Project 13
Group F10

College of Engineering
Department of Mechanical Engineering
presents

RAF-2000 Gyroplane Fuel System Safety Redesign

Problem Statement

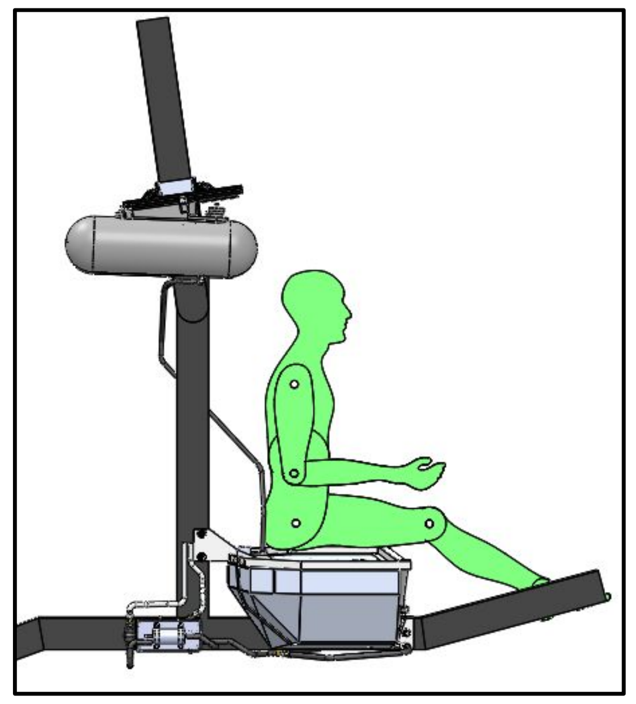
The standard fuel tank for the Rotary Air Force RAF-2000 gyroplane is constructed of fiberglass, the seams of which are vulnerable to failure when exposed to the ethanol content in modern fuels. The tank is situated under the seats, therefore, seam failure results in fuel pooling in the footwell of the passenger cabin. This puts occupants at risk of fume inhalation and possible fire. This could cause extreme danger if failure occurs in flight. The current placement of the fuel tank also places the Center of Gravity (CG) too low with respect to the line of thrust from the pusher prop at the rear. This leads to the aircraft nosing down under throttle, which has resulted in crashes in the past when flying close to terrain. Overall, the standard fuel system is outdated, lacking accurate fuel level and pressure monitoring.

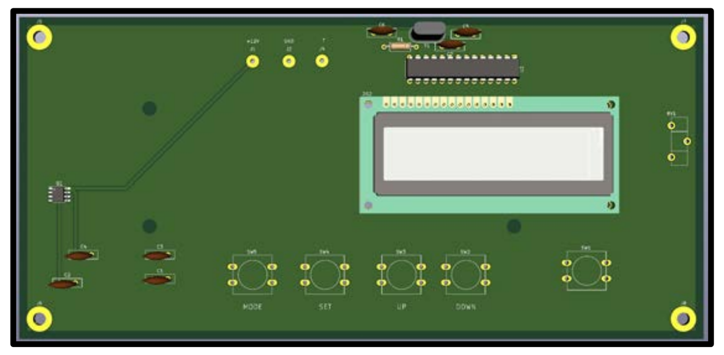
Meet The Team

From left to right:
Michael Chiavacci, Francisco Carvajal, Steven Parker, Cody Rahders

Inital Design

To design the new fuel system for the gyroplane, Team Under Pressure used Solidworks to create the solid models. The fuel system was designed for safety, with the use of check valves, redundant fuel pumps, and a transducer to measure fuel flow and calculate remaining flight time.





This printed circuit board was created on KiCad in order to monitor fuel flow rate, and compute fuel level from the known volume and fuel consumed. This was done using an ATmega 328-P and prototyped on an Arduino for testing.

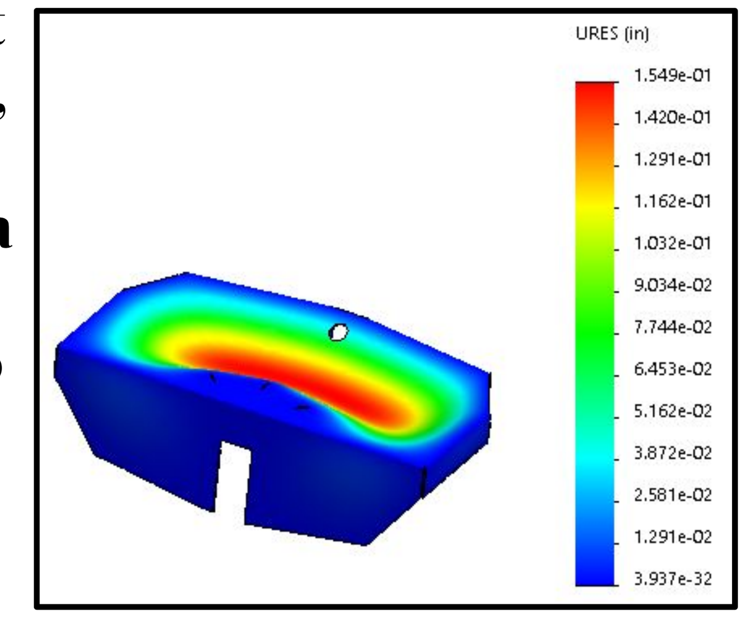
Manufacturing

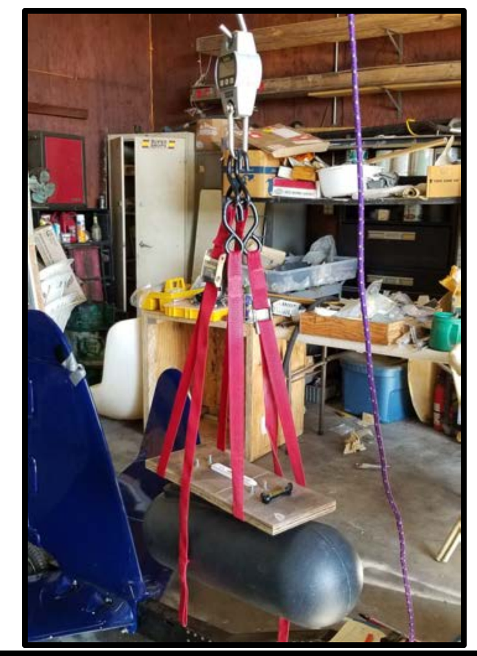
The design has a strong focus on manufacturability to be within the capabilities of an RAF-2000 builder, as they are "home built" aircraft. The design avoids the requirement of specialized tools or CNC milling, with all the parts being possible to fabricate with common tools. For example, the water jetted parts can be made instead with pneumatic shears.

All tank parts were designed in commonly found 1/8" and 1/16" aluminum sheet metal. Total raw material cost was $400, a $290 price reduction from the previous tank. A water jet was used to cut out the sheet metal, a box brake for bending the pieces, and a TIG welder to join the individual parts together.

Analysis / Testing

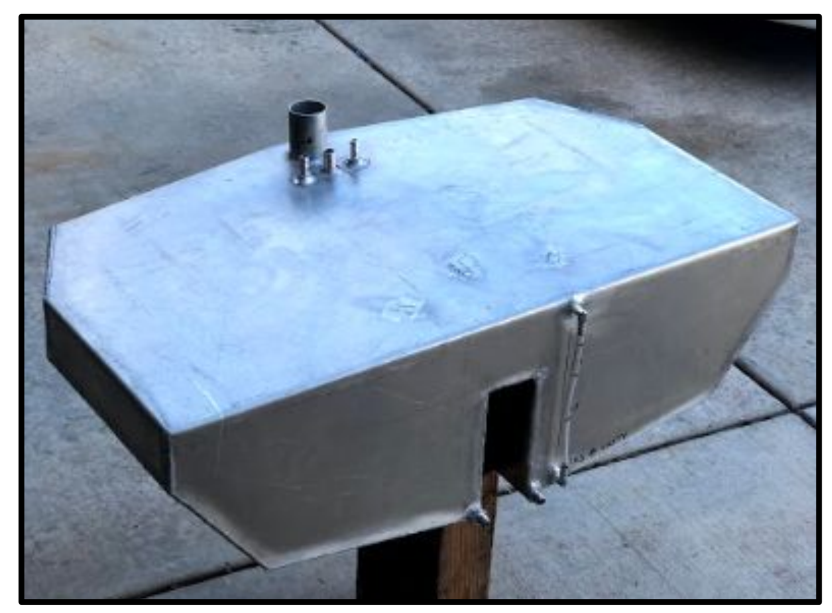
To ensure the design was sufficient to perform under flight conditions, Finite Element Analysis (FEA) was used with an industry standard of a minimum 1.5 Factor of Safety. The fuel tank top supports up to a 1000 pound load with a 1.8 FOS.





Each FEA run was double checked with hand calculations for validation and testing. Commercial off-the-shelf components underwent verification to ensure the parts were manufactured to spec.

Final Assembly



The new tank's dry weight is 29 pounds and has a capacity of 20.5 gallons. Dry weight is decreased by 6 pounds while retaining 90% of the original capacity. To compensate, accomodations for optional ferry tanks are included. The result is improved flight characteristics while dramatically improving system lifetime, compared to the original fiberglass construction.

A fuel box was designed to hold the many components for fuel distribution while protecting them from the elements. Contained inside are the fuel filter, transducer, check valve, and a electric fuel pump.