University of New Hampshire
College of Engineering and Physical Sciences

UNH SEDS

Department of Mechanical Engineering
Authors: Ryan Blatti, Thomas Collins, Chase Eldridge, Andrew Hosman, Silas Johnson, Tyler Landry, John Langer, Charlie Nitschelm, Collin Stroshine, Advisor: Dr. Todd Gross

Who We Are

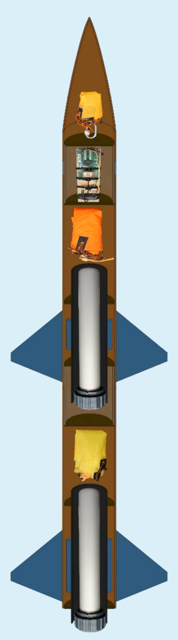
- A second year engineering organization comprised of students of all classes and CEPS majors
- A primary engineering goal of pursuing the art of high power rocketry with custom-made hybrid engines

SpaceVision, November 2018

SEDS Rocketry Competition, October 2018

The 3 Year Plan

Year One

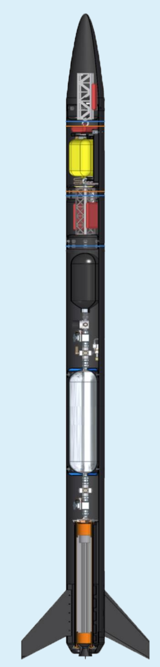


Rocket Building
Simulating
Launching
Optimizing

Hybrid Engine
Design
Manufacture
Test

Year Two

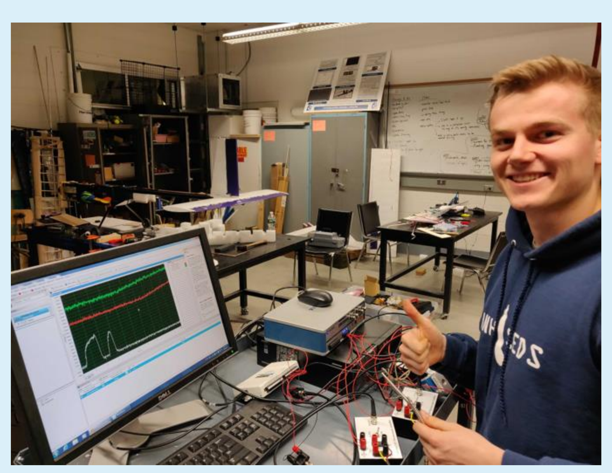
Year Three

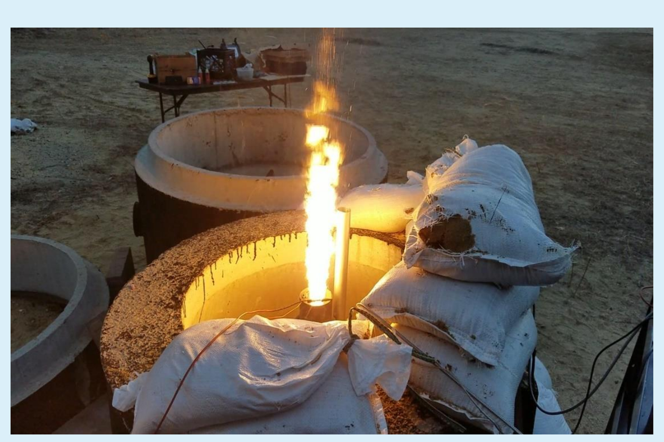


Hybrid Rocket
Engine Optimization
Rocket Integration
Competition

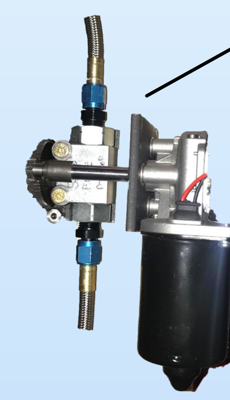
Hot Fire Test

- Worked with the UNH police and fire departments to locate a safe testing range and procedures.
- Test engine to determine thrust, mass flow rate, combustion temperature and overall functionality.
- Load cells and thermocouples were used to record data required for future optimization.
- Designed and manufactured a static test fire rig to secure the engine and withstand a force up to 500 lbs of thrust.
- Three hot fire tests were attempted, but due to weather, failed ignition and flow regulation a successful test has yet to be completed.

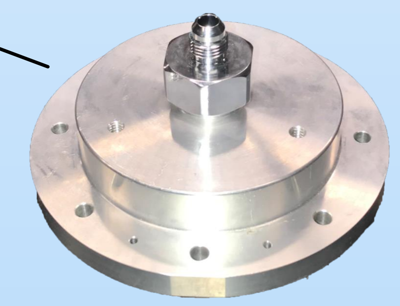




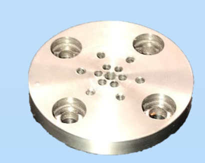
Oxidizer Tank
A highly pressurized vessel that contains liquid Nitrous Oxide, acting as our oxidizer within the combustion chamber



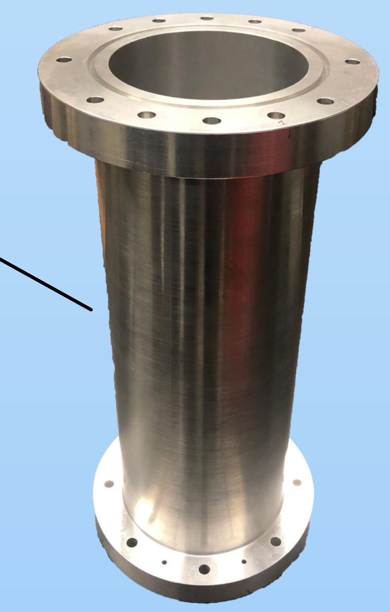
Flow Regulator
A motorized valve that monitors flow regulation of the oxidizer into the injection plate controlled by an electric motor and an Arduino.



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

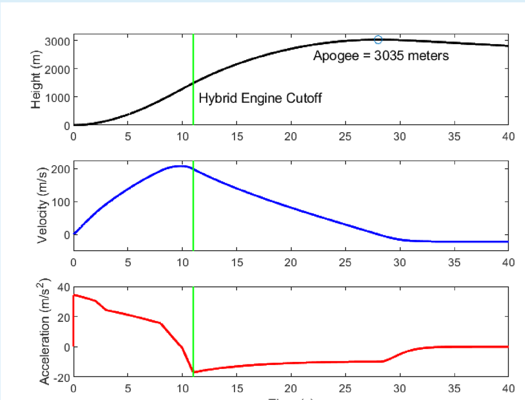


Combustion Chamber
An enclosed volume where the solid reducer and liquid oxidizer react to produce a superheated, highly pressurized chamber of gas

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

Current Work

- Improve flow regulation design by reworking gears
- Successfully test hybrid engine and work towards an optimum design using STFR V2
- Integrate thrust vectoring system onto the propulsion system
- Create accurate launch simulations with real-life data from the hybrid engine and rocket geometry

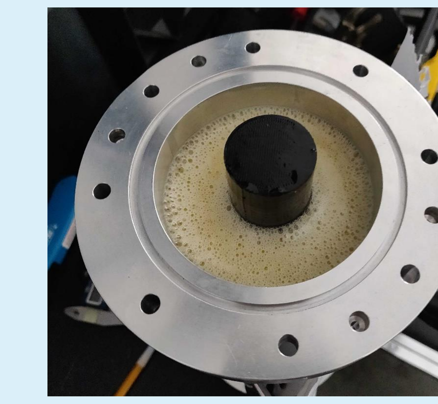


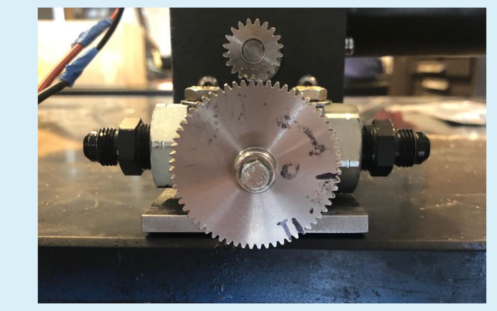
Acknowledgments

A huge thanks to all the members of UNH SEDS, Scott Campbell, Dr. Ivo Nedyalkov, Dr. Alireza Ebadi, Sheldon Parent, Andy Globe, Dave Emanuel, Chief Dean, Ronald O'Keefe, TURBOCAM International, Reilly Webb, the UNH Makerspace and our advisor Dr. Todd Gross for all the support

Fuel Selection and Flow Regulation

- Hydroxyl-terminated polybutadiene (HTPB) and liquid nitrous oxide were chosen as the reducer and oxidizer, respectively.
- A mold was 3-D printed to form the HTPB into a circular grain.

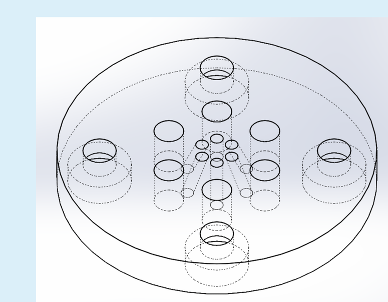




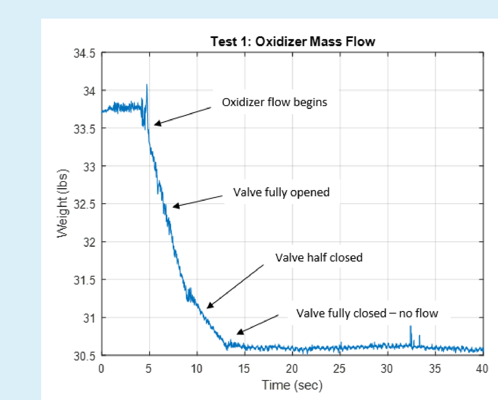
The flow regulator controls the amount of flow into the combustion chamber, permitting throttle, cutoff, and reignition

Oxidizer Injection

Various impinging plates were designed to be tested for ideal atomization of the nitrous oxide for maximum efficiency within the combustion chamber

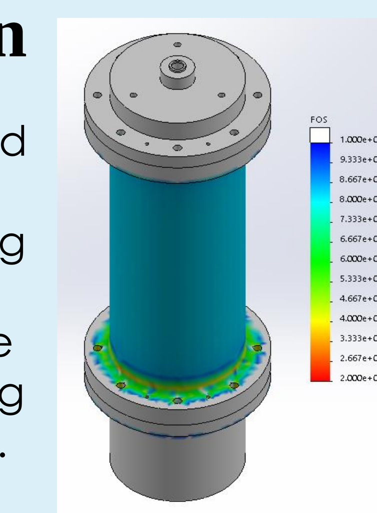


A cold fire test was designed to study overall oxidizer flow characteristics and allow a desired oxidizer flow rate of 1.5 lb/sec to obtain an engine burn time of 10 seconds



Combustion and Ignition

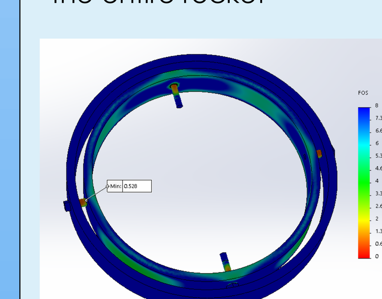
Incoming nitrous oxide impinges and atomizes saturating the fuel within the combustion chamber producing vast amounts of hot, dense gases. A river of hot gases flow through the graphite De Laval nozzle, converting its thermal energy to kinetic energy.



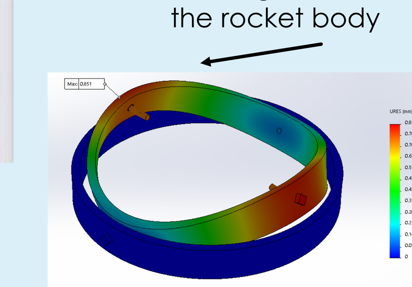
An igniter device is utilized to produce hot gases within the combustion chamber in preparation for oxidizer flow through the impinging plate.

Thrust Vectoring

4 steel pins are used to allow rotation of the hybrid engine while maintaining even distribution of thrust to the entire rocket



A gimbal ring is used to provide a second rotational piece that is placed between the engine and the rocket body



Two actuators positioned 90 degrees apart enable real-time pitch and roll control