Tuskegee University Rocketry Club

National Aeronautics and Space Administration Student

Launch Initiative Preliminary Design Review

Atmospheric Measurement and Aerodynamic Analysis

TURC 2015-2016 NASA USLI Team Members

Tyran D. Singleton II	Team Lead	Aerospace Engineering	Junior
Jessica Dedeaux	Safety Officer	Aerospace Engineering	Sophomore
Nick Griffin	Technical Design Team Lead	Aerospace Engineering	Sophomore
Jamal Wilson	Payload Team Lead	Aerospace Engineering	Junior
Jihad Kinsey	Structural/Manufacturing Team Lead	Mechanical/Aerospace Engineering	Junior
John Powell	Equipment Facilities Officer	Mechanical Engineering	Junior
Justin Smith	Educational Engagement Co-Lead	Aerospace Engineering	Sophomore
Erin Johnson	Educational Engagement Co-Lead	Mechanical Engineering	Sophomore
Andrew White	Aerodynamic/Propulsions Officer	Aerospace Engineering	Junior
Amira Collier	Team Lead Assistant	Aerospace Engineering	Sophomore
Uthman Clark	Recovery/Launch Officer	Aerospace Engineering	Sophomore

Team Mission

The goal of Tuskegee University's Rocket Club is to establish an educated base of students who are able to efficiently design, modify, and execute mission purposed rockets. The underlying purpose of the University's participation in the University Student Launch Initiative is to test the effectiveness of jute fibers as a eco-friendly alternative to fiberglass in the design of fins. During the launch, we will be able to test the aerodynamic forces acting on the fiberglass fins.

Facilities

For the the 2015--2016 Nasa USLI, the Tuskegee University Rocketry will be utilizing various laboratory and rooms throughout Tuskegee University college of engineering and Material Science including but not limited to:

- Model Fabrication Laboratory
- Satellite Design Laboratory
- Material Science Lab Downstair
- Material Science Processing Laboratory Farm
- Tuskegee University Wind Tunnel Lab
- Tuskegee University Propulsion Laboratory

Equiptment

Model Fabrication Laboratory

- Band Saw
- Drill Press
- Table Saw

Satellite Design Laboratory

- Oscilloscope
- Optical Table

Material Science Department

- Planetary Vacuum Mixer
- Oven
- Digital Scale

Material Science Processing Laboratory

- Wabash GS-30 Compression Molding Press
- Vacuubrand

Tuskegee University Wind Tunnel Lab

- Large Wind Tunnel

Propulsions Lab

- Transducer And Instrumentation Trainer

Summary of Preliminary Design Review

2.1 Team Summary

Tuskegee University Rocketry Club Tuskegee University 1200 West Montgomery Road Tuskegee, AL 36088

2.3 Payload Summary

The payload gathers measurements of pressure, temperature, relative humidity, solar irradiance and ultraviolet radiation. The measurements will be made at least once every second during descent, and every 60 seconds after landing until 10 minutes after landing. The payload will take at least 2 pictures during descent, and 3 after landing. The payload will have an autonomously orienting camera to portray the sky towards the top of the frame and the ground towards the bottom of the frame. The data from the payload shall be stored onboard and transmitted wirelessly to the ground station.

2.2 Launch Vehicle Summary

Diameter x Length	5.2’’ x 130’’
Mass	23.00lbs
Motor Choice	HyperTek L-200

Changes Made Since Proposal

3.1 Launch Vehicle/Payload additions

- Payload Location 58’’ into airframe
- Payload Altimeters
- Camera
- Thermometer
- Barometer
- Arduinos
- Solar Irradiance Sensor
- Humidity Sensor
- GPS
- UV Radiation Sensor
- Radio Transmitter
- LCD Screen
- Arduino/LCD Integrated User Interface

Changes Made Since Proposal (cont.)

3.2 Structures Subsystem

- Divided Airframe into 4 sections
- Chose Fiberglass instead of Jute Fiber
- Pin Lock Mechanism to Stabilize airframe
- Tether connects 4 sections together during recovery process

Vehicle Criteria

4.1 Launch Vehicle Selection, Design, and Verification

- In order to consider the mission a success, the vehicle must abide by all rules and constraints put in place by the USLI officials.

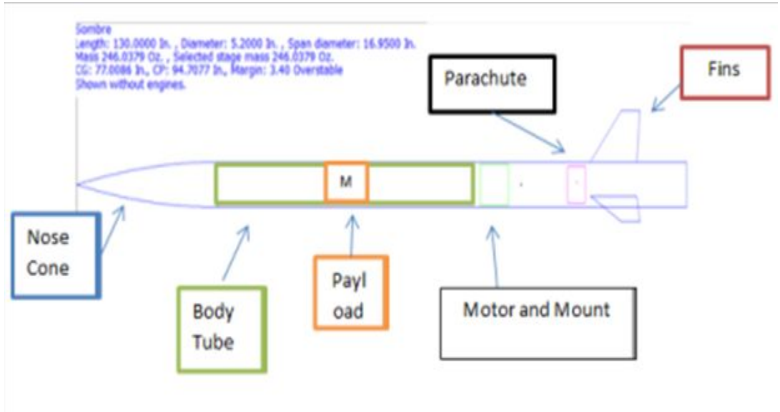
- Projected to reach an altitude of 5280 feet

Vehicle Criteria

4.2 Structure Subsystem

<u>4 .Structural Subassemblies</u>

1. Nose Cone
2. Body Tube
3. Payload/Avionics Bay
4. Motor Mount



Vehicle Criteria

4.3 Propulsions Subsystem

- Projected Weight is 23 pounds
- Calculated estimate of Center of Gravity is 88.859” into airframe
- Calculated estimate of Center of pressure is 94.7077” into airframe

- Based off these Parameters we have Chosen to use a Hypertech L-200 Motor
- This Motor will allow us to reach Apogee at 5280 feet without exceeding our 5400 feet.

Vehicle Criteria

4.4 Avionics Subsystem

To Optimize space within our rocket, we have decided to design the Avionics Bay directly above our payload Bay

Hardware

- PerfectFlite MINIALT/WD
  - Altimeter to control Recovery system
- StratoLogger SL-100 Altimeter
  - Acts as backup incase others fail
- XBee-PRO XSC S3B
  - Send altitude, payload, and GPS information to ground station

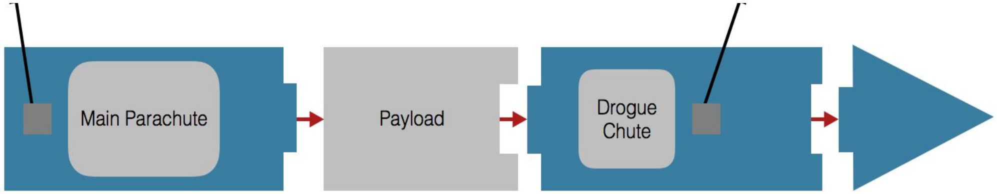
Mounting/Placement

- Each altimeter and gps will be placed in the avionics bay and they will be leveled with each other with an allowable clearance between each of them so that they're able to obtain accurate and consistent measures of elevation.

Vehicle Criteria(cont.)

4.5 Recovery Subsystem

The recovery system will be built into the front and rear body tubes as shown:



1)The front and rear body tubes (not directly related to the system)

2)The gunpowder charge (charge one and two)

3)The altimeters

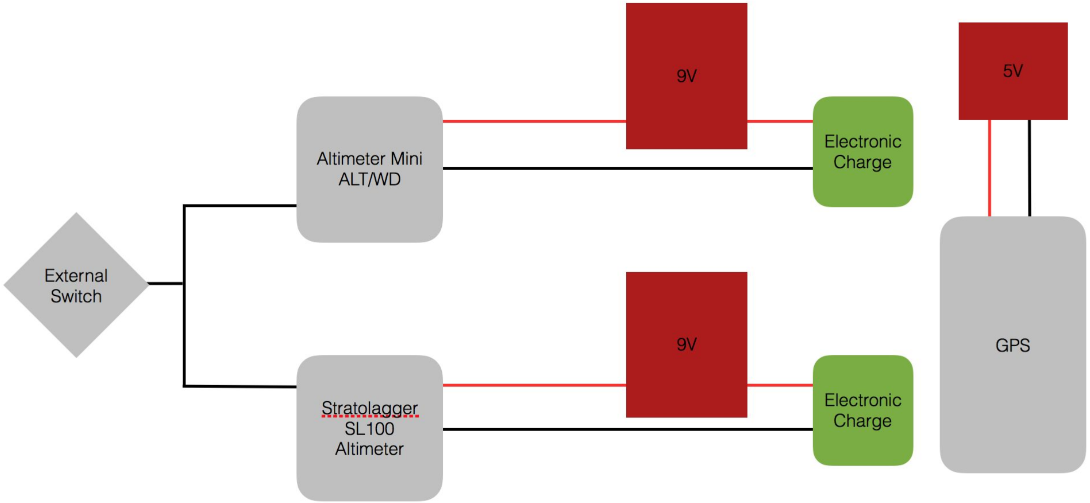
4)The drogue parachute

4.7 Power Subsystems

- Eight 9 volt batteries
- Payload components
- GPS independent power source
- Avionics system.

4.6 Communication Subsystem

- Transmitter(s)
- GPS
- Ground Station



Payload Criteria

5.1 Payload Selection, Verification, and Design

The measurements of pressure, temperature, relative humidity, solar irradiance, and ultraviolet radiation shall be taken with its respective sensors verified by testing, analysis, inspection.

5.2 Payload Concepts Features and Definitions

The complexity of a fully functional and reusable payload is an extreme challenge. We not only have to properly construct the components together but they must orchestrate in a manner that achieves accurate and tangible data. This requires proper interfacing, sufficient power supply, and adequate programming knowledge of all components of the payload. We also have plans to have a lcd screen to visually verify the functionally and results of each test of the payload.

Payload Criteria (cont.)

5.3 Science Value

The payload is designed to indicate the strain of the material on of the fins, study the pressure, temperature, relative humidity, solar irradiance, and ultraviolet radiation of the surrounding air from the time of apogee until either the rocket was recovered or ten minutes had passed after landing. By comparing the measured values to expected values, their credibility could be determined.

5.4 Payload Safety and Environment

Safety officer will assess the issue with proper EPE (rubber gloves, goggles). Safety Officers will move housing equipment to a secure and clean environmentally safe location and disable the payload.

Risk Factors

Chemicals and materials
-Bodily injury: irritation, burns, and allergic reactions
-Work stoppage
-Material Safety Data Sheets of all hazardous chemicals and materials will be available to and reviewed by all members.
-Facilities with fume hoods will be used for caustic materials.
-Protective equipment including, but not limited to, gloves, safety glasses, and filtered face masks.

Misuse of Power Tools
-Bodily Injury: Cuts, Abrasions, and Bruises
- Work Stoppage
-Instructions will be given prior to student use of equipment.
-Experienced technicians or upperclassmen must be present for all machining.

Unintentional Ignition of Igniters or Electric Matches
-Bodily Injury: Minor Burns
-Fire
-Loss of critical supplies
-All electric matches will be shorted together at their ends.
-Proper storage in secure grounded case.

Unintentional Detonation of Black Powder
-Bodily Injury: Serious Burns, and hearing loss
-Ejection charges will be filled last with flight computers deactivated.
-Handlers will wear work gloves and ear plugs.

Risk Factors (cont.)

Unintentional Ignition of Motor
-Bodily Injury: Serious Burns, Bruises, Loss of Life
-Cancellation of Flight
-Property Damage
-All motors stored unloaded without igniters.
-Prepared motors will not be loaded with igniters until mounted on pad.
-Loading must be supervised or performed by Certified personnel.

Component Damage Through Testing
-Increased costs
-Project delays
-Redesigns
-Wearing necessary and precautionary safety equipment.
-Only required personnel allowed in proximity to components during testing.
-Checklists utilized to ensure proper procedures during operation.

Launch and Recovery Problems
-Loss of Vehicle
-Loss of Payload
-Serious Bodily Injury or Death
-Property Damage
-Following TRA/NAR Safety Code
-Use of checklists.
-Cancellation of Launch in event of adverse weather conditions.
-All personnel must be at safe distance before ignition system is armed.

Safety Pledge

1. Tuskegee University Rocketry Club will only fly high power rockets or possess high power rocket motors that are within the boundaries of my user certification and required licensing.
2. Laws and Regulations All federal, state and municipal laws will be adhered to by the Tuskegee University Rocketry Team and all of its affiliates. Of which, the Federal Aviation Administration regulations regarding high power rocketry will be stringently followed. The support the Tuskegee University Rocket under their FAA waiver will be crucial to the team's progress while adhering to this. Ensuring the legality of the team's actions will be the responsibility of the Project Director and Safety Officers. These practices will further ensure the safety of all team members, the public and property. Stated by the FAA are the classifications and guidelines for such amateur rockets as our own in the FAR 14 Code of Federal Regulations, Part 101, Subpart C. This section sets the definitions for classes of amateur rockets, their operating limitations, and required flight waivers. The rocket the Tuskegee University Rocketry Team will construct is regulated under Class 2 – High-Power Rockets. The team is aware that a Class 2 – High Power Rocket requires a certificate of waiver from the FAA at least 45 days prior to the expected flight. It has been verified that the assisting rocketry organization, Tuskegee University Rocket does obtain sufficient waivers for our purposes. The National Fire Prevention Agency regulates the construction and operation of High Powered Rockets (defined under NFPA 1127, 3.3.13.1). The most important are the regulations pertaining to high power rocket motors and low-explosives. As of 2009, the Bureau of Alcohol, Tobacco and Firearms no longer classifies Ammonium Perchlorate Composite Propellant as a low-explosive. This propellant complies with NFPA 1127, 4.19.2.5, which states that exempt rocket motors shall be stored in noncombustible, re-closable containers. For this purpose, a large lockable pelican case fulfilling these requirements has been donated to the team. The explosive the team plans to employ in recovery system pressurization is FFFFg Black powder that will be ignited by electric matches. Both are regulated by the BATFE and the team understands that a Low-Explosive User Permit is required for electric match purchases. However, the team will take advantage of the LEUP exemption afforded by educational use of these regulated products.

Questions?