University of New Hampshire
College of Engineering and Physical Sciences

UNH SEDS

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SEDS USA

Who We Are

- A chapter of the Students for the Exploration and Development of Space, part of a nationwide organization
- A second year engineering organization comprised of students of all classes and CEPS majors
- A primary engineering goal of pursuing the art of high power rocketry with custom-made hybrid engines
- Focused on giving its members a unique experience in the design and manufacturing of rockets and rocket engine components


Project Overview

- Our main focus is to develop a rocket propelled by a student designed hybrid engine
  - A hybrid rocket engine uses a solid reducer with the assistance of a liquid oxidizer
- Compete in the Spaceport America Cup in June 2020 hosted in Las Cruces, New Mexico
  - A 10,000 ft. apogee competition implementing a student researched and developed hybrid class engine
- Design and implement a device to enable the gimbaling of our hybrid rocket engine to control flight dynamics in real time

Rocket Building Techniques

- To begin designing and manufacturing a rocket engine, it is crucial to understand overall rocket design, mechanics and manufacturing techniques
  - Utilized last years members to teach and mentor new members on the lessons learned from last years research
  - Hosted multiple building sessions and in-house competitions to compete on highest altitude achieved
- Learned the fundamental parameters that affect the performance of a rocket in flight, and tested first hand the effect of these design choices on the overall flight performance and path.

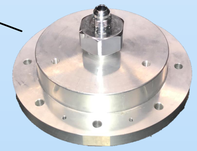

Reducer and Oxidizer

- The fuel selected is Hydroxyl-terminated polybutadiene (HTPB), a commonly used hybrid reducer.
- Liquid Nitrous Oxide was chosen as the oxidizer as it is commonly paired with HTPB and provided us with a great baseline of public knowledge
- A mold was 3-D printed to insert into the combustion chamber and form the rubber to a specific grain formation in preparation for combustion and radial burn rate

Oxidizer Tank
A highly pressurized vessel that contains liquid Nitrous Oxide, acting as our oxidizer within the combustion chamber

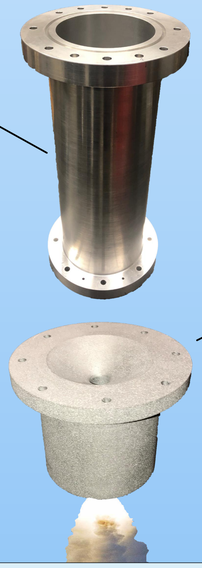
Flow Regulator
A motorized valve that monitors flow regulation of the oxidizer into the injection plate controlled by an electric motor and an Arduino.

Injection Plate
Responsible for providing desired oxidizer flow into the combustion chamber with the assistance of the impinging plate



Impinging Plate
An interchangeable cylindrical plate responsible for the impingement and atomization of the oxidizer flow streams

Combustion Chamber
An enclosed volume where the solid reducer and liquid oxidizer react to produce a superheated, highly pressurized chamber of gas

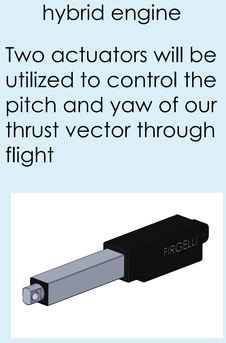


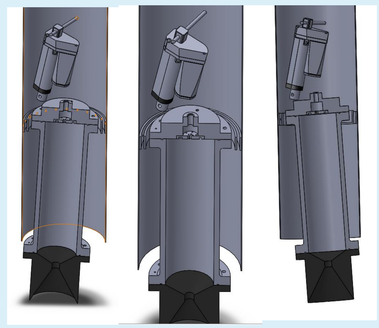
Nozzle
Graphite was machined into a de Laval curve responsible for directing the flow of hot gases outside of the combustion chamber into the environment providing thrust

Gimbal System

- Preliminary design work was started last year on commercial off the shelf 29mm engines to assist in the application of those techniques on a larger, homemade hybrid engine

Two actuators will be utilized to control the pitch and yaw of our thrust vector through flight





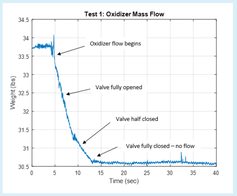
An accelerometer will be used to sense any variation in our zenith direction, and quickly redirect our engine thrust to return back to the desired flight path

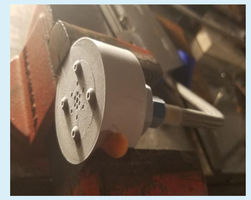
Manufacturing

- The combustion chamber and Injector plate were manufactured with the assistance of TURBOCAM International
  - Both components made of Aluminum 6061 for ease of manufacturing and Tripoli Experimental Rocket Recommendations
  - Injector plate designed so the plate can be reused, but hole inserts can be redesigned and replaced
- The nozzle was manufactured here at UNH by Scott Campbell


Cold Fire Test

- A cold test fire was conducted to examine the oxidizer flow through the injector insert, and to determine the mass flow rate
- Tested the flow regulation system
- Attempted to determine how far we must open the flow regulator in order to get optimal flow through the injector plate



Project Field Safety

- Must obtain a suitable location and testing infrastructure for safe testing procedures and events by communicating and negotiating with local officials
- Design certain field structures needed for the development of testing and launching semi-permanent buildings

Hot Fire Test

Engine Startup / Ignition Method

- Correct ignition method to start-up the engine and provide initial heat and pressure for further combustion with the oxidizer
- Obtain an initial injector flow rate

Hot Fire Testing Rig and Data Collection

- Used to safely test the hybrid rocket engine in a static rig
- Collect precise data on thrust, mass flow rate and combustion temperature for future optimization of the hybrid rocket engine geometry

Acknowledgments

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