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UNH SEDS

Project Overview

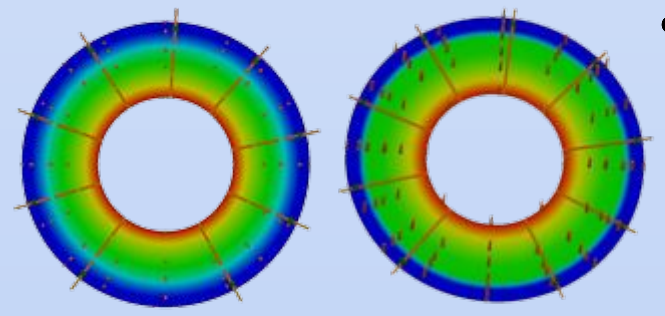
SEDS at UNH:
- A club for four years
- Progression:
  - Model rockets, hybrid engine, Spaceport America Cup first attempt, Spaceport America Cup second attempt

For Spaceport America:
- To design, build and fly a student made hybrid rocket engine to an apogee of 10,000 ft, carrying a payload of no less than 8.8 lbs.
  - Must use only non-toxic propellants
- All major components require a factor of safety of 2 or greater.
- Engine walls must be built to withstand 580 PSI of operational pressure / 1160 PSI testing standard)

SPACEPORT AMERICA® CUP

Hybrid Engine

- Our design utilizes a new swirl injection system to improve the vorticity and velocity of the oxidizer to ensure proper atomization before it is injected into the combustion chamber
- A flexible silica insulator is lined between the solid fuel and aluminum combustion chamber walls due to the low melting point of 6061 aluminum, and this improved model has passed multiple Solidworks thermal analysis tests



- Our system features an aluminum adapter plate that connects our current combustion chamber with our reusable stainless steel nozzle, which features a single use graphite insert

Frame

- This frame is different than last years in that it it shorter, has a smaller outer diameter, it is sturdier, and easier and safer to transport
  - Previous years frame consisted of four full length square bracket rods connecting square support plates
  - This year's frame is broken into four cylindrical sections with circular support plate/couplers for better support on all of the cylindrical components and easier and safer transportation. The cylindrical design also allowed us to reduce the outer diameter of the rocket
- The inner shell of the rocket is made of 6061 T6 aluminum and the outer shell is made of PVC
- Flow and stress analyses on the frame resulted in an overall force on the rocket
  - 121 lbs drag
  - 130.5 psi stress on the rocket
  - 70 lbs overall rocket mass

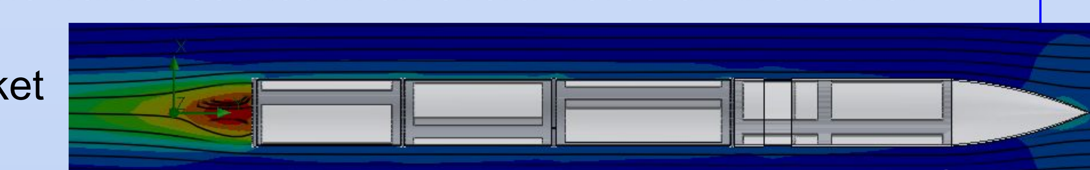


Fig 1. Flow Cut Plot

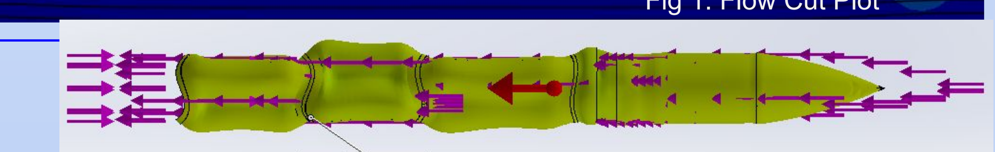


Fig 2. Axial Stress Plot

Banshee Engine

Our hybrid rocket engine is comprised of a solid HTPB rubber fuel and a liquid NO_2 oxidizer achieving an oxidizer to fuel ratio of 6.28

Swagelok Flow Regulator

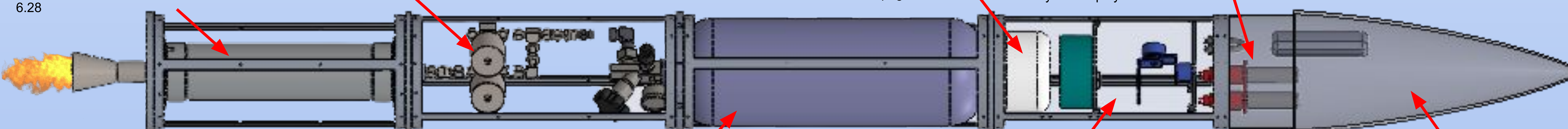
Regulates the flow of oxidizer to the combustion chamber where the liquid oxidizer will mix with the solid HTPB fuel. The regulator allows us to toggle the thrust output from the engine

Avionics Bay

Avionics control the Swagelok to regulate the flow of oxidizer to the engine and sends the signal to deploy the nose cone at apogee.

Recovery Bay

The recovery bay consists of a main and a drogue parachute, a "Tender Descender" to release the main parachute after the drogue has been deployed, and two CO2 canisters to pressurize the bay and deploy the nose cone.



Nitrous Oxide Tank

Highly pressurized tank containing liquid nitrous oxide is the oxidizer required for combustion. The NOS tank is the driving factor for the outer diameter of the rocket frame.

Payload

Spaceport America Cup requires a minimum 8lb payload to be on the rocket. Our payload is a gimbling 360° camera with VR headset accessibility.

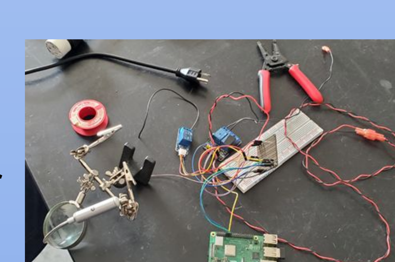
Nose Cone

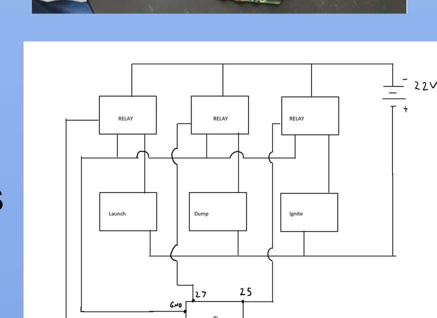
A 3D printed cast of the nose cone will be used to create the nose cone from fiberglass sheets. The case was made with the outer diameter of the rocket and the Von Karman nose cone model.

Machined Frame

- All frame couplers machined
  - Screw holes to be machined
  - Internal support plates to be machined
- Aluminum internal frame cut to size
  - Need slots cut
  - Need screw holes cut
- Need nose cone mold printed
- Need nose cone molded with fiberglass

Avionics





- Optimizing and refining the rockets avionics was our goal. For example, the previous year's team had both a Raspberry Pi and an Arduino to actuate the solenoids. Therefore, we were able to discard the Arduino and reconfigure our set up.
- Testing was key to our success. All three relays and both solenoids successfully passed examination. Once the rockets avionics was cleared by testing, we soldered all the electronics together.
- The Avionics team also constructed the actuating pressure for the valves. A manually operated valve with CO2 connected will pass through a pressure regulator to provide the operating pressure (0.15-0.7 MPA). This will allow the valves to open upon command.

Payload

- The Spaceport America Cup requires that the rocket have at least an 8.8lb payload, either deployed or undeployed
- Our payload system is a camera mounted on a 2-axis gimbal inside the rocket which can connect to the ground with a live video feed
- Using a VR headset, we are able to stabilize the gimbal and rotate it based on where the ground operator is looking
- This setup is able to rotate around the rocket continuously without tangling the wires, enabling a wider range of camera motion
- In order to see through the rocket frame to the outside, a small section of the rocket shell is made of transparent acrylic

Recovery

- In order to obtain full points in the Spaceport America Cup, all components of the rocket must be recoverable
- To recover our rocket, we use a two-staged recovery system by releasing a smaller, drogue parachute at the top of our trajectory to stabilize and slow down the rocket on descent. When the rocket falls below 2500 feet, we then release our much larger main chute to bring the rocket to its final descent velocity.
- Our system to release the two parachutes uses two separate, redundant CO_2 cartridges to eject the rocket nose cone. This opens the drogue chute while the main is contained in a deployment bag. After reaching the specified altitude, we use a black powder charge to open the deployment bag and release the main chute.
- Exploding bolts were designed and tested to deploy the nose cone but they were replaced with CO2 canisters to pop off the nose cone using pressure as it reduced length and complexity