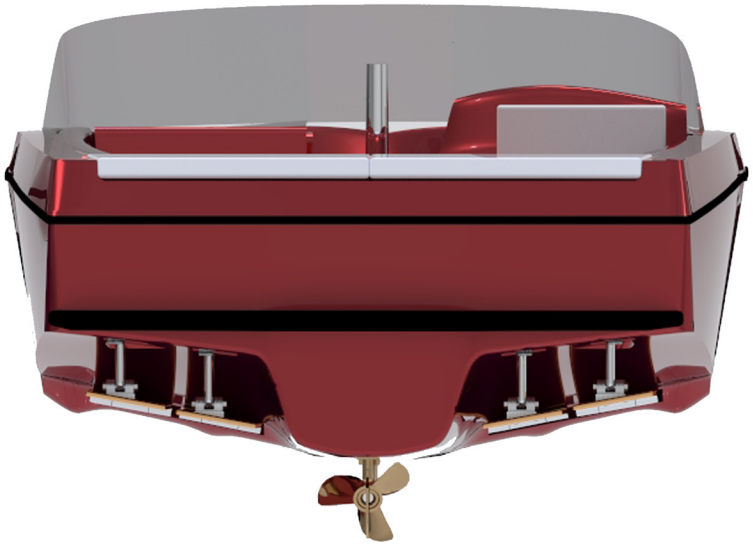


Before begining my hull construction in various shipmaking softwares, I decided to keep the center keel of the hull solid and static.

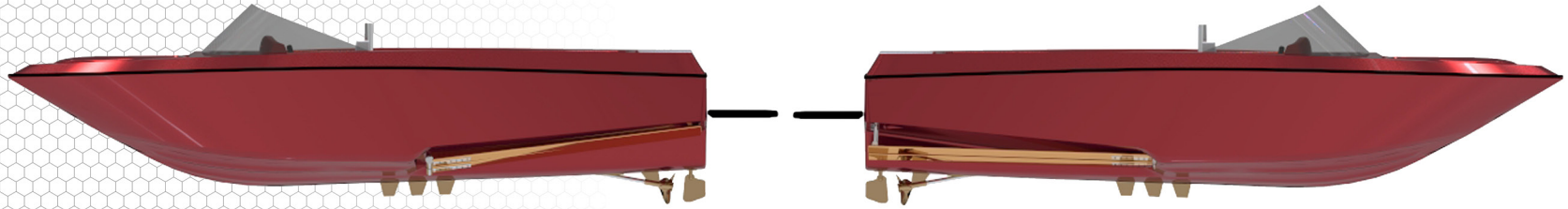
This greatly simplified the engineering involved as well as ensured the same strong and reliable drivetrain that the current recreational boats have.

HULL MODIFICATION METHOD





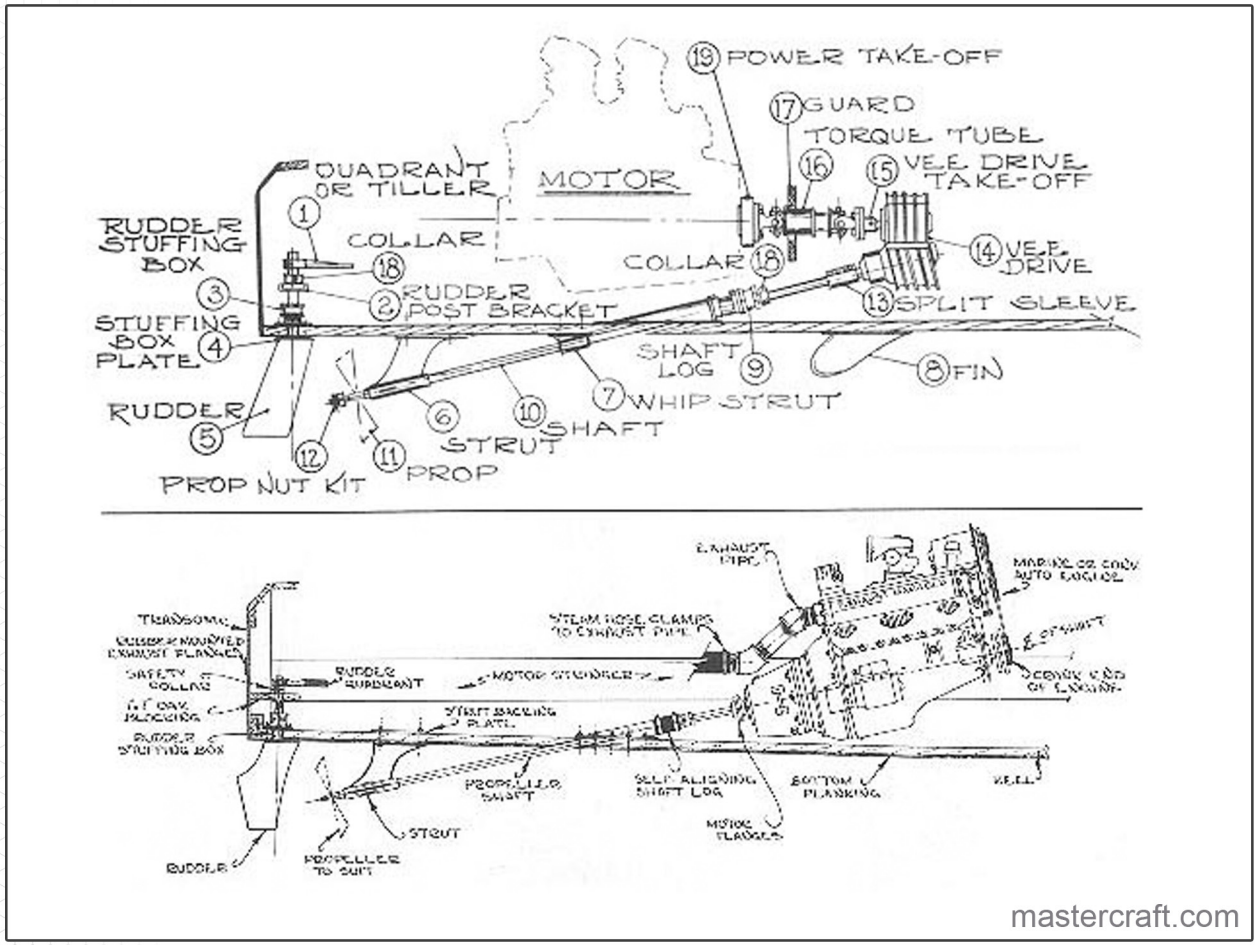
Linear-actuators move fibreglass pads up and down to modify the shape of the hull



LE DRIVE SHAFT STYLE DRIVE SHAFT STYHO

V DRIVE

DIRECT DRIVE



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MOTOR PLACEMENT MOTOR PLACEMENT MOTOR

V DRIVE

DIRECT DRIVE

FLOORPLAN TYPES

FLOORPLAN TYPES FLOORPLAN TYPES

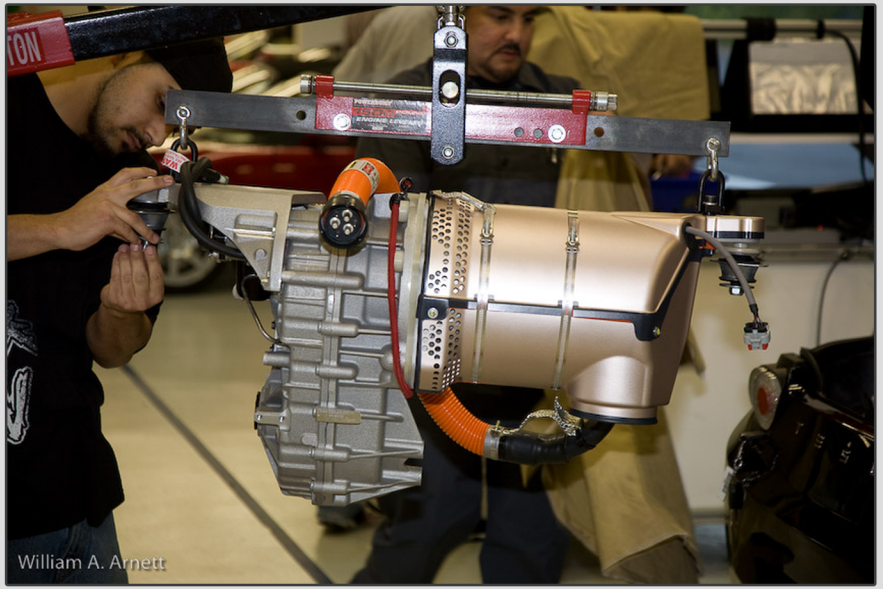
R CHOICE MOTOR CHOICE MOTOR CHOICE

INDMAR MCX

Weight: 430 lb
Efficiency 30%
Max Torque band: 1500 - 5500 rpm
Complexity: Complex
Cooling: Water
Maintenance: Oil changes, maintenance
Maximum Revs: 6000 rpm
Energy Density: Very High (Petrol/Gas)

TESLA MOTORS AC MOTOR

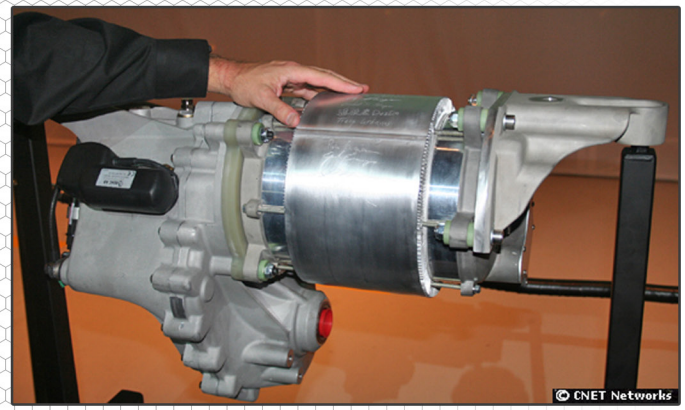
Weight: 70 lb
Efficiency 80-90%
Max Torque band: 0 - 6000 rpm
Complexity: Simple
Cooling: Air
Maintenance: None
Maximum Revs: 14000 rpm
Energy Density: Low (Lithium-Ion)

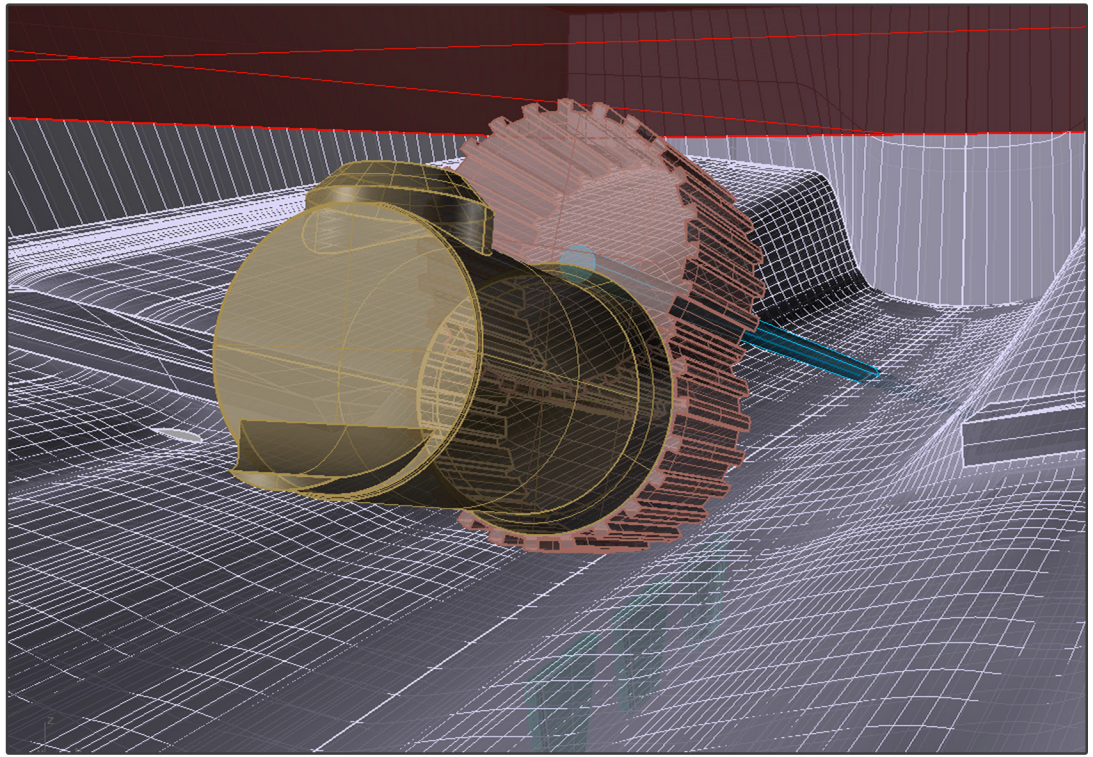


TESLA MOTOR SIZE SUPERIORITY

After creating a size accurate replica of the Tesla motor, I realized another positive.

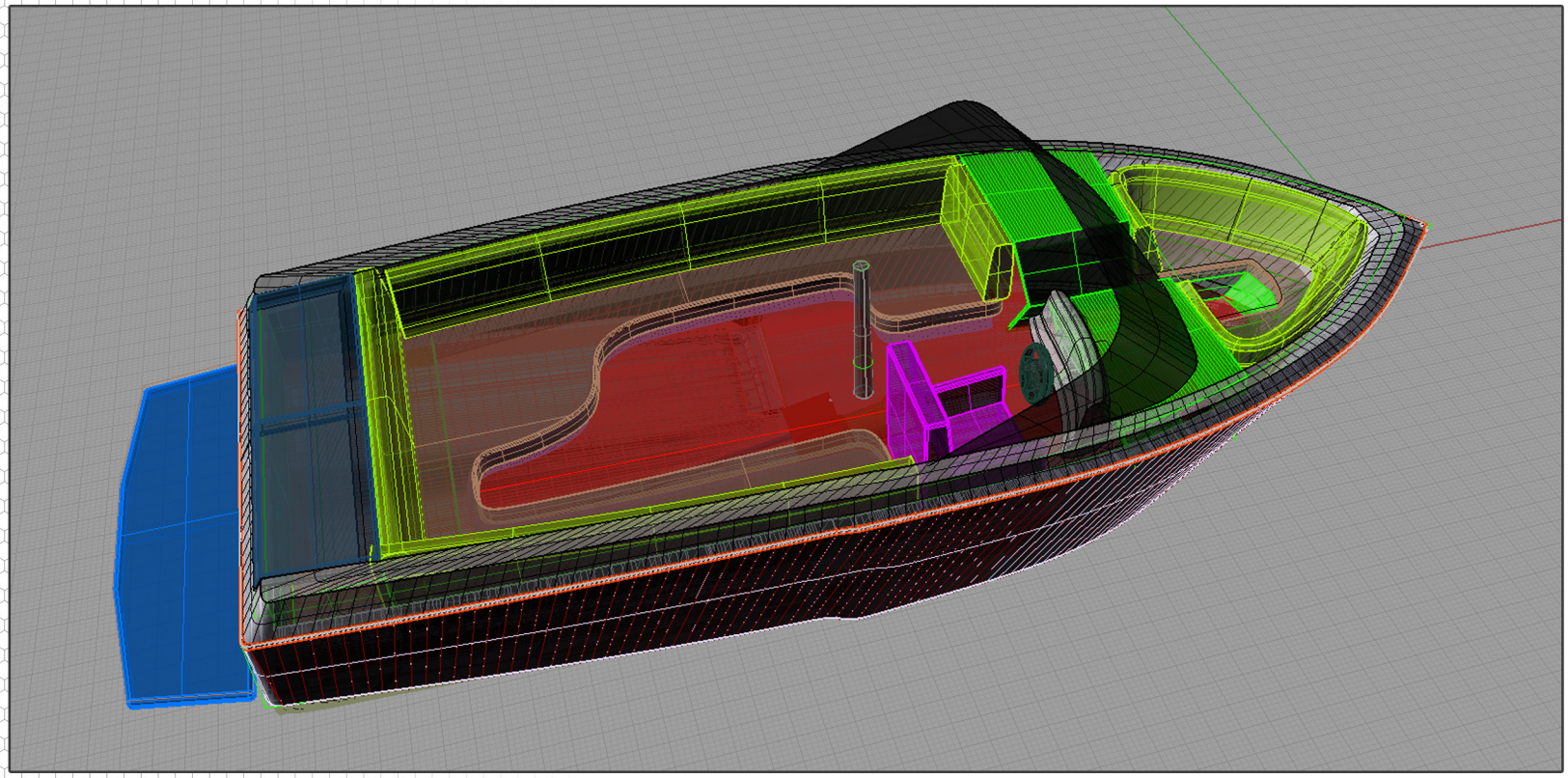
Due to the extremely compact size of the tesla and it's gearbox, the whole system can be hidden underneath the floor of the boat freeing up precious space.





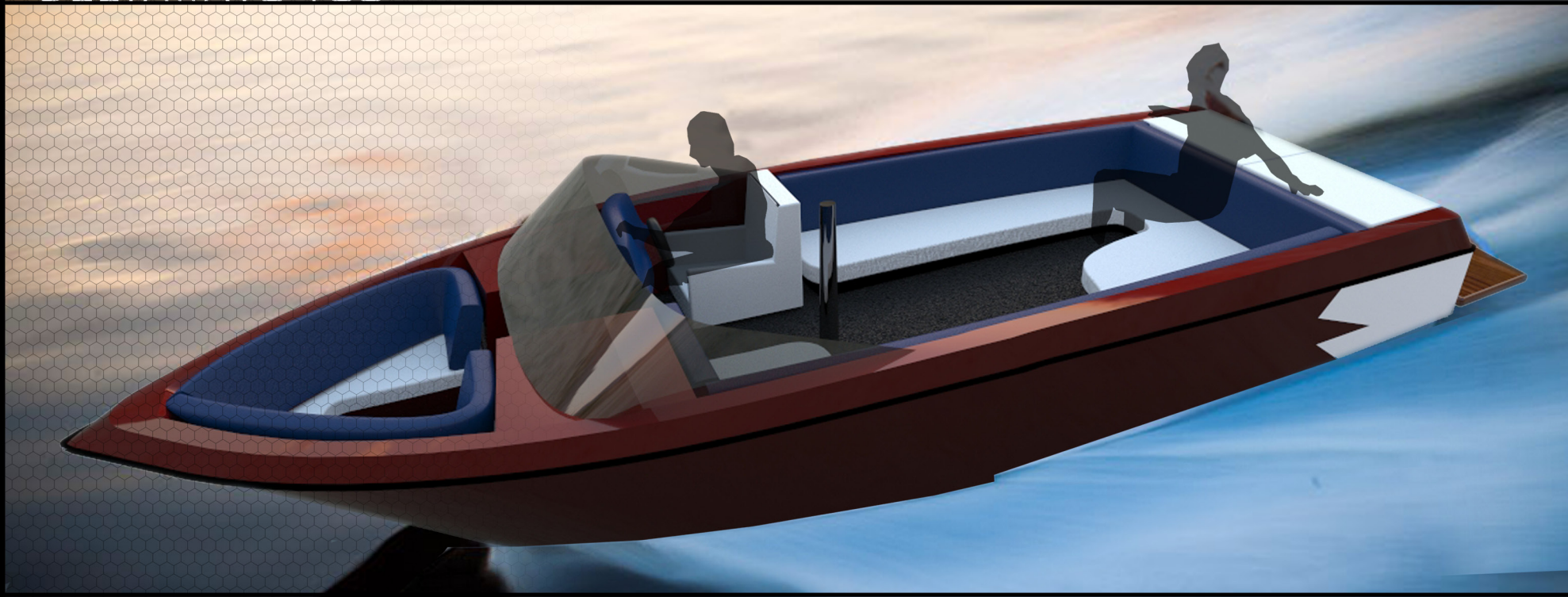
PRELIMINARY CAD CONSTRUCTION

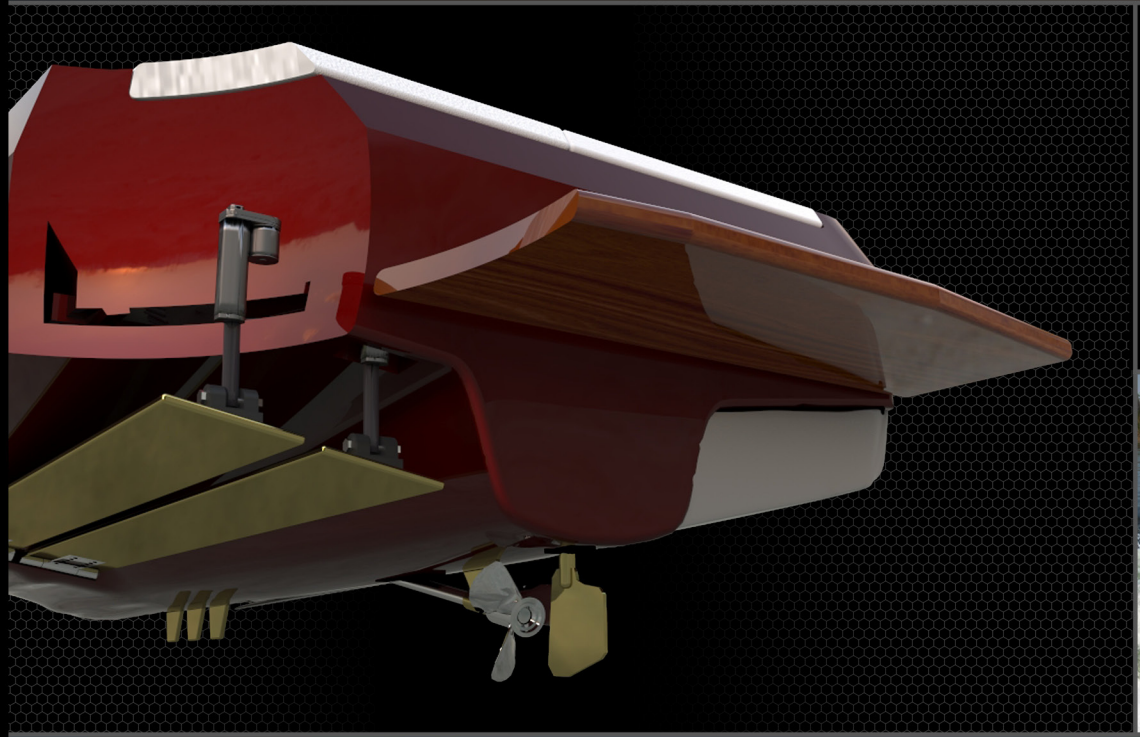
After creating a reliable hull and determining my powertrain and floorplan, I began adding basic features to give a general idea of scale and layout.



DESIGN CHECKPOINT DESIGN CHECKPOINT DESIGN CHECKPOINT

DELTAWAVE 100

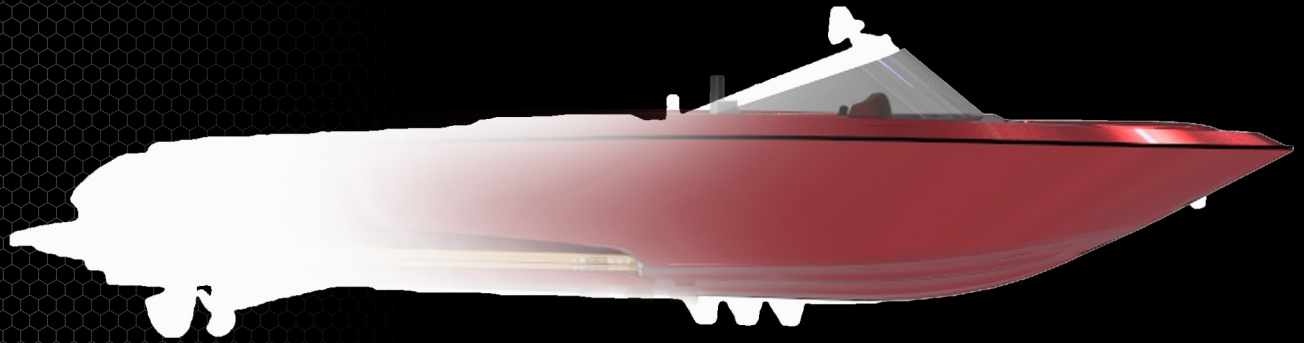




Inside of a polyurethane coated “Ballistics Nylon” shell linear-actuators move fibreglass pads up and down to modify the shape of the hull creating a flat stern or a vee shaped stern.

The Deltawave 100’s unique ability to dynamically on-the-fly change the shape of the hull from flat to vee and anywhere in-between gives the user unparalled control over the wake shape. Just seconds between flat slalom bliss to a wicked wakesurfing curl.

DESIGN CHECKPOINT



With the mechanical and functional systems in place, I can now direct my attention to styling, and interior/exterior add-on features.

DESIGN CHECKPOINT