100 Concepts

Attach winglike mechanism to the hardtop that generates lift	Lightweight hardtop with less dense fiberglass and resin	Implement light Plexiglas 'sunroof'	Use thinner airfoil for hardtop profile to reduce drag	Attach birds on top of the hardtop to help with lift
Carbon fiber hardtop	Alter aerodynamic capabilities of hardtop to improve performance	Make hardtop out of lightweight aluminum	Make water denser to reduce surface area of hull in contact with water, increasing boat performance	Attach rotors to the top of the hardtop to produce lift
Delete the hardtop	Run FEA procedure to optimize hardtop and minimize material in low stress locations	Turn the hardtop into a high lift wing	Extend hardtop into water on either side of the boat creating hydrofoils which will bring the boat hull out of the water at higher speeds & stabilize the boat when turning	Swim....it's cheaper
Strong light weight plastic material usage	Combine all 3 above ideas to get benefits from light weighting, aerodynamics, and optimization	Remove all internal materials in the hardtop to make it lighter	Eliminate motors to save fuel while implementing a pedal system to propel boat using human power	Use lightweight thermoplastics instead of fiberglass
Use glue instead of resin	Lightweight hardtop with less dense materials and with aerodynamic changes	Use less resin and fiberglass to reduce weight	Make a hardtop hologram, thus eliminating the hardtop whilst still having one	Have passengers use oars to increase overall power of the boat and increase performance
Mount with glue instead of bolts to save weight	Lightweight hardtop with less dense materials and less material usage due to optimization	Make the hardtop from a thin single sheet of steel	Use a sail instead of a hardtop that can double as a sail and hardtop and rigidly hold some electronics	Make it out of lightweight nickel phosphorous

Put holes in hardtop to make lighter	Active aerodynamics in the hardtop supports to alter orientation of hardtop depending on boat orientation and speed	Make the hardtop out of low-density polyethylene	Make hardtop out of solar cells and use the solar energy to sustainably power the motors, saving fuel	Integrate the mounts into the hardtop design to reduce mounting hardware weight
Install active aero to change aerodynamics during operation	Greatly increase coefficient of lift by changing hardtop profile, ignore drag coefficient	Greatly increase coefficient of drag by changing hardtop profile, ignore lift coefficient	Fill the hull with helium to help lift boat out of water, decreasing drag	Like a prop plane, use prop engines and mount them to hardtop, removing outboard motors for fuel efficiency
Change hardtop to soft top to make lighter	Exchange hardtop for hot air balloon to create lift	Make hardtop out of laminated paper	Wear a hat while boating so no need for a hardtop	Attach turbine engines to hardtop to increase lift and forward thrust, increasing performance
Thin out hardtop and instruct service person to avoid standing on it	Equip boat with large fuel tanks in place of water and waste tanks for longer motor usage and farther boat range	Use hellcat engines instead, they are abundant and relatively cheap and produce a lot of power for making things go faster	Use an electrochromic glass roof to allow for shade to be provided when needed and being lighter than fiberglass	Use less paint on the boat to make it lighter
Use another boat	Rid the hardtop of all inside supports for extreme light weighting	Buy more engines	Reduce amount of fiberglass used in hardtop	Reduce amount of resin used in hardtop
Make hardtop out of glue	Make hardtop heavy to weigh the boat down forcing it to reach plane speed earlier and stay planted in the water	Install jets under the boat acting normal to water line to increase lift on boat	Reduce amount of foam core used in hardtop	Reduce amount of gelcoat used in hardtop

Implement helium into layers of hard top. Will act as a buoyant force.	Use the hardtop as a wing like TIE fighters do from Star Wars except oriented perpendicularly to the TIE fighter's wings	Make smaller volume hardtop	"You can have any color you'd like so long as it's black"- except we use white	Attach sails on top of the hardtop
Attach actuated microjets to ensure decreased drag and flow separation	Replace foam support for a 3d printed accordion structure	Attach necessary equipment on places other than the hardtop	Make the supports and the hardtop a single piece, reducing weight from fasteners	Project the hardtop as a hologram for aesthetics to reduce weight
Change the hardtop for an airfoil	Use biomimetic design to copy aerodynamics of stingray	Make the hardtop out of 3D graphene	Make the hardtop out of aero graphite	Make hardtop out of metallic micro lattice
Use S-2glass as the primary material instead of E-glass	Biomimetic design against aerodynamics of flounder	Make hardtop out of thin PLA plastic 3D printed	Reduce gravity	Use biomimetic design to copy aerodynamics of a hawk and incorporate those aerodynamics into the design of the hardtop
Use a circular hardtop instead of a rectangular to save material	Reduce EPA regulations on the engines of the boat to increase performance	Make sides of hardtop curved like an airplane wing to increase lift	Attach airfoil flaps to the hardtop and use an Arduino and a stepper motor to control the flaps to get the best lift.	Make the hardtop out of lithium
Make the hardtop smaller in area	Integrate hardtop to front of the boat to create a closed environment in the cockpit and thus rid the boat of potential air vacuum under hardtop	Using a less dense core to reduce weight	Make servo actuated mounts to allow the hardtops angle of attack be adjusted during operation	Use a rocket engine when extra speed is needed

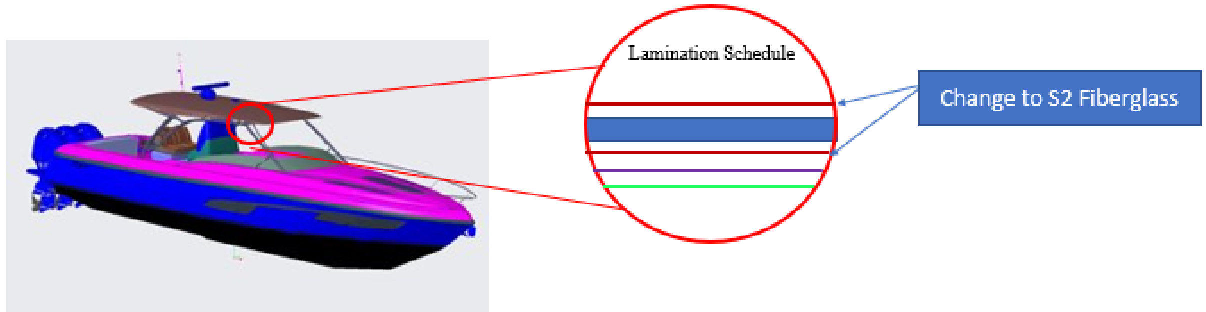
3D print the whole hardtop with lighter material, saving money in assembly	Like the lids of a dumpster, use hard plastic that can support heavier loads and deform but not break (cheap too)	Make hard top out of cardboard and make it water proof	Increase down force so the boat becomes a submarine	Change the hardtop for an improvised tent
Have a maximum capacity of 2 persons on the boat	Make engines more efficient to increase boat performance	Make the hardtop out of a thin layer titanium	Change the hardtop for a folding one that can be folded backwards when not needed and opened when needed (convertible)	Soak the boat's hull in oil to reduce friction since oil is less dense than water.

After generation of our 100 concepts (see appendix for full table), we recognized five medium fidelity concepts and three high fidelity concepts. The three high fidelity concepts developed were light weighting the hardtop with less dense fiberglass and resin, altering aerodynamic capabilities (lift, drag, orientation, geometry) to improve boat performance, and the third being a combination of optimization from minimizing material use, aerodynamic changes, and material changes all into one design. The five medium fidelity concepts were to use S-2 glass instead of E-glass, use lightweight thermoplastics instead of fiberglass and foam, install active aero, use a less dense core material to reduce hardtop weight, and to model the hardtop to be a high lift wing.

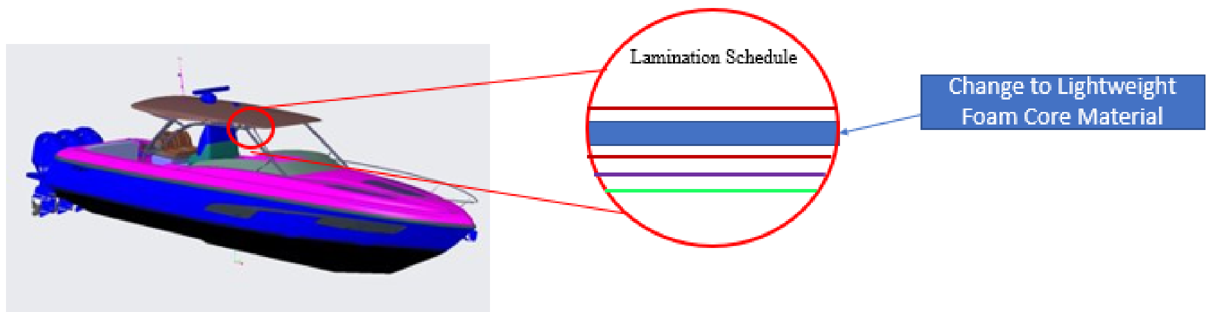
Concept Generation Tools:

The two concept generation tools we used the most when determining our 100 concepts were the Anti-problem and the Battle of Perspective methods. This is because the nature of our project is that of a non-mechanical design problem. In order to stay creative and generate many ideas, none of the ideas generated were discarded and ideas were thought aloud with the group members. For the 'Anti-problem' we said to ourselves 'We want a hardtop that is heavier and reduces boat performance' and brain stormed ways to avoid this problem and used these in our chart. Thinking of how NOT to solve the problem of improving boat performance helped us to generate many ideas that could potentially solve our problem. For the Battle of Perspectives, we took the perspectives of "Lighter hardtop vs Faster boat" and "Boat buyer vs Boat manufacturer" and created solutions for each side of the perspectives and tried to find common ground while discussing the pros and cons of each.

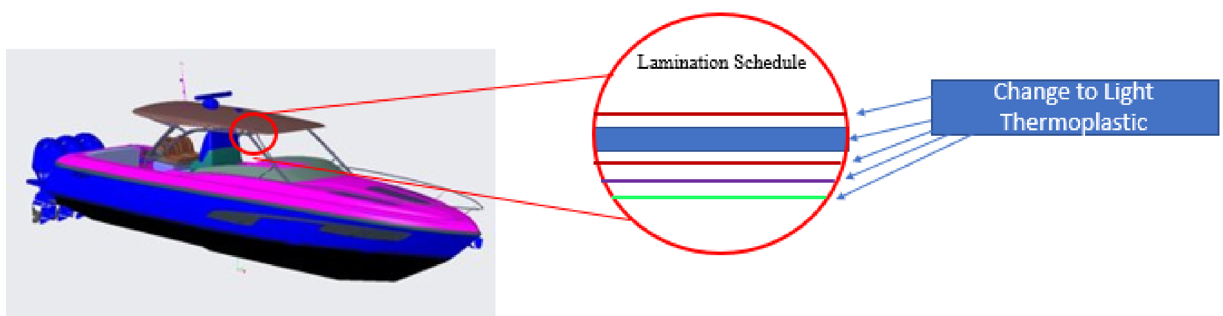
Medium Fidelity Designs:



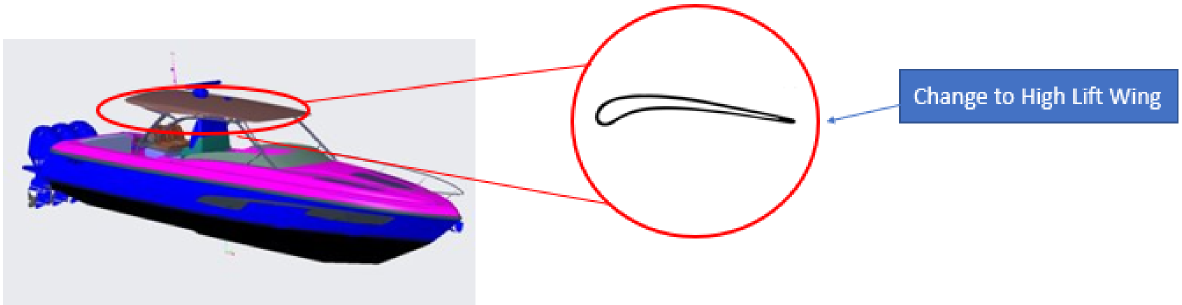
This design replaces the current e-glass with lighter and stronger S2 fiberglass. This was chosen as a medium fidelity item because we believe it will satisfy our customer requirements.



This design replaces the current foam core with a lower density one. This was chosen because the current foam core takes up a lot of volume and using a much lower density core foam will lighten the hardtop significantly.



This design replaces the current hardtop materials with a lighter thermoplastic. This was chosen because of the lightweight nature of thermoplastics when compared to resin, foam and fiberglass that is currently used.

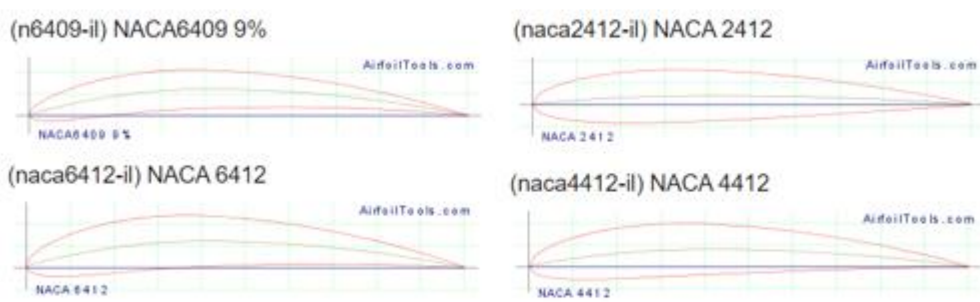


This design replaces the hardtop with a high lift wing design. This was chosen because Intrepid wants the improvements to the hardtop to increase lift generated. This will increase vessel performance by helping get the boat out of the water to reduce friction.

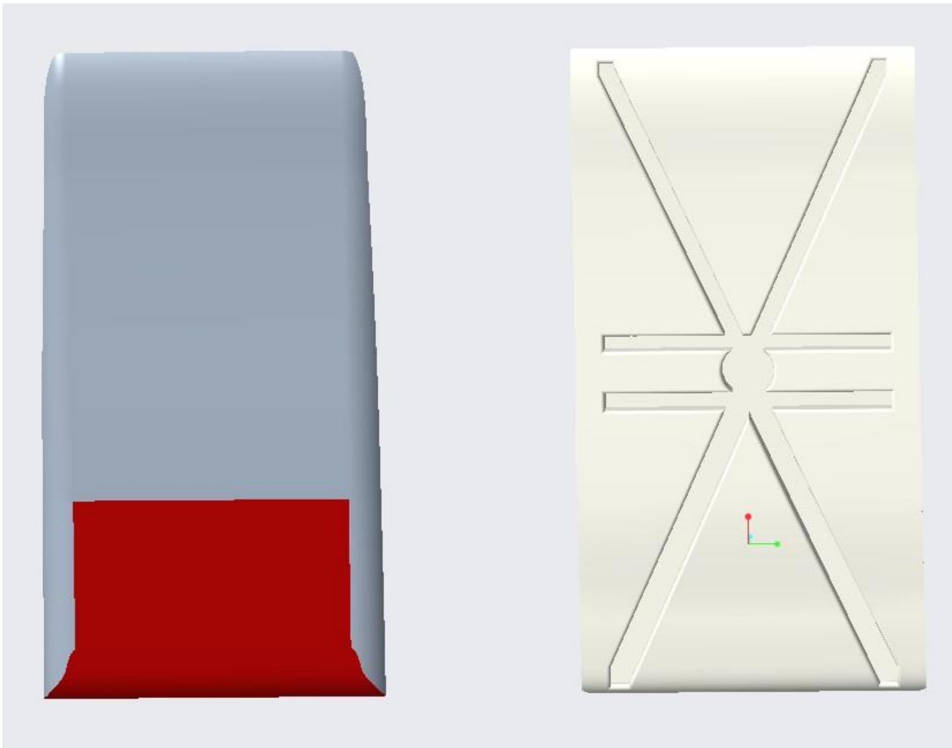
This design implements an active aerodynamics system to help generate lift and decrease drag. While lift generation is important for top speed, having increased drag will have a detrimental effect on performance. The active aero addresses both problems by changing shape to produce lift and changing shape to reduce drag.

High Fidelity Designs:

For the aerodynamic improvements to the hardtop, we will use NACA airfoils to determine benchmarks and compare it to the current hardtop model and the improved hardtop model. The four airfoils we are using for modeling are shown below. These were all found to be airfoils with high lift-to-drag ratios. This design will require several iterations and testing across many different attack angles.

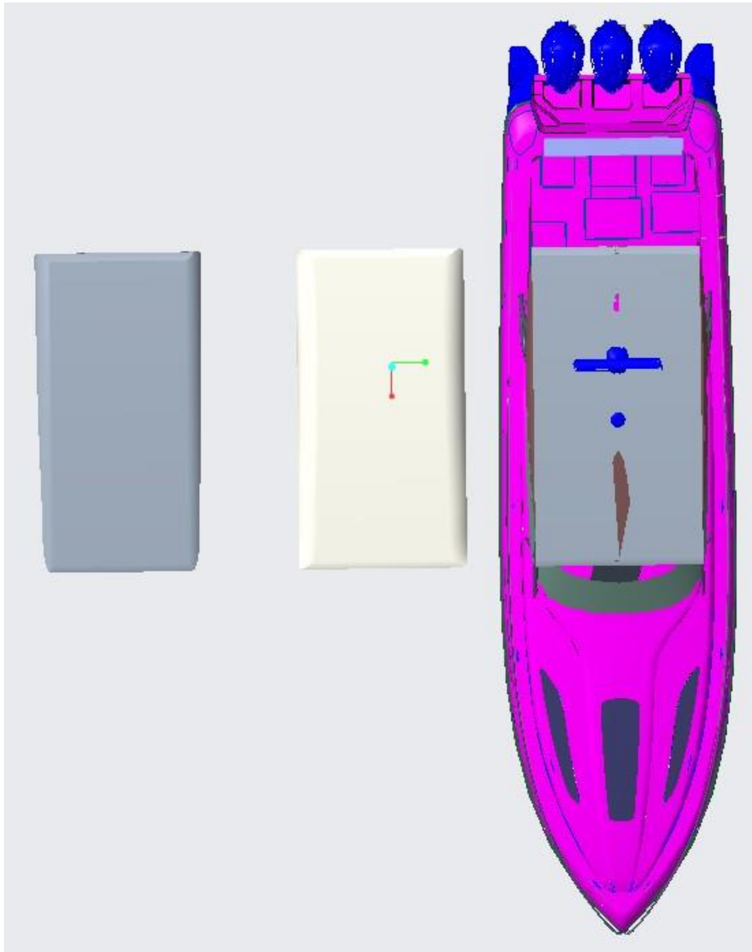


This can be roughly shown by the picture of the model below where the red colored surface highlights the difference in the mounting surface that offers a different angle of attack and models the hardtop more closely to a NACA 2412 wing, giving it more ability to generate lift. The red surface along with the curvature of the hardtop extends and creates a larger area that is exposed to wind flow, directing the air down and creating lift.

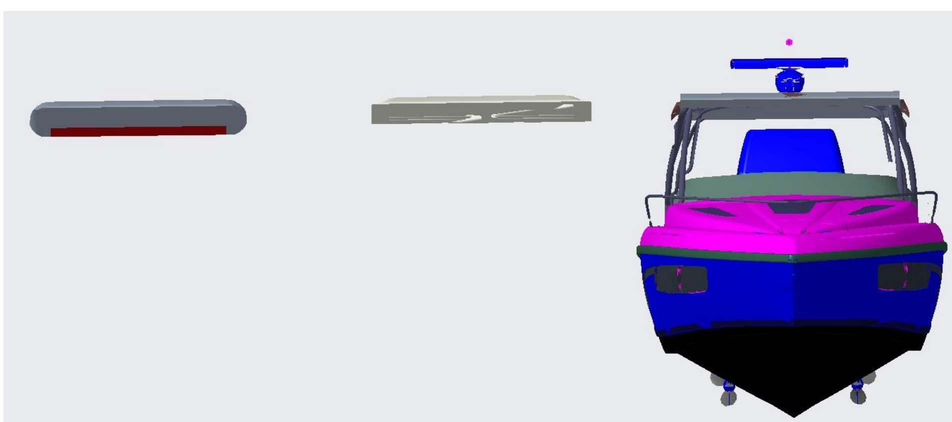


Our second high fidelity design is light weighting the hardtop. This will be accomplished by selecting lower density fiberglass and resin. Our customer specifically requested we light weight the hardtop and that is part of the reason why we chose to move forward with this design. A basic model is shown below in the following pictures attached to the model 409 Valor. Though material changes cannot be seen in the model as the overall hardtop shape is the same, this will cause the hardtop to be lighter, promoting the improvement of on water performance.

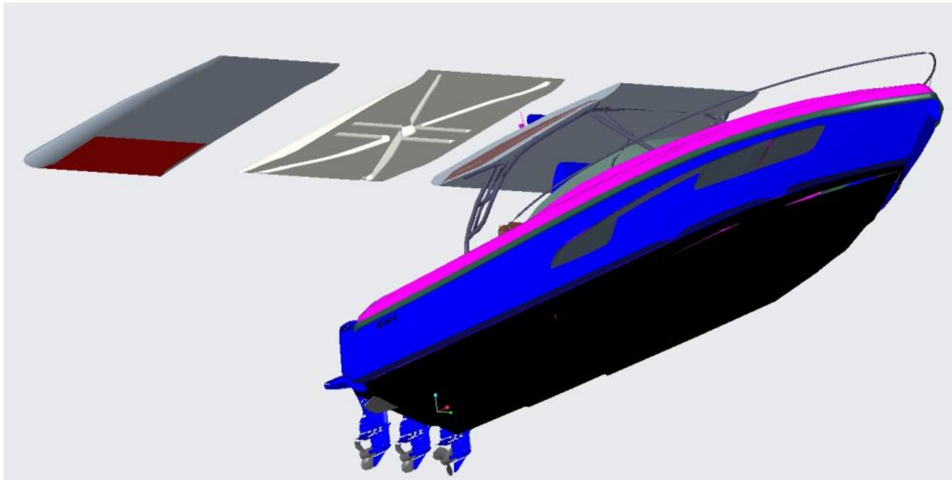
Our third high fidelity design is optimizing the hardtop. Shown above next to the aerodynamically enhanced hardtop, the white model shows areas where the wire and chase tubes have been reduced to reduce material and save weight. This can also account for areas of low stress where material can be minimized. This model is a crude model and visualizes the basic concept that will result from optimization. This will be done by performing FEA on the hardtop to check where stress concentrations are and remove material where it is not. This will help reduce overall weight and material cost of the hardtop.



All 3 prospective designs, side by side to show comparison of overall top shape



All 3 designs to note thickness differences from FEA (middle), and aero enhancements (left most)



All 3 designs to note curvature difference, material minimization, and general cross section differences