Critical Design Review

Tuskegee University

USLI 2009

Summary of Preliminary Design Review Report

Team Summary

School Name	Tuskegee University

1. Changes made to Vehicle Criteria

   - The vehicle has changed in overall size from 4.75 inch diameter to 4.5 inch diameter due to the availability of commercially made bodies.

2. Changes made to Payload Criteria

   - At this point, no changes have been made to the payload items. All items presented in the proposal are part of the current plan.

3. Changes made to Activity Plan

   - The following changes have been made to the Activity Plan:

     a. Water tunnel testing has been canceled due to tunnel issues

     b. Electrical testing has been completed on the GPS/Transmitter/Receiver but has not been completed on the Sensors for CO/Temp because they have not been delivered yet.

     c. Rocket body build has started through the testing of materials, but the tubes have been ordered but not delivered.

Team Members

Name	Position	Classification	Major
Brandow W	Student Team Project Manager	Senior	Aerospace Science Engineering
Chris C	Asst. Student Team Project Manager	Senior	Aerospace Science Engineering
Darrian D	Electrical/Science Team Lead	Junior	Electrical Engineering
Adrian G	Electrical/Science	Junior	Electrical Engineering
James D	Mechanical Team Lead	Grad Student	Mechanical Engineering
Lumumba O	Structures Team Lead	Junior	Aerospace Science Engineering
Angelo A	Structures	Junior	Aerospace Science Engineering
Chris H	Structures	Junior	Aerospace Science Engineering
Shayla G	Motor Team Lead	Senior	Aerospace Science Engineering
Brittany G	Motor Lead	Senior	Aerospace Science Engineering

Vehicle Criteria

1. Mission Statement

    - The mission of the Tuskegee University Student Space Launch Experience (TUSSLE) rocket is to carry a scientific payload to a target altitude of 5,280 feet (1.609 kilometers). The structure must be strong enough to withstand the forces of launch, protect the payload, and ensure stable trajectory and recovery for future missions. The design should be such that the rocket is stable enough to provide true trajectory, but not excessively stable so that the rocket turns into the wind and flies horizontal prior to apogee.
    - The scientific payload will calculate and determine the surface temperature, humidity, dew point, and Carbon Monoxide levels in the atmosphere as well as wind speed from apogee to landing. These are some of the primary items that would be considered on distant planets to give a good indication of the inhabitability of that particular planet. Our design is to make the systems rugged but inexpensive and easy to retrieve the data once collected.

2.

e. *No forward firing motors or rear ejection parachute designs* At this point, none of these items are included in the area of possibility and will be avoided completely.

m. *The maximum amount teams may spend on the rocket and payload is $5000 total.* The construction costs will be below this number. See attached budget.

3. Mission Success Criteria: This will be broken down into three separate areas, Mission Success (Complete), Mission Success (Partial), and Mission Failure.

    a. Mission Success (Complete) for vehicle
        i. Completion of flight profile includes:
        ii. Ignition
        iii. Launch and successful separation from launch rail.
        iv. Flight to apogee of approximately 5,280 AGL
        v. Successful deployment of main and lower stage parachutes
        vi. Descent rate of <12 ft/sec for electronics section, descent of <20 ft/sec for

i. Failure to transmit data for more than 50% of the flight
ii. Failure of batteries to prove power during entire flight
iii. Failure of sensors to record data on more than 3 of 4 parameters

Major Milestone Schedule

Event	September	October	November	December	January	February	March	April
Initial								

Vehicle Systems Overview

The following systems are needed for full function of the vehicle throughout the entire flight envelope.

A. Altimeter system for pyros.
B. Pyro systems to ensure proper separation of the desired sections for parachute deployment.
C. Shock cord to provide load attenuation.
D. Parachutes designed to provide proper descent rate.
E. Proper fin design to provide enough stability for flight, but not too much stability to cause wind-vaning.

The following section will deal with the trade studies for materials in regards to the overall construction of the vehicle.

1. Trade studies for Vehicle structure material

Material	**Tensile Strength (MPa)**	**Modulus of Elasticity (GPa)**	**Cost**	**Ease of Machinability**
Kevlar/Twaral	500	75	Medium	Medium
Nylon 6,6	85	3.5	Medium	High
Syalon 101	450	288	High	Low
Zircalon 5	500	205	High	Low
Fiberglass	250	80	Low	High
Carbon Fiber	1100	70	Medium	High

Note: Ease of machinability: High denotes that the material is easily machinable

2. Normalization of Values

Normalization of values

Material	1	2	3
Tensile Strength	<100	<200	>300
Modulus of Elasticity	<5 GPa	<50 GPa	<100 GPa
Cost	High	Medium	Low
Ease of machinability	Low	Medium	High

3. Weighting of items

Weighting factors

Material	1	Reason
Tensile Strength	1	Majority of flight profile will be in compression and will be augmented with stiffeners as needed
Modulus of Elasticity	2	Need a stiff material but not as critical
Cost	3	Very important due to budget constraints
Ease of machinability	2	

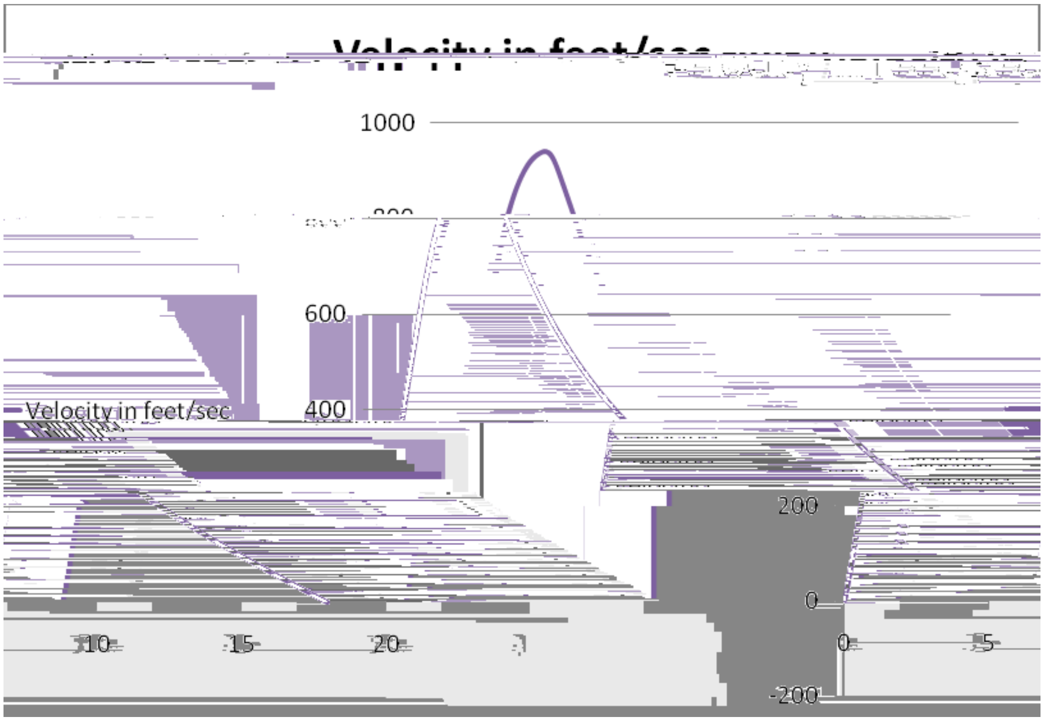
Vehicle Design Overview

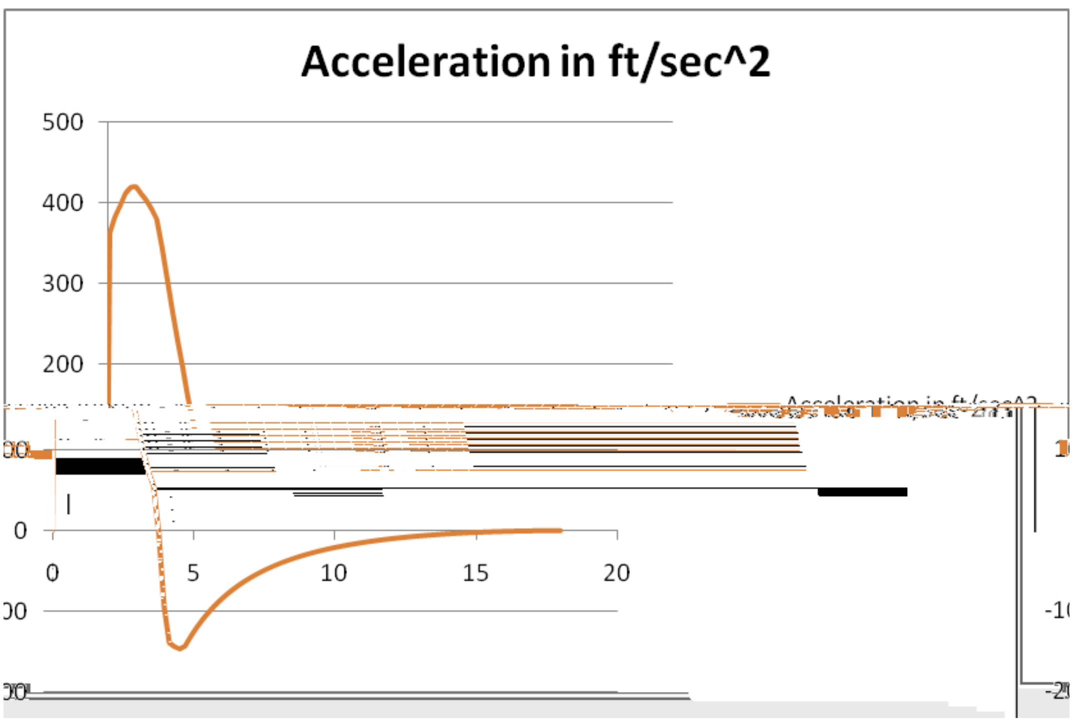
Version 1 of Flight Vehicle

The overall length is 11.25 feet. The calculated cd-value is 0.75 and the lift-off weight is 23.31 pounds. The calculated Center of Gravity (CG) is 8.85 feet from the nose and the Center of Pressure (CP) is 9.25 feet from the nose. This gives the rocket a stability of 1.01 calibers.

Recovery Subsystem

Initial sizing of the parachute was for a single parachute at a diameter of 14.57 feet with a 12 panel design. We will use this as a basis to design two separate parachutes so that the aft section with the motor will descend more rapidly and the electronics section will descend at a rate not to exceed 10 feet/sec. The initial calculations given by SpaceCad v. 4 provided the initial parachute sizing and will be used for the two-parachute model. Testing will begin over December to determine the amount and type of ejection charge. Use of either black powder or smokeless power is expected. All hazmat/safety procedures will be followed in regards to the explosive materials. A drogue parachute of approximately 30 inches will be used. This parachute has been tested in the past and works satisfactorily.




Acceleration in ft/sec^2
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400
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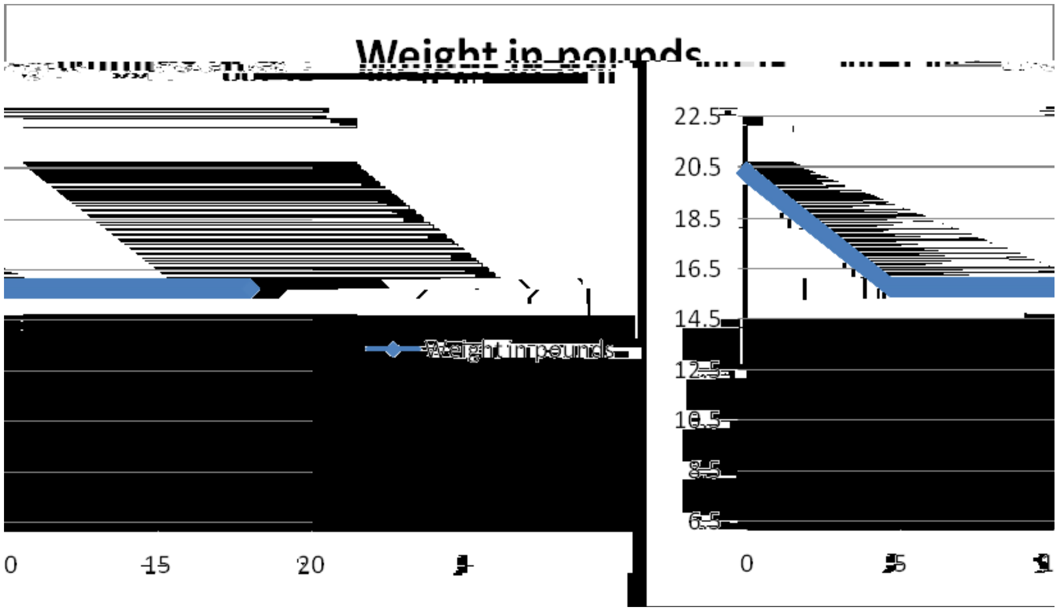
15
20



Payload Integration

The payload will be configured in the rock

4. Owens-Corning Fiberglass fabric
5. Krylon® spray paint
6. Title 14, Part 101, Subpart C
7. NFPA 1127, Code for High Power Rocketry

The actual sheets are not included in this document in order to reduce overall length, but are available upon request.

Payload Criteria

Payload

Item	Function
EL-USB-2-LCD	Humidity, Temperature and Dew Point Data Logger
EL-USB-CO	Carbon Monoxide Data Logger
MiniAlt/WD	dual logging event altimeter
standard serial RS-232 format adapter	PC connect data transfer kits for Altimeter
ARTS TX-900G	Altitude, GPS and Wind speed Telemetry transmitter
ARTS RX-900	Receiver for your Telemetry System
Standard Alkaline 9V battery	Altimeter Power supply

Carbon monoxide, Temperature, Hu

Safety and Environment (Payload)

The safety officers will be the same mentioned in the vehicle section. The failure modes mention on page 7 will have the following mitigation plan:

1. Battery
   a. The potential problems with the lithium-polymer battery pack include fire and contact with skin.
   b. The battery will be charged in a Nomex sock with proper charging techniques in a safe area.
2. Motor
   a. The motor has the potential catch fire due to malfunction.
   b. The motor(s) will be placed in approved containers and transported in accordance with Federal, State, and local laws. The motors will only be
   icleis notd inflights.0TcThe -0.0001 Tw 12 0 0 12177 257.28001 TmF

Expendables***	$200
GPS module	$220
PC Board	$400
Total	**$2,870.00**

*** Expendables include batteries, soldier, paint, etc.

On the following page is a breakdown of the actual funding as presented to the Alabama Space Grant Consortium (ASGC) for fund matching.

Tuskegee University

Cost Estimate for 1 year USLI Competition

Funding Agencies: Alabama Space Grant Consortium, Tuskegee University, External Sources

1. PI Salary /Fringe

Faculty Advisor/PI	Months	Time & Effort	Annual Salary	Fringe	Overhead	Total

ASGC 9/1/2008-7/30/2009	Tuskegee Cost Share 9/1/2008-7/30/2009	External Funding 9/1/2008-7/30/2009	Project Total 9/1/2008-7/30/2009
$1,312	$7,366	$992	
$240		$120	
$346		$298	
$200		$300	
$2,098		$1,710	
$2,870			
$300			