Rocket Project Final Report

Matt Altis,
Georgia Institute of Technology, Atlanta, GA, 30332
Carlos Mercado,
Georgia Institute of Technology, Atlanta, GA, 30332
John Harrison Bohannon
Georgia Institute of Technology, Atlanta, GA, 30332

Summary of Findings

During the process of designing our rocket, we found that there were many challenges and obstacles that did not seem to exist at the very beginning of the design process. Whether it was last minute 3-D printing rings to allow the small 1/2A engine to fit on our rocket or removing weight to fit the altimeter inside of the body tube, we had to make multiple adjustments to our optimal design. We were not disappointed with the results of our flight, as the simulation accurately represented the experimental heights we recorded.

Nomenclature

A = Cylinder Diameter
C = Chord Length

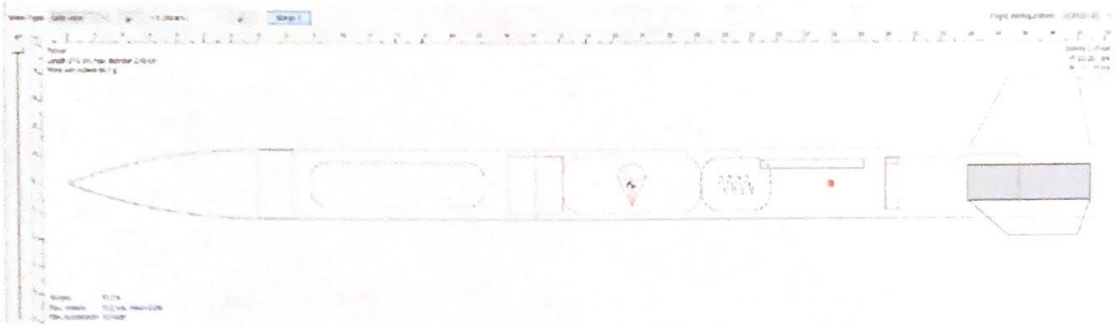
Introduction

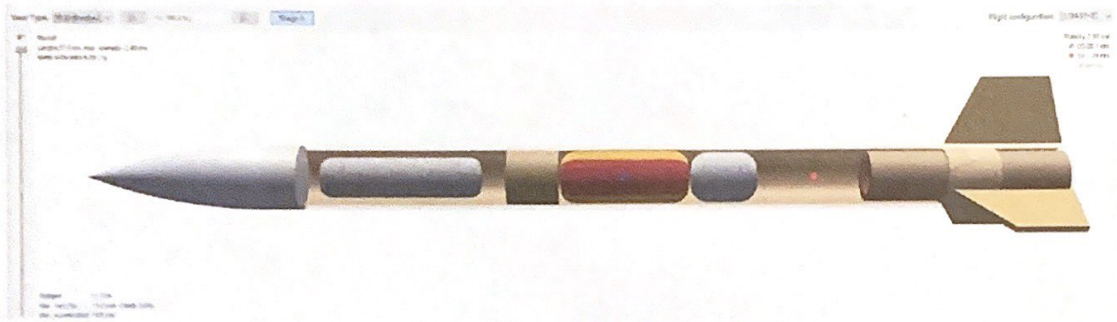
Rockets are an aerospace vehicle that can perform a wide variety of tasks, whether it is launching a payload into outer space or just launching a PNut altimeter to around 100 feet. Thankfully we were assigned with the latter task for this assignment, but we did have to take many factors into account when working around these design parameters. One of the primary challenges of this project was to build our rocket based on the fact that a 1/2A motor would be used to launch it. We had to take the mass and size of our rocket into consideration in order to reach 100 feet with this type of motor. However, we also had to make our rocket large enough to store the altimeter and any extra mass we wanted to add. In the rest of this report, we will further dive into the details of how we sought to overcome these design challenges.

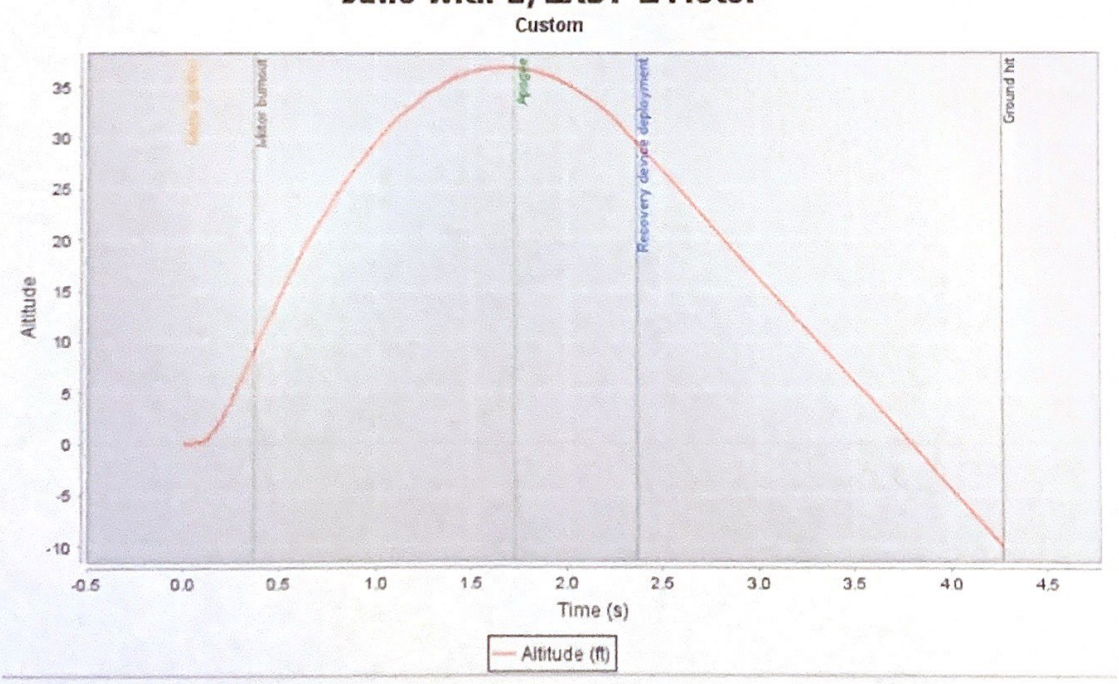
Model Rocket Kit Selection

Carlos:

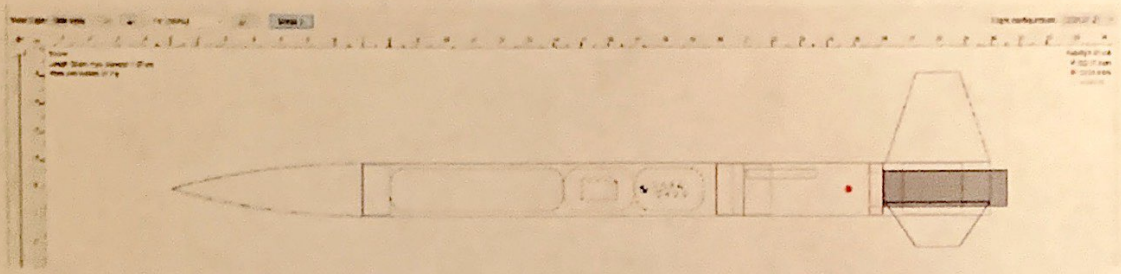
Juno Rocket:

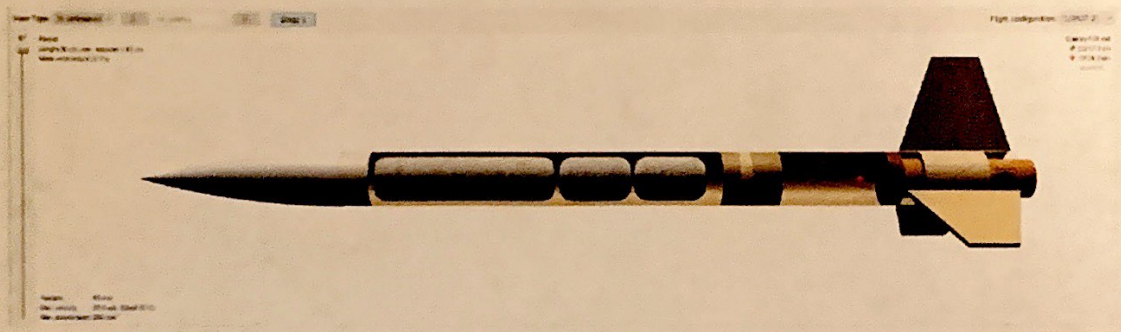






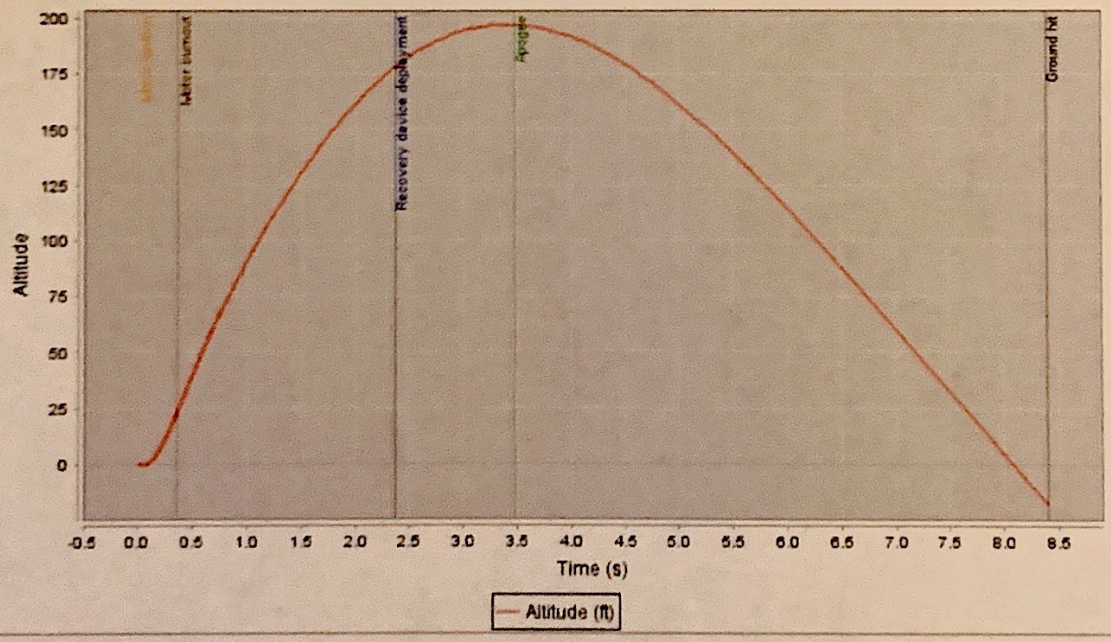
Hebe Rocket Version 1:



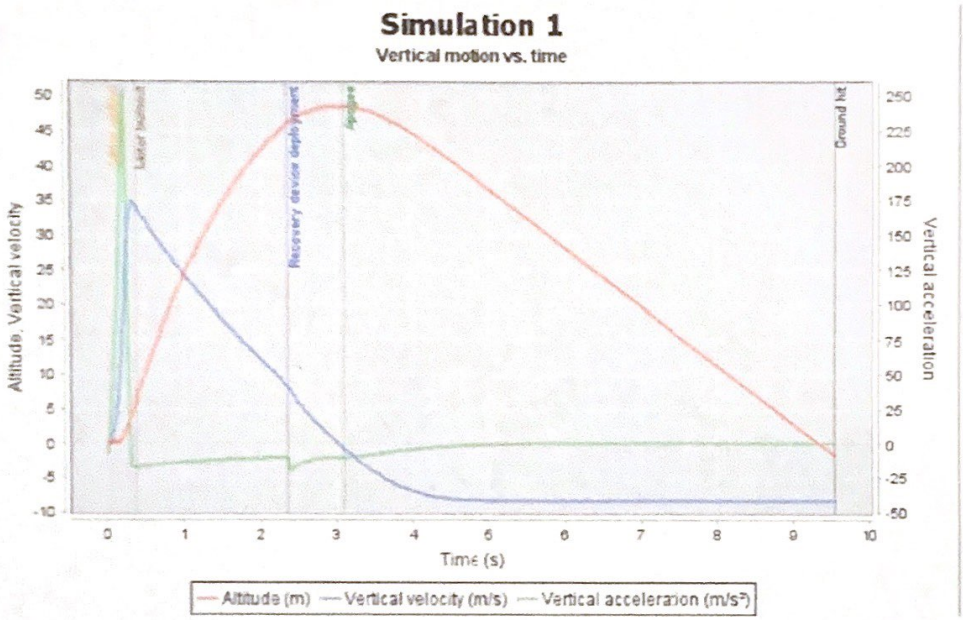


Hebe Version 1 with 1/2A3T-2 Motor

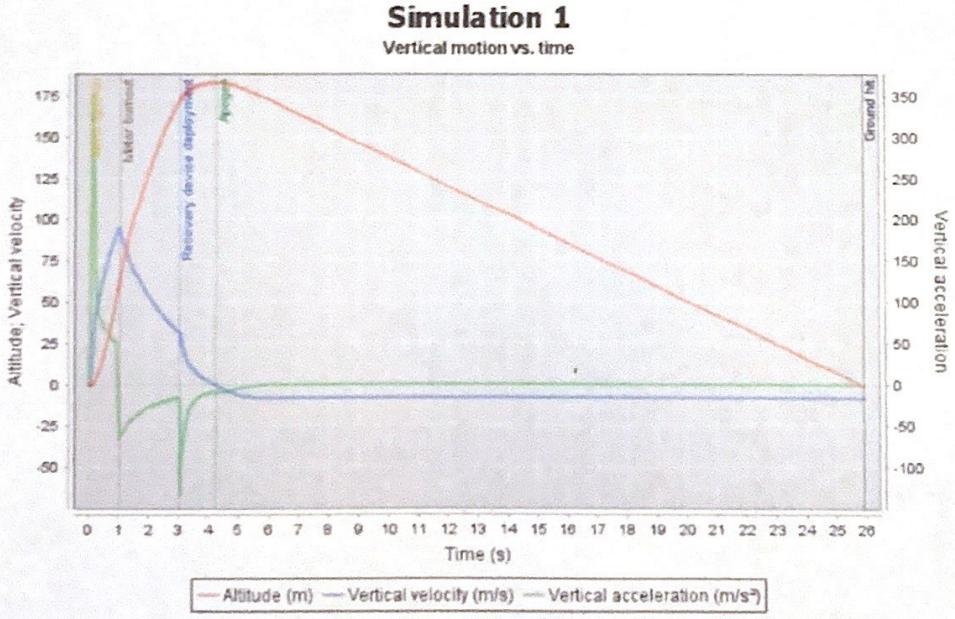
Custom



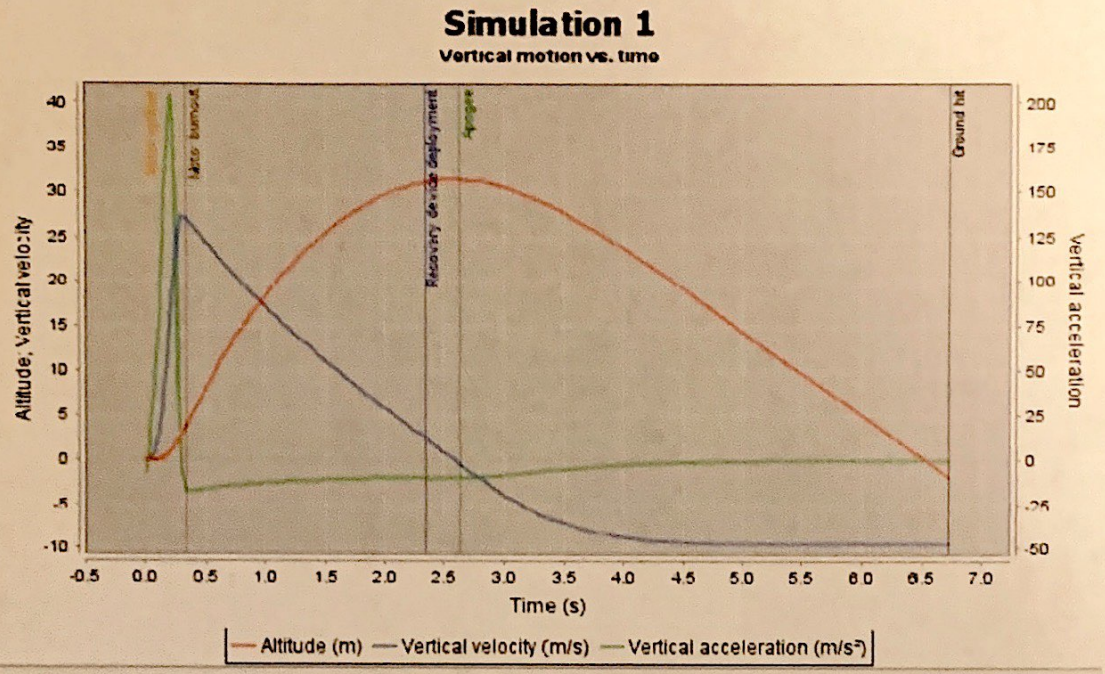
Harrison:



This rocket plot is of the Yellow Jacket by Estes with a 18mm 1/2A6-2 rocket motor. It went about 50 meters.

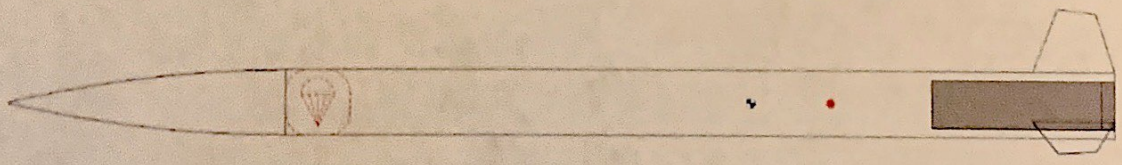


This rocket plot is of the same Yellow Jacket design, except with a B4-2 rocket motor. I wanted to see how high I could launch the rocket given the body it had. It went almost 180 meters.

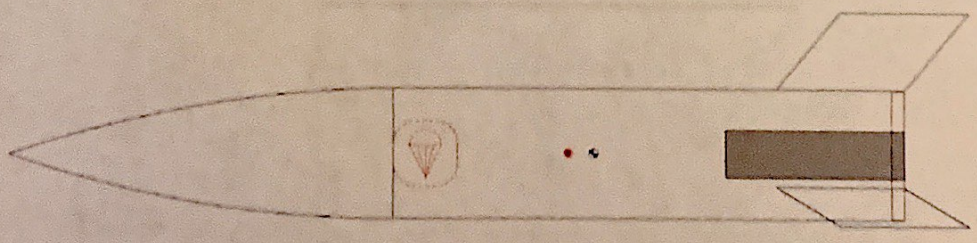


This rocket plot was of a rocket design that I created myself that was trying to get as close to 100 ft as possible. This rocket was powered with a 1/2A6-2 motor, and it got very close to the 100 ft height we needed. It climbed to about 32 meters, which is about 105 ft

Yellow Jacket Rocket:

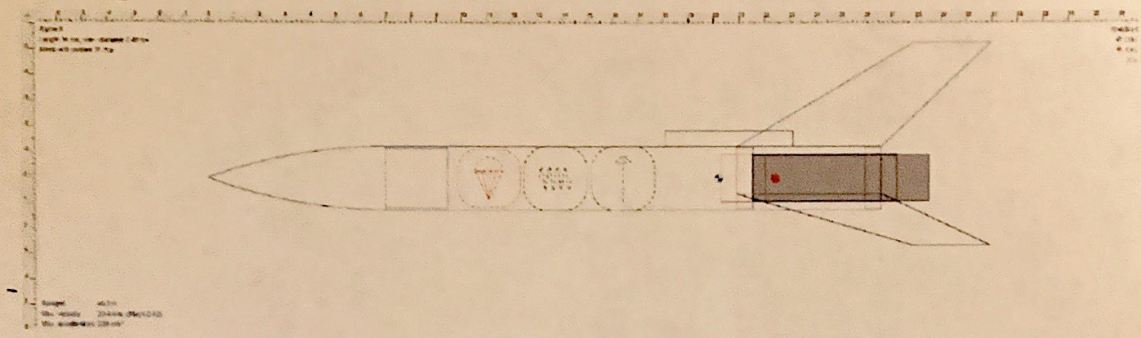


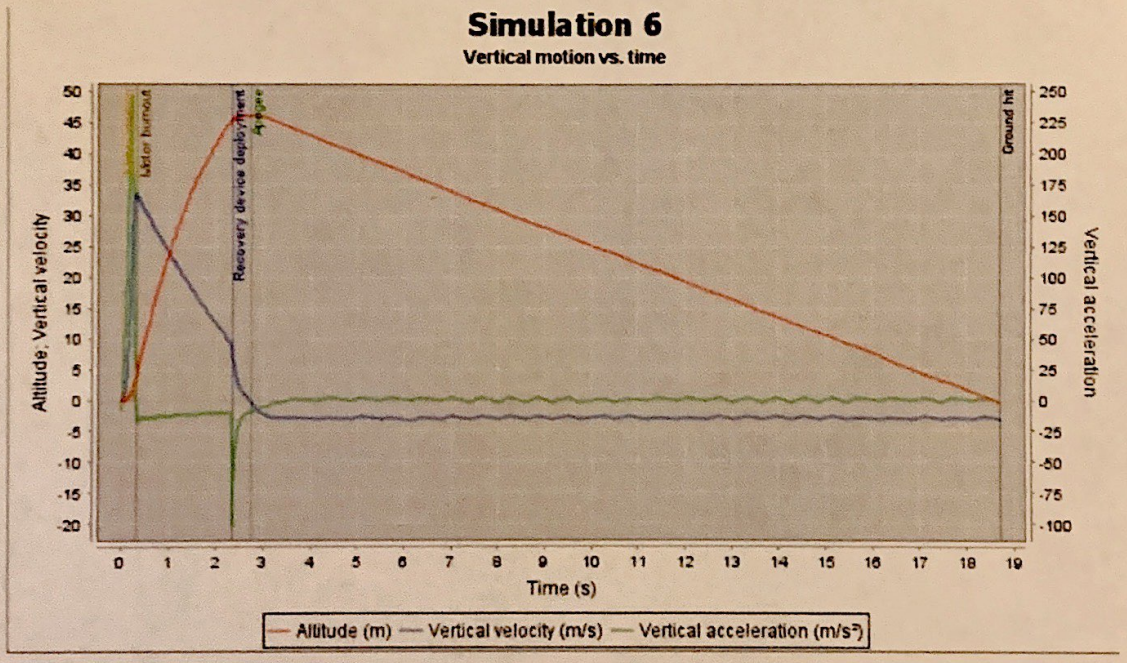
Personal Rocket:



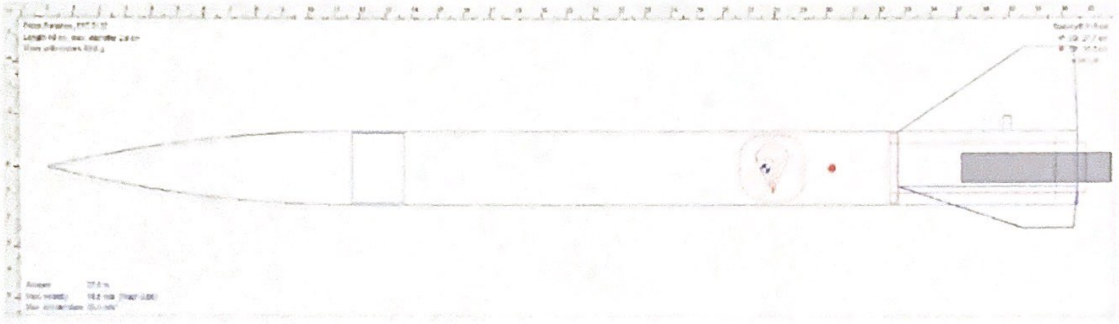
Matt:

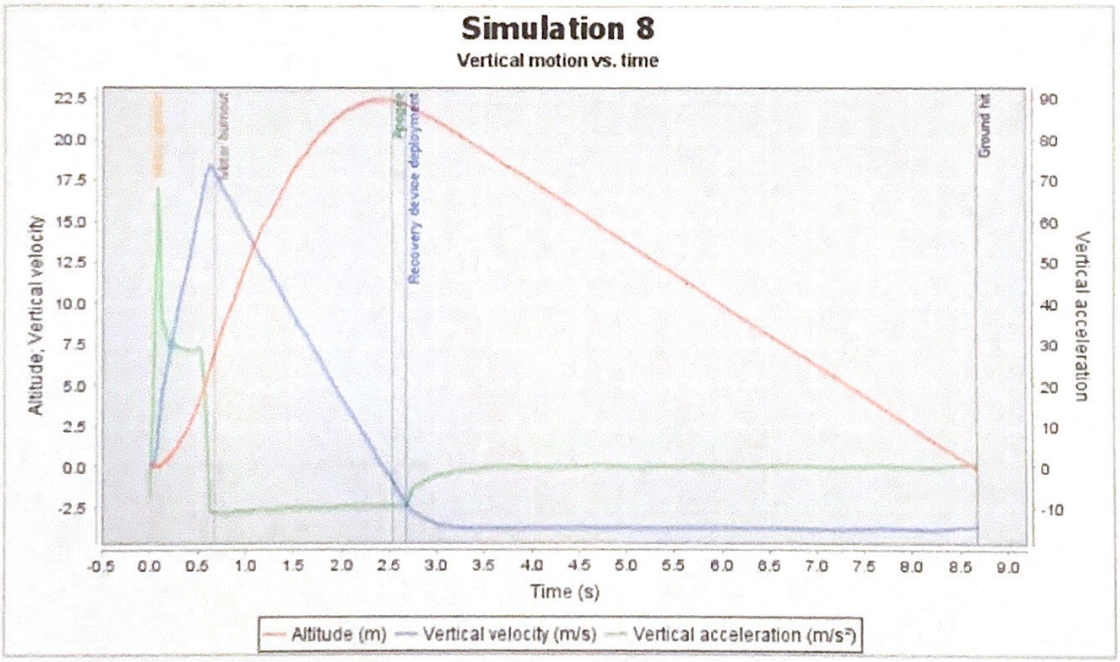
Estes Alpha





Estes Banshee





In the end, we decided to go with the Hebe model that Carlos researched. This model was simple to design and had a predicted apogee of around 200 feet. We would only need to modify the original design to include a section that could protect the altimeter from damage during flight, as well as add mass to the rocket to reduce the apogee below 100 feet.

General Overview of Design Modification

Component	Length (in cm)
Length	35.5
Width	1.87
Fin Length	3.18
Fin Width	3.81

Weight And Balance

Component	Mass (g)	Center of mass location (cm)
Nose cone	4.91	4.5
Payload section	20.53	11.5
Body tube 2	2.68	25.8
Launch lug	0.157	26.3
1/2A3T-2 motor	6.6	33.75
Fins	0.59	33.6

Calculated Center of Mass (Using Table): 18.2 cm

Measured Center of Mass: 18 cm

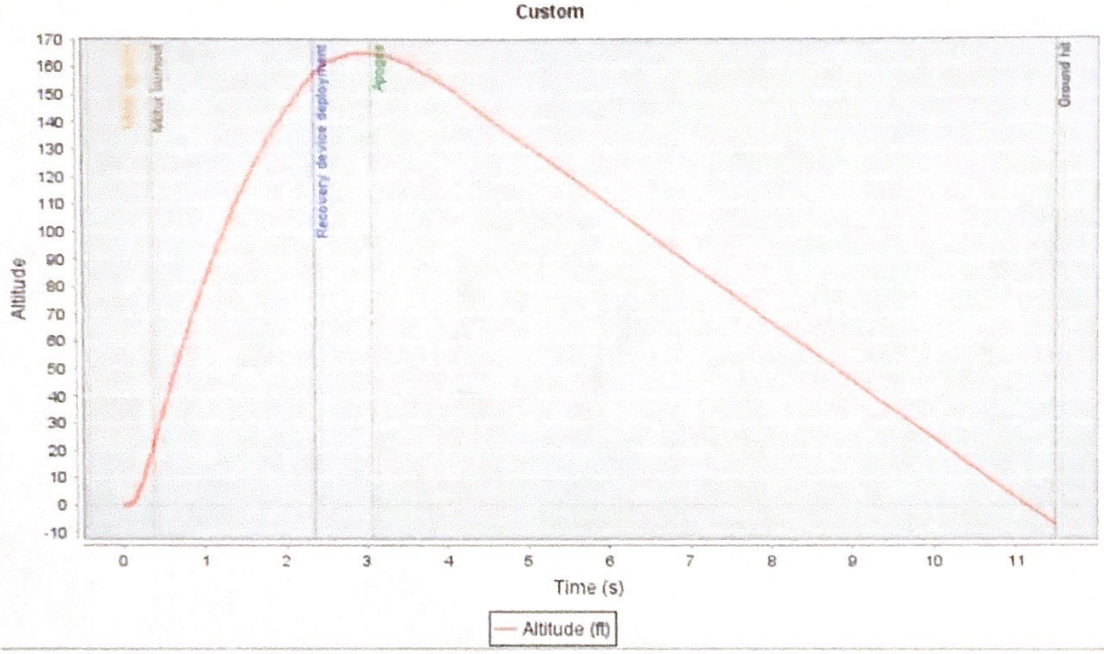
Design Modification Process

The main modification to the Hebe rocket was to include a payload section that would protect the Pnut altimeter from the rocket ejection charge. We did this by creating a section of body tube that was sealed off at the end closest to the rocket motor. This sealed end was made of a cardboard coupling tube with the end closest to the nose covered by a cardboard disc, and the end closest to the rocket motor was sealed with a nose cone cap. The nose cone cap seal has a hook used to attach a shock cord and parachute. The other end of the payload section was attached to the removable nose cone. With a removable nose cone we could easily add components to the payload section. This section of the body tube added an additional 5.5 cm length to the 1st Hebe design so that our final rocket had a total length of 35.5 cm. The main

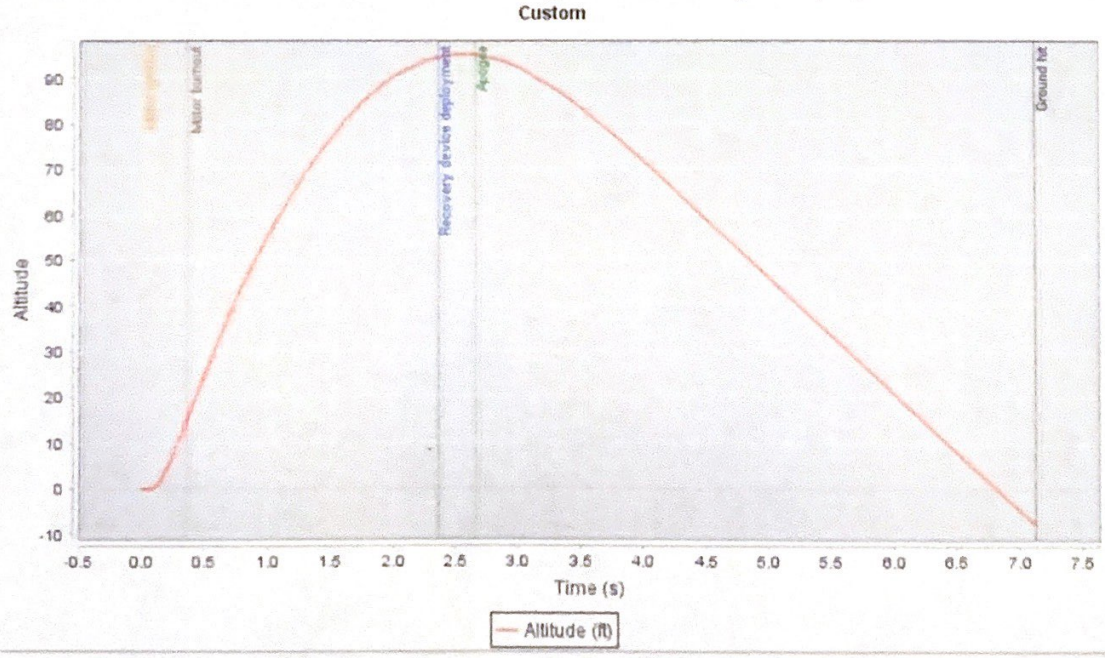
payload was the Pnut altimeter that had 7.3 grams of mass which resulted in a simulation predicting 165 feet apogee. We then added 12 grams of lead weights to the payload section. Adding the lead weights gave us a simulation with a predicted apogee of 98 feet. Lastly, we had to design a smaller tube adapter that would insert into the rocket end to hold the small 1/2A3 engine in place. This required 3-D printing centering rings that would hold the motor mount tube of 1.3 cm diameter inside of the 1.8 cm diameter main body tube.

Modified Hebe with payload section:

Modified Hebe with Altimeter Payload, 1/2A3T-2 Motor



Modified Hebe with additional 12 grams of Payload, 1/2A3T-2 Motor



Flight Test Results

According to the Openrocket simulation, our rocket was expected to reach an apogee of around 98 feet. On one of our flights, our rocket had an apogee of 140 feet. This is mainly due to the fact that we had to remove some of the lead weight to make room for the altimeter. On our second test flight, our apogee was a little bit lower than the first, as we were able to find a way to get the extra lead weight to fit into the payload section. Unfortunately we did not get data for this flight due to altimeter malfunction, but it was most likely closer to the target altitude than the first.

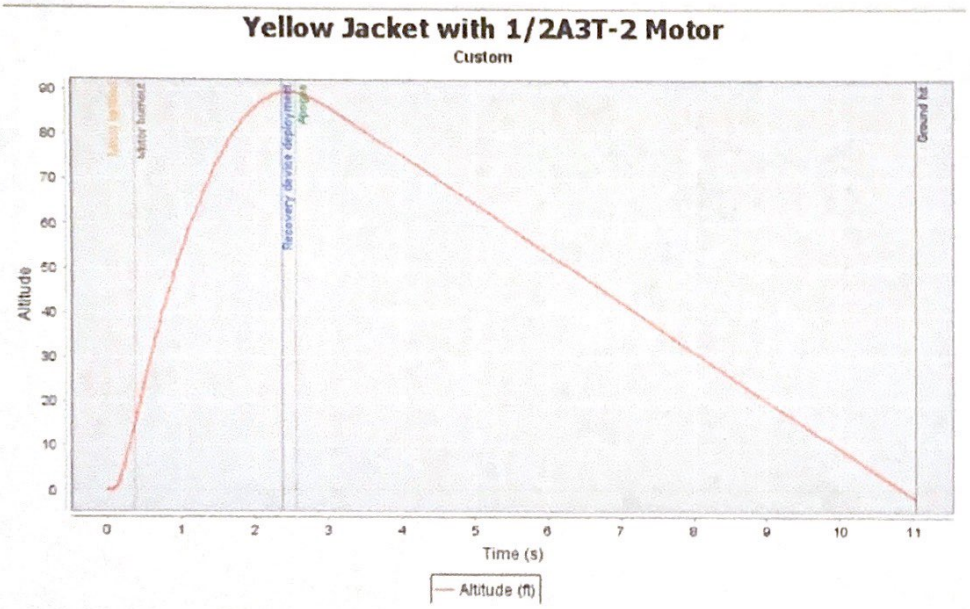
Conclusion and Further Design Improvements

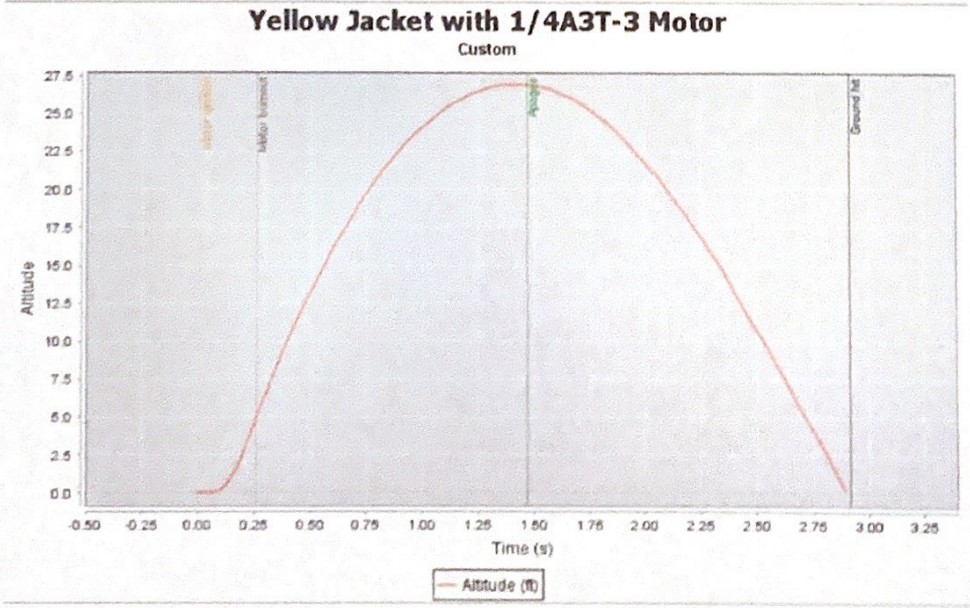
Overall, our rocket performed as expected in the software for our launches. We had no difficulty getting the motor to fit into the tube, but we did find a bit of trouble fitting both the lead weights and altimeter in there. We would need to make small modifications to the space requirements for the additional lead weights. Ideally we would want to design the payload section with a length just large enough to accomodate the altimeter and lead weights in a snug fit.

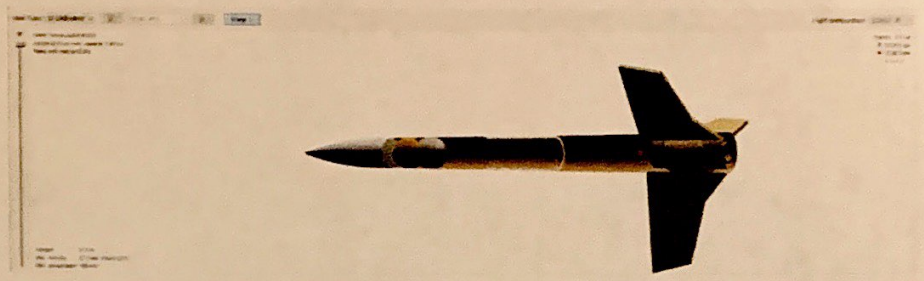
Appendix

Yellow Jacket Simulations:

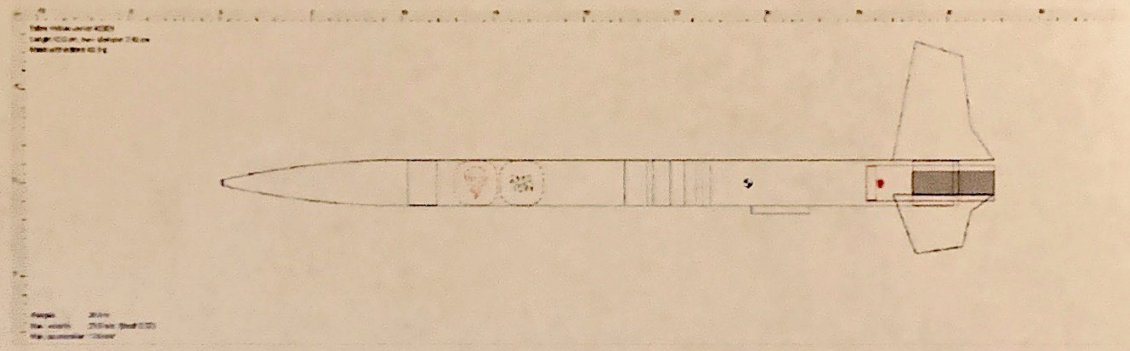
Carlos Mercado:

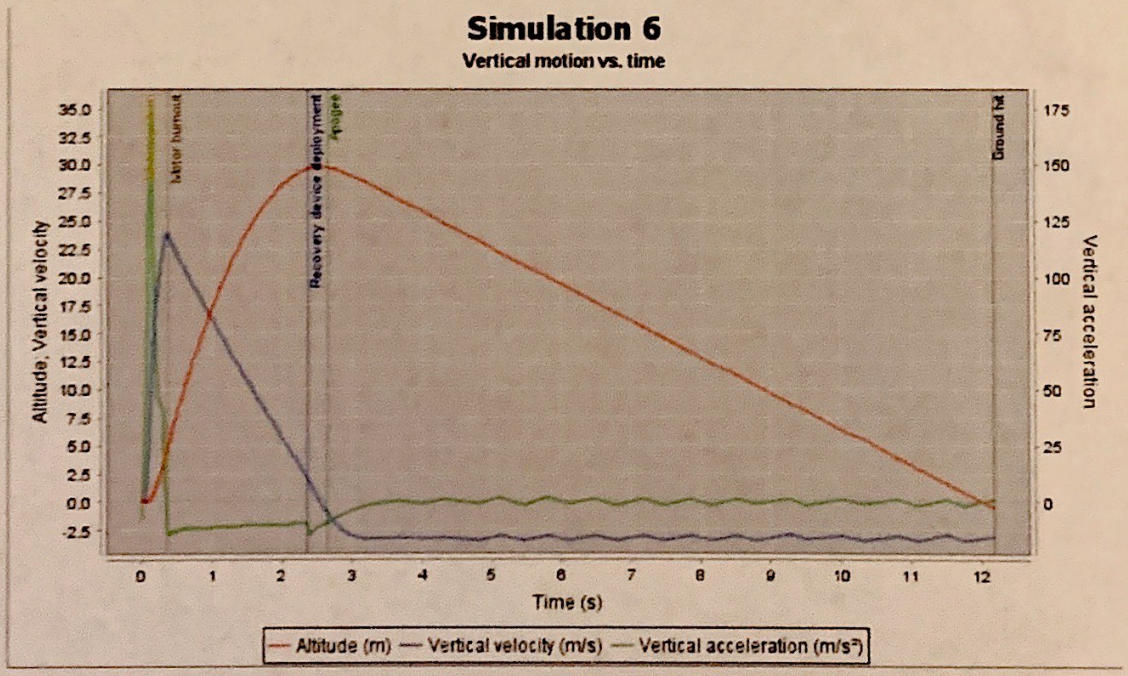






Matt:




Simulation 6
Vertical motion vs. time
Altitude, Vertical velocity
Vertical acceleration
Time (s)
Motor burnout
Recovery device deployment
Apogee
Ground hit
Altitude (m)
Vertical velocity (m/s)
Vertical acceleration (m/s²)