

Group Mid–Power Rocket Project (GMPR)

Darin Bui, Nathan Ge, Wei Han Chua, Isrrael Sumano
ENGR 96R
Fall 2023

Performance Goals

- Have $1.25 < \text{stability} < 2.5$
- Have a minimum off the rail speed (rail length 6 feet) of 75 ft/s
- Have a time to apogee of less than 15.5 seconds from ignition
 - (ejection charge can be shorter than 14 seconds)
- Come as close as possible to the target apogee of 2,750 ft
- Carry one raw Large Chicken Egg to apogee and recover without breaking

Technical Requirements

- Carry an altimeter to measure apogee
 - Safely recover all rocket components (No ejecting the egg or altimeter and ditching the rest of the rocket)
 - Successfully sit on the launch rail using launch lugs without interference from the fins
 - (1/4 in diameter launch rail, 6 ft approximate)
-
-

Team Roles

OpenRocket Design (Apogee & Stability Optimization) - All

CAD - Darin

Nosecone/Transition - Wei Han

Body tube - Isrrael

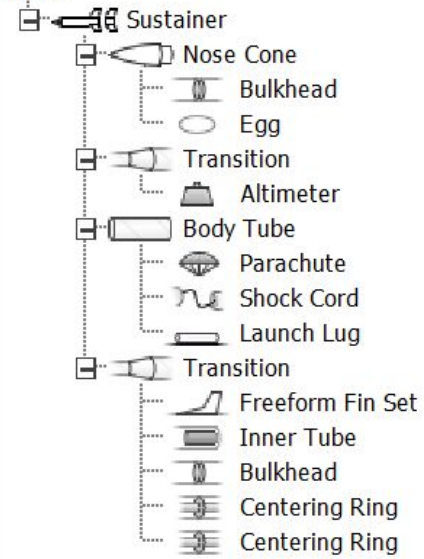
Fins/Boattail - Nathan

Payload - All

Electronics - All

OpenRocket Design

Rocket

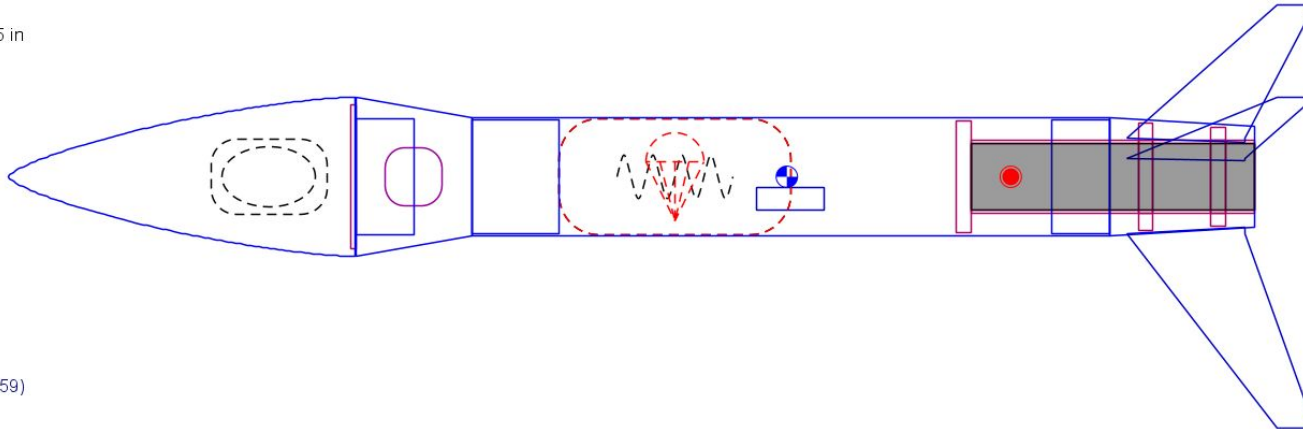


Rocket

Length 22.553 in, max. diameter 2.75 in

Mass with no motors 426 g

Mass with motors 555 g



Stability: 1.41 cal

CG: 13.439 in

CP: 17.303 in

at M=0.30

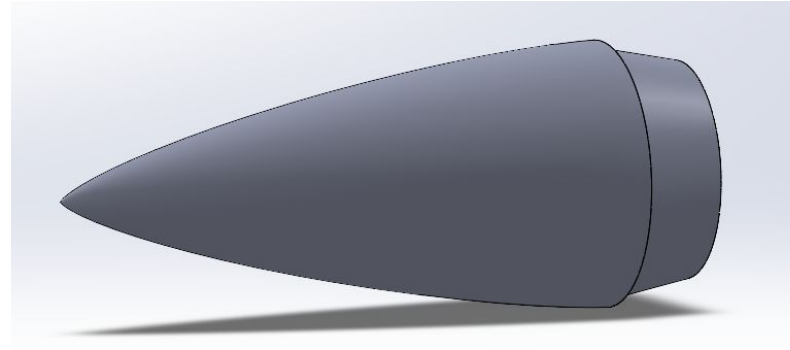
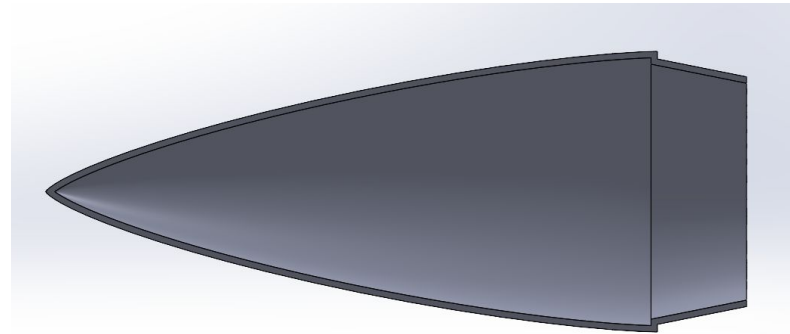
Apogee: 3187 ft

Max. velocity: 660 ft/s (Mach 0.59)

Max. acceleration: 569 ft/s²

Nose Cone

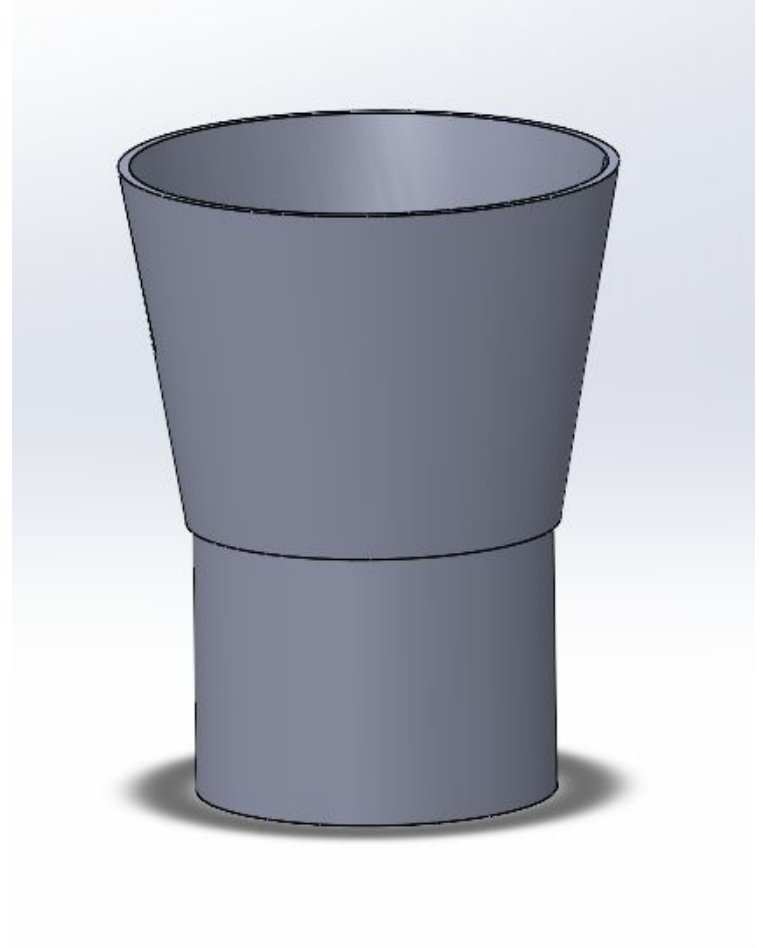
- Haack series
- Shape parameter: $C=0$
- Length: 6"
- Base diameter: 2.75"
- Material: PLA - 3D printed
- Contains the payload (egg)



$$\theta(x) = \arccos\left(1 - \frac{2x}{L}\right)$$
$$y(\theta, C) = \frac{R}{\sqrt{\pi}} \sqrt{\theta - \frac{\sin(2\theta)}{2} + C \sin^3(\theta)}$$

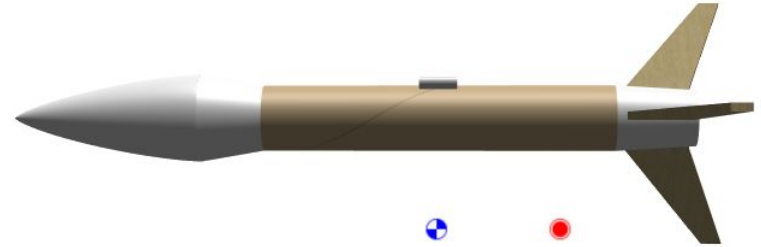
Transition Section

- Conical
- Length: 2"
- Diameter (attached to nose cone): 2.75"
- Diameter (attached to body tube): 2.052"
- Material: PLA - 3D printed
- Contains an altimeter



Body Tube

- Length: 11"
- Outer diameter: 2.052"
- Inner diameter: 2"
- Material: carbon fiber
- Contains the bulkhead to hold the motor



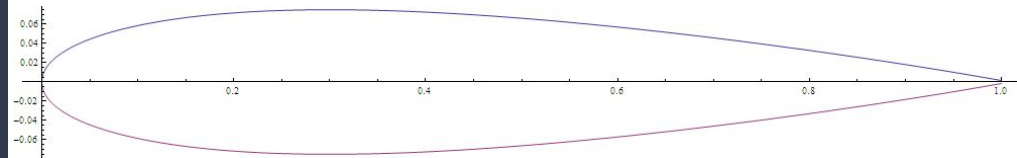
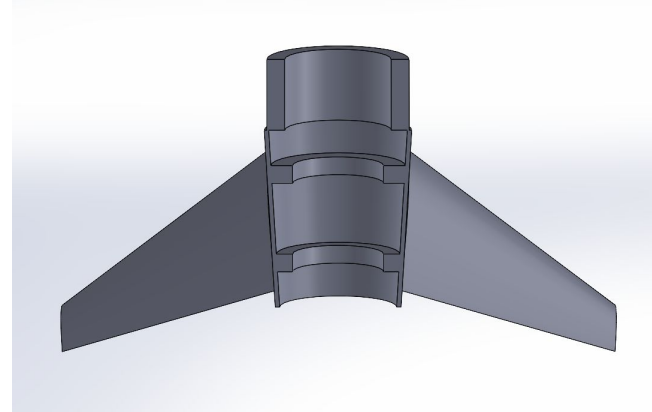
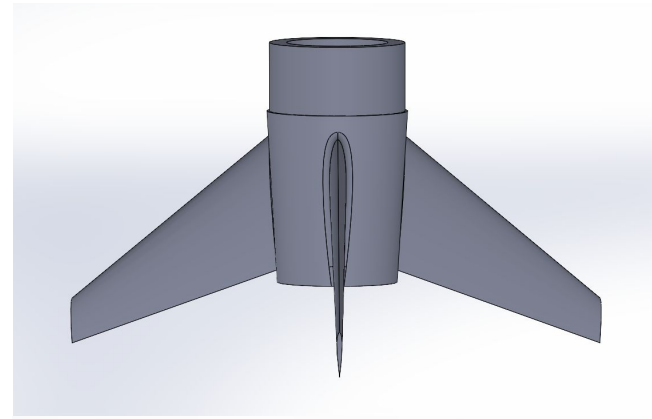
Boattail/Fin Can

- Length: 2.5"
- Diameter: 2.052" - 1.75"
- Material: PLA - 3D printed
- Contains 2 centering rings to hold the motor in place (see next slide)



Fins

- 3 fins
- Material: PLA - 3D-printed with the boattail
- Cross-section: NACA-0012 airfoil

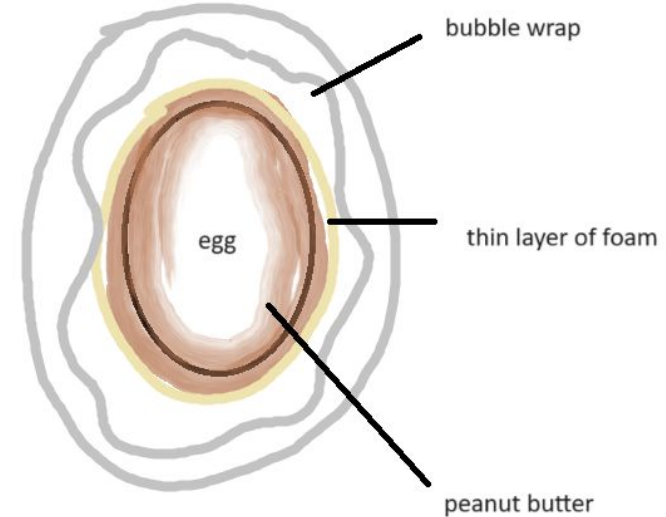


Recovery

- Parachute
 - 30" octagonal diameter
 - 8x 30" shroud lines
- Ejection Charge
 - ~0.4s before apogee
- Descent
 - Time from deployment - 217.37s
 - Ground hit velocity - 15.24 ft/s

Payload

- Egg will be stored in nose cone
- To protect the egg, we plan to use:
 - Bubble Wrap (on the outer layer)
 - Foam (on the inner layer)
 - Peanut butter on outside of egg??



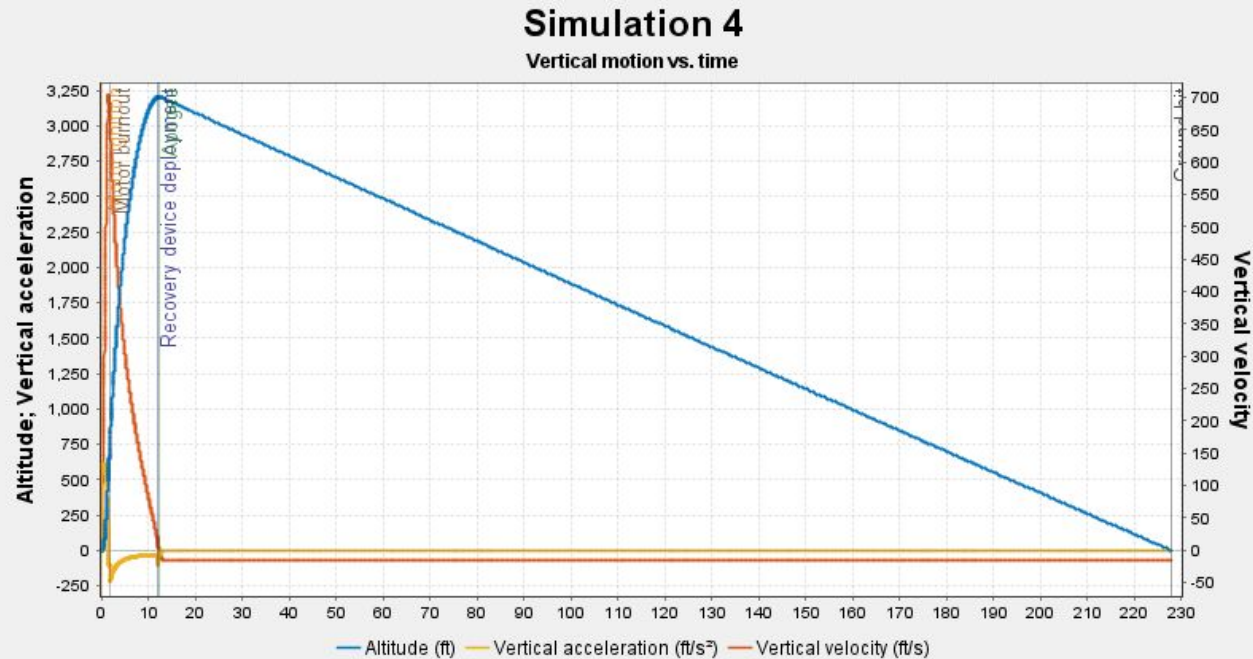
Flight Overview

Apogee	3187 ft
Max velocity	660 ft/s
Max acceleration	569 ft/s ²
Velocity off rod	57.9 ft/s
Time to apogee	12.3 s
Flight time	217 s
Ground hit velocity	15.2 ft/s

Length	22.399 in
Max diameter	2.75 in
Mass (no motor)	426 g
Mass (with motor)	555 g
Stability	1.41 cal

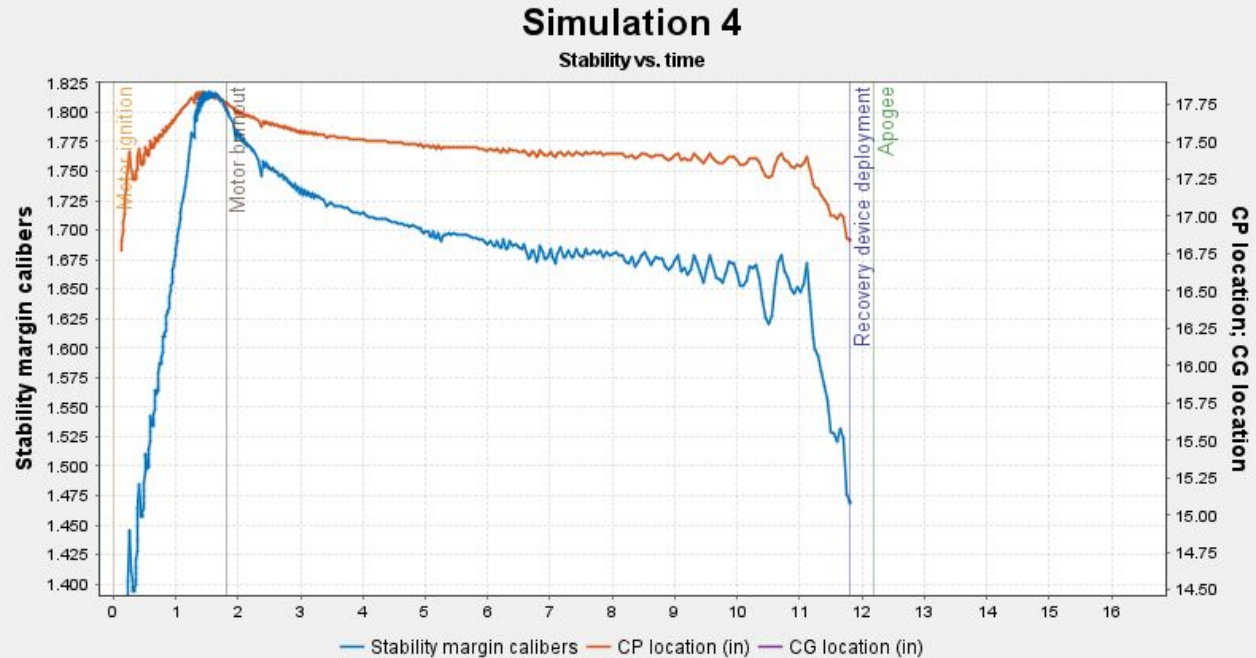
Flight Characteristics

- Predicted apogee: 3187 ft
- Velocity off rod: 57.9 ft/s



Flight Stability

- Stability: 1.41 ca



Project Timeline

Week 6 (current)	Finalise design and CAD
Week 7	3D-print nose cone, transition section, boattail Start work on body tube
Week 8	Complete body tube & parachute Ensure 3D-printed components fit body tube
Week 9	Assemble rocket Prepare for launch