Group Mid-Power Rocket Project (GMPR)
Engr 96 - Fall 2022

Introduction

In groups of 4 or 5, you will be constructing a G-class rocket with a target apogee of 2,750 ft. This project aims to emphasize project management, rocket design, manufacturing techniques, design review presentations, and flight analysis. Your rockets will use some of the most powerful mid-power motors ever!

Project Guidelines

Rocket Design

Ultimately any rocket design you come up with is encouraged as long as it is safe, manufacturable, flies well, and meets all the requirements below. All design decisions on the size, shape, materials, finish, etc will be left to you. However, we will discuss some design options in class and you should feel free to ask the instructors design questions at any time during the process.

Requirements

Your Rocket must:

- Carry one raw Large Chicken Egg to apogee and recover without breaking (extra credit)
- 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 (however the ejection charge can be shorter than 14 seconds)
- Come as close as possible to the target apogee of 2,750 ft
- Carry an altimeter provided by the mentors which will measure apogee
    - Either homemade or provided (jolly logic altimeterone)
- 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)
- Look pretty (paint the outside!)
- Be aerodynamic (make fillets)
- Use one single motor provided (Aerotech G80-10T)
- Be launched by a control box made by YOU

Aerotech 29mm Motor - G80T-10 (apogeerockets.com)

Flight Readiness Review (FRR)

You will create a presentation outlining your design, including the thought process and analysis/calculations behind all notable design decisions. You must also present a manufacturing timeline that considers contingencies and possible setbacks will be presented. Any flight simulation and predictions should also be included. See the example FRR given for more specific direction on format and content.

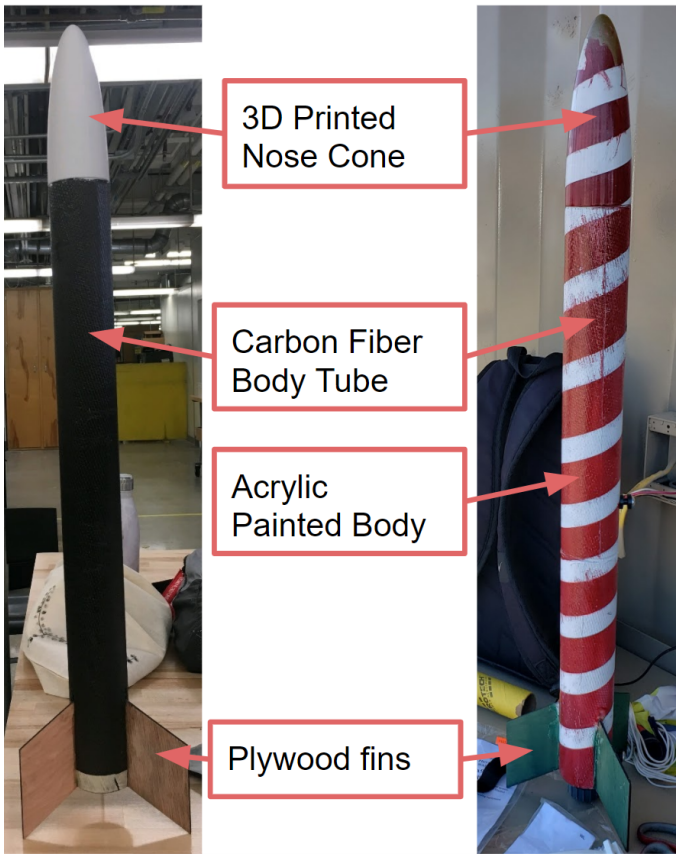
This year we will do post flight reviews where you can present your design and the outcomes of the flight. These will take place Sunday, **November 20**!

Additional Guidelines

Apogee Prediction

Most if not all students will be using OpenRocket's flight simulation tools to predict apogee. To get a more accurate model, make a fully detailed model (consider things such as finish technique, epoxy mass, component materials, and mass distribution).

If you have an interest in developing your own flight simulation using MATLAB or a similar resource, this is also an option. Contact Mark Ferrufino if you're interested in this. You are of course free to explore this option and still use OpenRocket for final predictions.



Additional Guidelines

Fin fitment

Generally, fins have a fin tab section which fits into two bottom centering rings

Slits cut into body tube to allow fins to pass through tube walls

Thrust bulkhead

Will need a hole for ejection charge outlet (protrusion from motor is 0.75” diam)

Motor mount tube

Preferably you will have a motor mount tube run along inside of centering rings that motor will sit within (serves as sleeve for motor so that it does not contact centering rings directly)

Motor tube: 1.140” ID, 1.210” OD

Motor Dimensions:

Length: 4.88 in

Diameter: 1.14 in

** Motor tube will fit this perfectly

General Tolerances

0.010” seems like a relatively good tolerance for any kind of fitment; can be fine tuned

Carbon Fiber or Fiberglass Body Tubes
Inner Diam will be same size as mandrel
Wall thickness approx 0.026”
Maximum Usable length = 23”

Laser Cutting Tolerances
Laser cutter takes off approx 0.015” extra kerf width
e.g. if you want a circle 2.50” OD exactly, make the diameter 2.53” to account for extra cutting on both sides

Laser Cutting Drawings
If using solidworks, create a 2D sketch in a part file then save as .dxf or .dwg. These can be imported into CorelDraw, which is the drawing tool used by the laser cutters in the makerspace.

Can also use a pdf. Dimension parts in powerpoint and save as PDF. Make sure all the angles & dimensions are correct though

[30" Printed Nylon Parachute (apogeerockets.com)]

Pictures (ignore terrible epoxy)

*4 fins w/ fin tabs, 2 centering rings with fin slits, 1 centering ring w/o slits, thrust bulkhead

*note: These do not include a motor retainment tube

Available Materials (subject to change dependent on availability)

Raw Materials:

- **¼” plywood**
- **Pre-impregnated Carbon Fiber sheet**
- **3D printing capabilities (PLA)**
- **Various Paints, Bolts, Epoxy**
- **Mandrels for Carbon Fiber (2”, 2.5”, 3.00”) (3” most available, recommended)**

Rocket Parts:

- **Aerotech 29mm Motor - G80T-10 (apogeerockets.com)**
- **30" Printed Nylon Parachute (apogeerockets.com)**
- **Shock Cords**
- **Altimeters**
- **Rail buttons (similar job as launch lug)**
- **Standard Airfoiled Rail Buttons (fits 1 Rail - 1010) (apogeerockets.com)**
- **Flame Blanket**
- **Electronics (optional)**

Some Ideas for Additional Design Features

- Transition section
- Custom avionics package
- Custom altimeter
- Method to facilitate retrieval in the desert (GPS Tracking, Beeper)
- Custom ejection system
- A boattail
- Other suggestions are welcome! Contact your mentors.

Design Features Not Allowed

- Adding a second motor, such as for a powered second stage
- Active control surfaces
- No animals

Grading Rubric

Unless otherwise noted score interpretations are as follow:
5: excellent, 4: very good, 3: good; 2: mediocre; 1: poor (x2 for 10pt categories)

Project Outline & Timeline Thoroughness of outline & timeline with proper contingencies. Agreement of planned & actual progress.	/5
PDR Professionalism of materials & presentation; thoughtfulness of design decisions	/5
Rocket Build Sturdy & flightworthy airframe; aesthetic appeal & finishing touches (e.g. chamfers, bevels, rounded corners)	/5
Rocket Innovation New and/or creative additions to your rocket design, addition of payload (chicken egg or homemade altimeter)	/10
Rocket Launch Begin with 10. Subtract 2.5 for unsuccessful recovery. Subtract 1 for every 500 feet away from predicted apogee.	/10
Final Presentation Accurate representation of flight results. Thoughtful analysis of weak points and improvement areas in flight & design/build.	/5
Total	/40

30-40 = A+ 20-30 = B 10-20 = C <10 = D

Course Bonus Point Opportunities

In accordance to the class syllabus, there will be the opportunity to obtain up to 10 bonus points towards your final grade. Any points above 40 gained on this assignment will go towards the bonus points for your overall grade.