Rocket Level 2 Report

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Contents

Aim

The aim is to try being as close to the apogee of 1200 meters and completing level 2 rocketry. If anything during flight the rocket fails, or if the rocket is not successfully recovered, I will fail to complete level 2 rocketry and would have to restart again next year.

Design overview

Recovery and staging design

The standard parachute is required by NZRA so the rocket will have a parachute made of nylon for the recovery system specifically a double deployment recovery (shown in Figure 1) that will be deployed at apogee. This is a simple recovery system and is consistent in safely recovering the rocket. The variables that I would have to consider is the size and mass of the rocket that will dictate how large the parachute would be to safely recover the rocket.

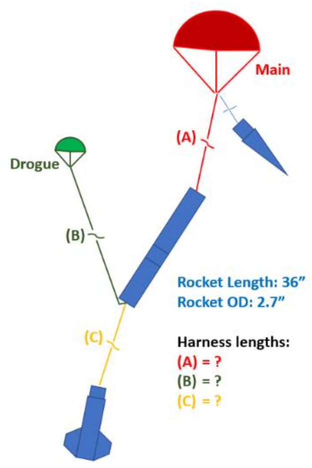

Figure 1: Dual deployment recovery (Recovery Harness Lengths for Dual-Deployment Rocket?, n.d.).

The rocket will lift off from the launchpad and exhaust all the solid propellent (J316 – 8) to reach an apogee of around 1200 meters and will then eject the parachute at apogee to make recovery easier. The landing requirements for the rocket is to land at a maximum velocity of 7.5 m/s with a drogue velocity of less than 40 m/s, this process is shown in Figure 2.

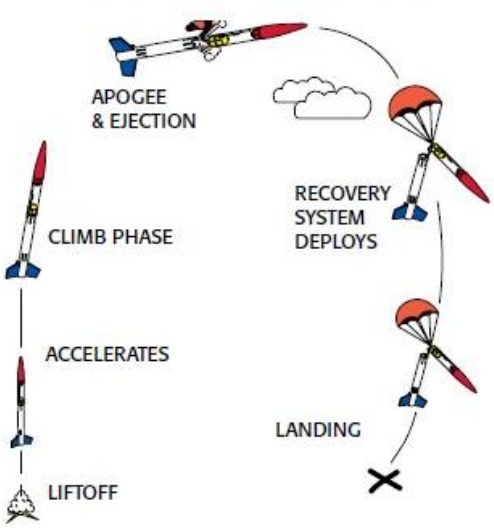

Figure 2: stages of the rocket (High power Rocketry: DUAL DEPLOYMENT Introduction, n.d.).

The drogue parachute will be deployed at apogee and the main parachute will lunch at an altitude of 500 meters. The rocket will land around 7 m/s, thus meeting all the requirements for the recovery.

Material Choices

The materials that are commonly used for student made rockets is carbon fibre and fibreglass as they are easily available, light weight, strong, and have material properties that is suitable for any part of the rocket. Comparing commercial properties of carbon fibre and fibreglass. High quality carbon fibre is more than 20% stronger and has a smaller thermal expansion co-efficient than fibreglass but fibreglass is 3x cheaper than carbon fibre. Fiberglass is not electronically conductive unlike carbon fibre and would not interfere with the flight computer onboard of the rocket. Therefore, fibreglass would be used for the body, fins and nose cone.

Body

The body inner diameter is 70mm with a thickness of 2.5mm fibre glass because there is an abundance of 70 mm mandrels for motor tubes that UC Aerospace can provide. There would be two tube couplers for the parachute to be released, one within the nose (length of 140 mm) and the other in the middle (length of 175 mm) of the rocket. Two centrings with an outer diameter of 67.5 mm, inner diameter of 42 mm and a thickness of 12.7 mm and one motor retainer to hold the rocket motor in place as shown in Figure 3.

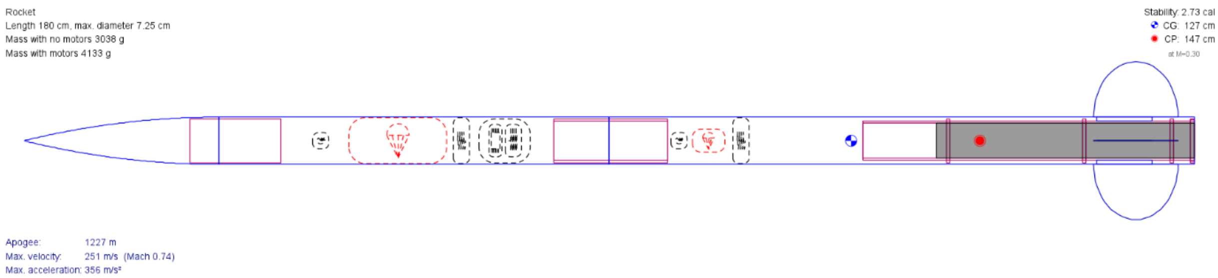

Figure 3: Level 2 Rocket in OpenRocket.

A motor retention will be added to the rocket so that the engine doesn't move forward or backwards. If the engine slides forward it would result in the parachute to deploy prematurely and if it slides backwards the engine will fall out. The motor retention would be made from aluminium because of the temperature of the rocket motor. This will be made in two parts, one to be put on the motor mount and a cap to screw on it after the rocket motor is placed inside.

The mount of the PCB will look like Figure 4 and will be screwed onto the coupler. The reason why it is screwed onto the coupler is because if it is attached to the inner diameter, it would be hard to make it symmetrical or if screws are not being used may not hold the PCB in place properly. Then the PCB will slide into the mount and a cap will be placed on the top of the PCB and screwed on.

Figure 4: PCB mount (Purtzer, n.d.).

Fins

The types of fin options and a simplified explanation of the negatives and positives are shown in Figure 5. Elliptical fins are the final decision as it is the most aerodynamic fin and is the hardest to make, this would be a good learning experience to manufacture difficult shapes with composites. The fins would be 25 mm from the bottom of the rocket to reduce the chances of the fins hitting the ground first and there will be wall fins that goes in 6.25 mm into the rocket so that the fins have a less likely chance to break.

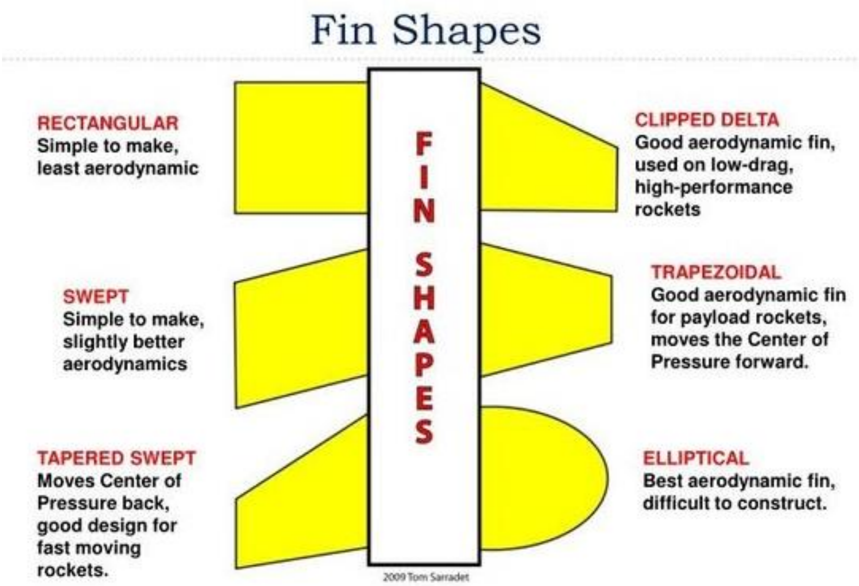

Figure 5: Fin options and explanation (Ackerman, n.d.).

Nose cone

The type of nose cones is conical, ogive, ellipsoid, power series, parabolic series, and haack series. Open rocket simulations, the conical decreases ground velocity and increases apogee, Ellipsoid increases ground velocity and decreases apogee and the other types doesn't change the values of the rocket or is negligible (if the values change by a couple shown in Figure 6). Thus, the final decision is the ogive as the ground hit velocity is below the maximum velocity, the targeted apogee at around 1200 meters doesn't need to be to be increased or decrease and ogive is more aesthetically pleasing.

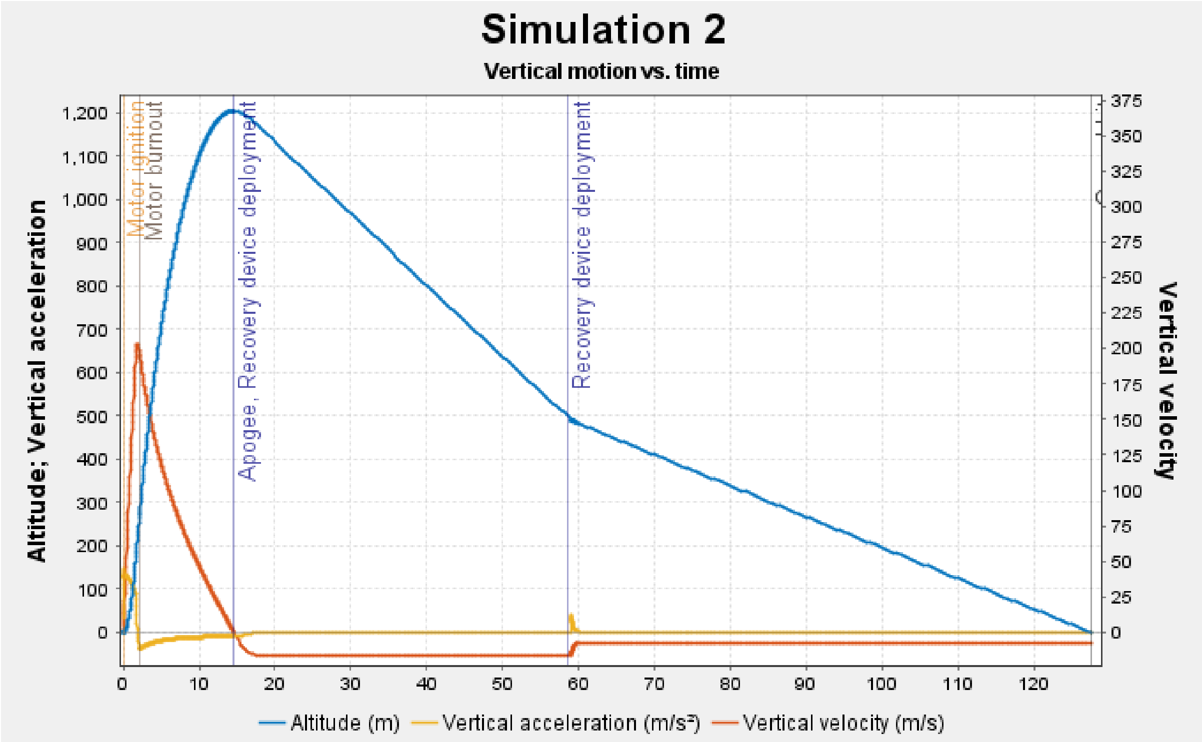

Figure 6: Simulation of how the rocket will perform.

Materials approximation

This is the approximation of the materials that is needed to build the level 2 rocket.

- Fiberglass for the nose, body, and fins: Amount = 500 cm^2
- Aluminium for one motor retainer: Amount = 13 cm^2
- Balsa wood for the two centre rings and the tube couplers: 0 cm^2
- Rope for the parachute: 150 cm
- Nylon for parachute: 15 cm^2

Timeline of the build

This is the goals should be accomplished by each month so that the rocket could be lunched on lunch day.

From July 2024 onwards to February 2025

August:

- Body and nose
- Motor mount
- Parachute

(24 August to 8 September mid semester break)

September:

- Finnish the fins
- Couplers

October:

- Shock cord
- Flight avionics mount

November – Nothing preparing for final year exams.

December:

- Motor retention
- Put it together and paint

February:

- Lunch day

References

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