PROJECT: **Messenger**

VALID THROUGH: **Preliminary Design Review (see *Project Cycle Schedule & Guide 2020-2021*)**

PREPARED BY: **Rob Davis, Technical Planning Committee**

Revision	List of Changes	Date
0	N/A	10 – 1 – 2020

1 - PROJECT DESCRIPTION

Design and manufacture a *CUNY Experimental* Series Sounding Rocket to be flown in the 10,000-foot apogee, commercial off-the-shelf (COTS) propulsion category of the Intercollegiate Rocket Engineering Competition (IREC) at the 2021 Spaceport America Cup (SAC).

2 - RESOURCES & REFERENCES

Engineering & Operations Shared Drive Library

Elements of Rocket Propulsion & *Rocket Propulsion* are the two main rocket engineering textbooks (see above)

Aspire Space Technical Papers

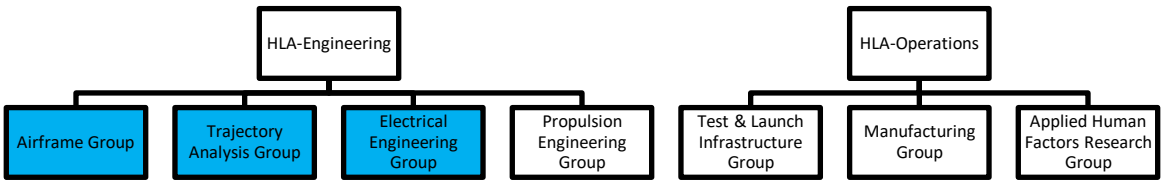
Collegiate Rocketry Slack Channel

NAR Handbook

Make: High Power Rockets

Advanced Model Rocketry

3 - PROJECT RESOLUTION



The three principle Groups involved in Project Messenger are Airframe, Trajectory Analysis and Electrical/Computer Engineering, though the project may require others. The breakdown of each Group into Sections and sub Sections is as follows:

- Airframe Group
  - Aerodynamics Section
  - Structural Engineering Section

- Electrical and Computer Engineering Group
  - Recovery Systems (SRAD and COTS) Section
  - GPS Tracking Requirements Section

- Trajectory Analysis Group

4 - MAJOR SYSTEMS, STRUCTURES AND COMPONENTS BY GROUP/SECTION

1. Airframe
   a. Phenolic Body Tubes (2)
   b. Nosecone (1)
   c. Main Fin Set (1)
   d. Mid-Body Fin Set, if any (1)
   e. Motor Mount (1)
   f. Cubesat Payload Test Bed (3)
   g. COTS SRM (1)
   h. Motor Retainer (1)
   i. Rail Buttons (2)
   j. Rail Button Hard Points (2)

2. Recovery Systems
   a. RAPTOR CO2 Ejection System (2)
   b. Shock Cords

c. Tether Descender (1)
d. 72” Main Parachute (1)
e. Main Parachute Bag (1)
f. 36” Drogue Parachute (1)
g. Forged-Type Eye-Bolts

3. Electrical Systems
    a. COTS GPS / Recovery System Initiator Solution (ESRA GPS Requirement)
        i. Primary COTS Recovery System Initiator
        ii. GPS for Rocket Recovery
    b. Raven3 Altimeter
        i. Secondary COTS Recovery System Initiator
    c. SRAD Recovery System
    d. Power Supply
    e. Electrical System – CubeSat Test Bed Interface

5 - DESIGN BASIS

As the hybrid engine will be flown at the 2022 Spaceport America Cup (SAC) hosted by the Experimental Sounding Rocket Association (ESRA), the design must comply with the last revisions and relevant sections of:

ESRA Design, Test and Evaluation Guide
SAC Range Standard Operating Procedures
IREC Rules and Regulations

All of which can be found here: http://www.soundingrocket.org/sa-cup-documents--forms.html

Technical Planning Committee may also establish further guidelines based on the National Fire Prevention Association (NFPA) consensus codes, particularly:

1127 - Code for High Power Rocketry

Though it is not the responsibility of the design teams to be familiar with them, NFPA Codes are available for free electronic viewing here: https://www.nfpa.org/Codes-and-Standards/All-Codes-and-Standards/Free-access

In addition to these requirements all design teams are expected to obey all safety rules and best practices observed at CCNY, the chosen test location and those currently being observed in the collegiate rocket engineering community.

6 – CUNY Experimental (CX) Characteristic Features

CUNY Experimental (CX) sounding rockets are single-stage, single-motor sounding rockets employing the same general features:

1. COTS Solid Rocket Motor

    1.1. Traditionally, but not necessarily the M750W. Preferred for its long burntime and gentle thrust profile.

    1.2. https://thrustcurve.herokuapp.com/simfiles/580ee54e0002e90000000297/

2. Non-Pyrotechnic Parachute Deployment (NPPD)

    2.1. RAPTOR CO2 Ejection System

        2.1.1. https://www.tinderrocketry.com/raptor-co2-ejection (instruction manual)

        2.1.2. https://fruitychutes.com/buyachute/co2-ejection-system-c-20/peregrine-raptor-co2-system-kit-23-to-45-gram-p-183.html (other listed features)

3. Attitude Triggered Recovery (ATR)

    3.1. Use of a gyroscope to initiate the drogue chute deployment at apogee

    3.2. Apogee is the location when the rocket is moving the slowest, i.e. the shock forces on the airframe will be the lowest

    3.3. Altimeter-based drogue chute deployment, by comparison, occurs when the rocket is in a dive, i.e. the shock forces on the airframe will be comparably large

4. Wood, Fiberglass and Phenolic Construction

    4.1. Simple building materials readily available, affordable and with proper craftsmanship, structurally sound to over Mach 1

    4.2. Process of “Lamination” of fins and bulkheads with fiberglass dramatically increases strength

    4.3. Fiberglass shreds mixed with resin until “snotty” makes for an incredibly strong adhesive for fillets

Recovery System Electronics			
Recovery System	Near-Apogee Drogue Chute Deployment Initiating Sensor	Main Chute Deployment Initiating Sensor	Notes
SRAD	Gyroscope $\alpha = setvalue$	Altimeter $h = setvalue$	The method of using a gyroscope to initiate the first deployment event is called "Attitude-Triggered Recovery".
COTS	Altimeter $\frac{dh}{dt} < 0$	Altimeter $h = setvalue$	This may or may not be accurate for a given COTS system. It is the responsibility of the designer to do their own homework.

Recovery Systems Concept of Operations

(See ESRA Design, Test and Evaluation Guide for definition of "armed")

1. Unarmed Ascent

   Recovery Systems are unarmed until rocket motor burnout.

2. Armed Ascent

   Recovery Systems are armed after rocket motor burnout.

3. Armed Descent

   Main parachute Recovery Systems is arm sometime between rocket motor burnout and just after apogee.

7 - ENVIRONMENTAL, HEALTH AND SAFETY CONCERNS

A non-exhaustive list of potential/likely hazards across the entire project are listed here for reference in later PDR / CDR presentations:

1. Inhalation hazard
    1.1. Epoxy; work with in a well-ventilated space
2. Irritant hazard
    2.1. Epoxy; wear nitrile gloves
3. Power tool use
4. Compressed gases
    4.1. RAPTOR CO2 Ejection System
5. Environmental hazards specific to the launch location
    5.1. Heat Exhaustion
    5.2. Dehydration
    5.3. Falling debris
6. Hazards associated with travel
    6.1. Fatigue
    6.2. Car accidents
7. Hazards associated with Coronavirus Pandemic
    7.1. Follow all CDC and CUNY recommendations

8 - RECORD KEEPING

Observe good record keeping practices by:

1. Keeping dated design notebooks
2. Commenting Excel workbooks / Matlab code or any computer analysis
3. Ensuring drawings are maintained according to *HLA-Engineering Schematics Labeling Guidelines (2020)* (Contact Mohammad Chowdhury for the latest copy)
4. Maintaining minutes of every design meeting OR filling out a weekly design team summary

9 - SOURCE OF FUNDING

Project Messenger will be funded through Harlem Launch Alliance Inc. grant and donation solicitation and the budget granted to the HLA Undergraduate Student Organization by the Undergraduate Student Government.

10 - COST ESTIMATE

To be made during the Preliminary Design Review (December 3, 2020)

11 - SCHEDULE & DELIVERABLES

See *Project Cycle Schedule & Guide 2020 – 2021*

12 - REFERENCE DRAWINGS

To be updated after the Preliminary Design Review

13 - REVIEWS AND APPROVALS

Preliminary Design Review

Date: December 3, 2020

Minutes and/or Comments: