# Union College 2021 Rocket Team

UNION COLLEGE
FOUNDED 1795

Maxx Jakeway
Structures Engineer
ME Class of 2021

Matthew Larosa
Propulsion Engineer
ME Class of 2021

Giancarlo Sabetta
Flight Controls Engineer
ME Class of 2021

Daniel Gioioso
Payload Structural Engineer
ME Class of 2021

Leo Minami
Payload Electronics Engineer
ME Class of 2021

Lucas Cavendage
Simulation Engineer
ME Class of 2021

Advisor - Professor Andrew Rapoff

## Abstract

The UC Rocket Team annually designs, builds and test a solid propellant rocket capable of launching to 10,000 ft and deploying a payload. Historically, the team has taken the rocket to competition at the Spaceport America Intercollegiate Rocket Engineering Competition (IREC) in New Mexico, in the 10,000 ft commercial off the shelf category. The 2021 UC Rocket comprises five critical mission groups: structures, propulsion, flight controls, simulation and payload. In addition to experimental testing, theoretical simulations of the rocket's flight characteristics and performance were conducted using Rocksim. Due to the COVID-19 pandemic, the UC Rocket Team will be presenting the results of this year's work at the Virtual Spaceport American Competition in early summer 2021.

## Structures

The rocket is 109" in length and is composed of three fiberglass reinforced phenolic tube sections: the aft body, fore body, and payload body. To adhere to IREC rules, the payload body is 6" in diameter, however to increase portability of the disassembled rocket, the remaining sections were designed to be only 4" in diameter. A 3D printed, ABS reducing coupler is used to mate the payload body and the fore body sections, while the remaining sections are connected via plywood bulkheads and shear pins. At different stages during flight, the body sections separate via pyrotechnic black powder charges. The drogue parachute is released from the aft body, the main parachute from the fore body and the payload from the payload body respectively. The aft body section also contains the motor mount for the solid fuel engine, as well as aluminum brackets for mounting the fiberglass fins. Figure 1 presents a schematic of the assembled rocket.

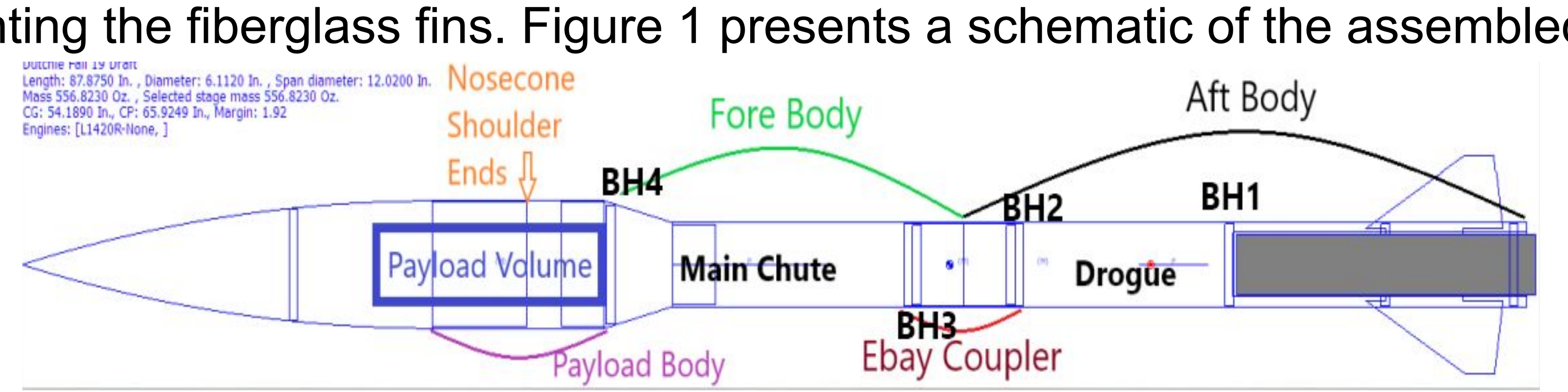


*Figure 1. RockSim outline of Rocket*

## Propulsion

The rocket is propelled by an Aerotech L-class 1365M solid fuel motor. The motor has an average thrust of 1365N over a 3.5 second burn time, giving it an impulse of 4,780Ns. The L-class motor was chosen due to its short burn time and powerful thrust profile and specifically the 1365M motor was chosen because the thrust provided by the motor is capable of propelling the rocket to the desired height of 10,000' according to RockSim simulations. The motor is mounted to the rocket using an Aerotech reloadable motor system, which is aligned vertically inside the aft body tube using centering rings.

## Flight Control

The flight control system is responsible for initiating each phase of rocket flight as well as monitoring, recording and transmitting information about rocket status. The primary flight computer is an Altus Telemetrum which utilizes an ultra low power ARM core processor and a sensor suite comprised of an accelerometer, barometer, and GPS. The Telemetrum is responsible for firing both the apogee and main pyro charges which cause the separation of each body section and the deployment of the drouge and main parachutes respectively. The Telemetrum also logs and transmits all flight data to the ground via 433 MHz. The rocket utilizes dual redundant flight computers such that in the event one computer fails, the rocket remains fully functional.

*Figure 2. Altus Telemetrum flight control computer*

## Payload

The payload is a fully independent system that contains its own recovery system and computer hardware. The payload is deployed at 1500' from the fore body section via gravity after the payload bay charge separates the nose cone from the fore body. The payload bay charge is activated by a barometric altimeter. Once deployed, the payload descends to the ground under parachute. The payload uses a Raspberry Pi micro-computer that interfaces with various environmental sensors and a digital HD camera to record valuable environmental data as the payload descends through the atmosphere. As the payload is likely to land a great distance away from the rocket, the payload also includes a dedicated GPS tracking system, which is separate from the rocket's own recovery systems.

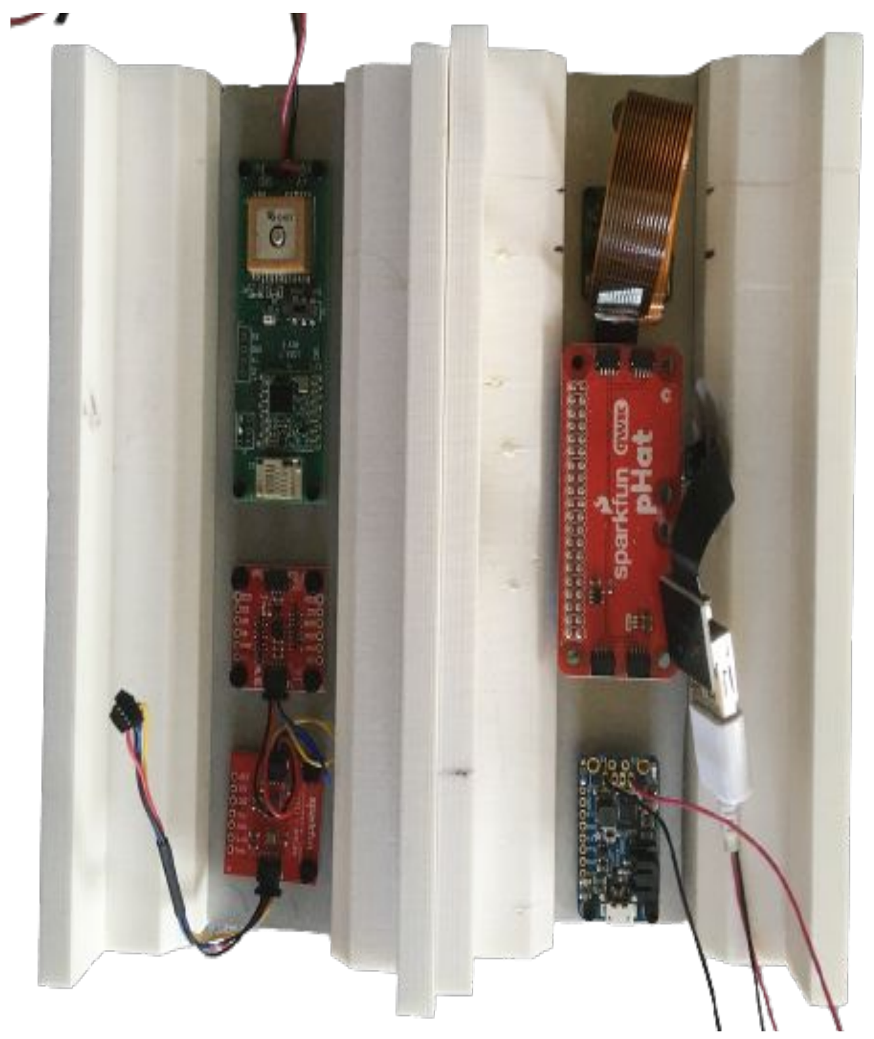

*Figure 3. Payload assembly showing Raspberry Pi and Sensor Suite*

## Simulation

Theoretical simulations were conducted using RockSim to test and design the rocket's flight characteristics and performance. Specifically, RockSim was used extensively to calculate rocket stability under different designs by ensuring a static margin below 2.0. RockSim was used to determine the optimal fin design, as well as in selecting the appropriate motor. During the component testing phase with smaller rockets, RockSim was crucial for the design and stability calculations of these test bed platforms.

**Acknowledgements:** Stan Gorski, Rhonda Becker, Rob Harlan and Paul Tompkins