**747 Project Proposal 2019**

**Rocket Men**

Group Member Names

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# Objectives

With this project, the team aims to characterize and predict the behavior of various off the shelf solid rocket engines. More specifically, through analysis of the engine thrust and driving pressure, velocity of exit products and transient engine performance can be investigated. Pressure is to be measured with a pressure transducer and disposable tubing will be connected to separate and protect the device from high temperature flow out the end of the engine. Thrust can easily be measured by applying thrust on the surface of a load cell. Most hobby rocketry companies publish data from internal tests to aid in the customers decision. The data includes a thrust vs. time curve and various geometric and weight related measurements. Thrust is determined primarily from the momentum of the outgoing gas as well as the product of the pressure differential at the end of the rocket and ambient pressure multiplied by the nozzle exit area. Typically, momentum of the outgoing gas is the dominant term contributing to engine thrust, however, with information regarding exhaust pressures, the term related to a pressure differential can be approximated. Through this analysis, the contribution of these two terms to the overall thrust can be evaluated, giving nearly all engine parameters.

# Background and Analysis

A rocket engine uses a solid fuel-oxidizer propellant that combusts to produce hot gas bi-products that pressurize and heat up within the chamber. The hot, pressurized gases travel down through the nozzle and converts its thermal energy into a high kinetic energy that creates a momentum differential that accelerates the entire engine in the opposite direction. The two factors that determine the force of an engine is its outgoing gas momentum, and the differential pressure of the engine environment to the atmosphere. The equation below illustrates this.



The overall thrust , and the engine pressure, , will be measured using a load cell and pressure transducer. The area of the throat, , can also be measured via a caliper. The mass flow rate, , can be calculated with the safe assumption that the grain of the fuel burns linearly outwardly and the total burn time. The specific impulse, which defines the overall efficiency of the engine , can then be calculated directly two different way with the equations below.





An overall system error can then be determined, as our overall devices and testing set-up will introduce error that will propagate to our final conclusions. Commercial off-the-shelf engines also are supplied with an overall thrust curve, so our base data can also be compared to the supplier information to ensure that our base data is like what is supplied and assumed.

# Experimental Approach

A static test fire rig with the ability to measure load and incorporate a pressure tube will be used to house the test. The electronics for successful ignition will be pulled from the UNH SEDS team. The data acquisition will be done from the UNH SEDS data cart to ensure reliable and accurate collection. A total of 3 engines will be tested, all the same type to get multiple data sets to get information on how much an engine can vary. This information can be used to help with the errors in simulation within the UNH SEDS team from test launches.

# Equipment Needed

* Pressure transducer with high temperature plastic or metal extension
* 100N Load Cell to measure thrust created by solid rocket engines
* High-speed capable camera for visual analysis and verification
* Hot-fire test rig
* Data acquisition equipment
* Ignition wire and electronic equipment