

Project Blackfoot

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The United States (US) Navy’s fleet of surface ships is comprised of large, highly-capable, yet costly warships that take years to build and maintain. At their current capacity, US shipyards struggle to build new complex ships like the Ford class aircraft carrier or Zumwalt class destroyer. This new construction backlog also inhibits each shipyard’s ability to maintain the Navy’s existing fleet. As high end at-parity adversaries build weapons capable of causing major battle damage and ship attrition, the Navy must create ships capable of delivering major combat capabilities using less shipyard resources. Emerging autonomous capabilities allow us to create unmanned and rapidly producible swarm ships capable of delivering lethal combat power at a low cost. Inspired by the WWII era Patrol Torpedo (PT) boats, we propose an autonomous swarm of planing surface combatants that can be built in commercial pleasure craft shipyards and delivered to battle without stressing existing naval assets.

The design team spent a significant time clearly defining the ship’s Concept of Operations (CONOPS) and outlining the requirements as this project is unique and this framework needed to be established in order to start to design our vessel. The CONOPS involves not only the mission of the PT boat once in the Operational Area (OPAREA), but also the method of transport from the manufacturing site to the OPAREA. After the problem was clearly defined and with the design philosophy established, we moved into design space exploration. We utilized both qualitative and quantitative means to make design decisions. We created a Python script to automate the generation of over 50,000 variants of hulls so that we could select the best five to analyze further. We considered 19 combinations of payloads and then narrowed it down to three options. Using the selected five hulls and three payloads, we conducted an Overall Measure of Effectiveness (OMOE) analysis to select a final variant. The parameters of this selected hull are listed in the two tables below in table 1.

Parameter	Value
Length on Deck	40 ft
Beam	8 ft
Chine Height	4 ft
Chine Width	5 in
Chine Beam	6.4 ft
Bow Fullness	0.3
Bow Rake Angle	40 degrees
Mid Deadrise	20 degrees
Aft Deadrise	15 degrees
Material	Fiberglass

Parameter	Payload Option C
Weapons	2x Saab Torp, 4x Spike NLOS
Length (in)	178
Weight (lbs)	2,900
Max Eff Range (NM)	13.5

Table 1: Final Variant characteristics

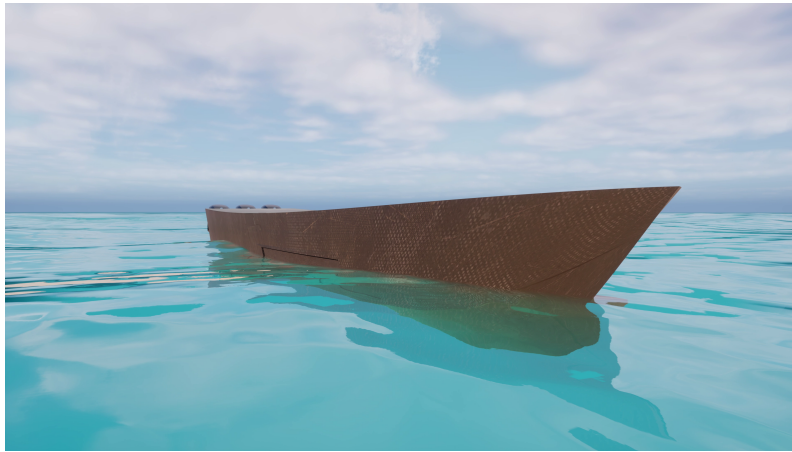


Figure 1: Final PT Boat Design

Next the design team moved into detailed design. With our vessel dimensions determined, we made careful decisions about arrangements, considering weight distribution with each iteration of the design. Additionally, we designed weapon launchers for our unique mission and also designed stern launch equipment to launch the swarm of PT boats from the stern ramp of the Roll-On/Roll-Off (Ro-Ro) vessel, ARC Endurance. Electrical and auxiliary equipment was selected and loitering times were verified based on equipment power needs. Our final arrangements are shown below in figure 2.

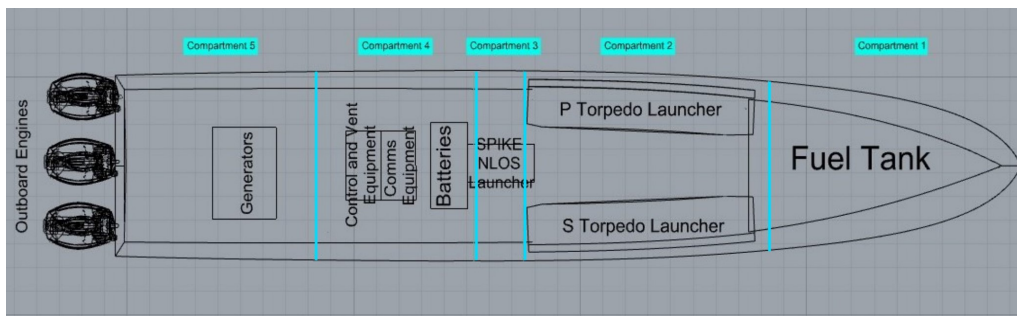


Figure 2: 2D Arrangements of Final Design

Finally, we completed feasibility and performance analyses on the final variant. We analyzed intact and damaged stability, powering and resistance, trim, and seakeeping through a variety of hand calculations and computational methods. The PT boat successfully met all requirements, passed our stability checks, and met all other applicable standards.