Harvard-Westlake School
Preliminary Design Review

Summary

Team Summary

- Harvard-Westlake School
- North Hollywood, California
- Teachers
    - Mr. Jacob Hazard
    - Ms. Karen Hutchison
- Mentor
    - Mr. Rick Dickinson (NAR L3)

Launch Vehicle

- 4” Diameter, 90” Length
- Pro54 K445 Standard Propellant
- 36” Drogue Parachute, 72” Standard Parachute Deployed at 500’ AGL

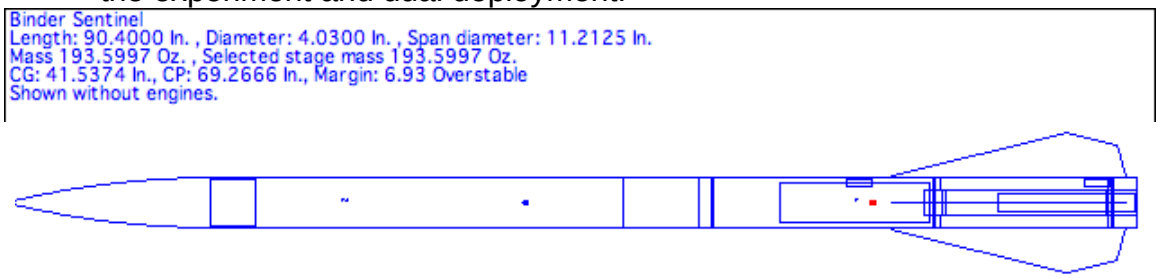
Payload

- Analysis of effects of acceleration and altitude on live bacteria cultures
- One small sample will be placed on a slide and a wireless camera with a microscopic lens will send live video to the ground.
- Another sample, in a test tube, will be secured in the rocket. An identical control sample will be kept on the ground. We will analyze which sample dies first.

Changes from Original Proposal

Vehicle Criteria

- The vehicle used will now be based off the Binder Design 54mm Sentinel.
- An avionics bay will be attached to the Sentinel in order to make room for the experiment and dual deployment.



Payload Criteria

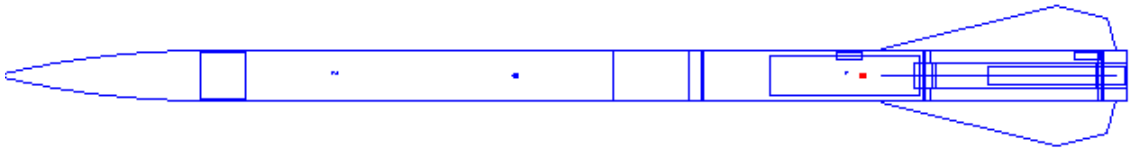
- We will use three samples:
  - Control test tube on ground
  - Experiment test tube in rocket avionics bay
  - Small sample in microscope slide

Activity Plan

- The Activity Plan has not changed

Vehicle Criteria

- Harvard-Westlake will test the effects of acceleration and high altitude on a live bacteria sample.
- Schedule
  - November 16: Project Initiation Complete – Design finalized
  - November 20: Components ordered
- Vehicle Design
  - The design is based off the Binder Design Sentinel
    - The Sentinel is a basic 4” diameter single deploy rocket. It will provide a simple platform to base our designs off of.
    - The shape of the fins minimize damage from landing on hard surfaces
    - The motor mount is 54mm, allowing for a wide range of powerful motors



  - A Binder Design Avionics Bay will be attached to the Sentinel to provide room for the experiment platform.

        - The Avionics Bay is 12” long – the longest commercial bay available. This will allow maximum flexibility in our experiment design
    - The K445 motor is made by Cesaroni.
        - The K445 motor will push the Sentinel rocket well over one mile, according to RockSim. Since RockSim tends to underestimate the Coefficient of Drag, it is better to design the rocket to fly to an altitude well above the goal.

Results	Engines loaded	Max. altitude Feet	Max. velocity Feet / Sec	Max. acceleration Feet/sec/sec	Time to apogee	Velocity at deploy Feet / Sec	Altitude at deploy Feet
	[J460T-14]	3671.85	646.53	498.54	13.99	62.57	3614.30
	[J800T-14]	5318.01	957.52	1022.82	15.67	16.17	5317.95
	[J415W-18]	5227.99	773.60	688.35	16.45	150.86	4842.19
	[K550W-18]	6424.08	966.72	627.23	17.46	116.80	6179.56
	[K695R-14]	5904.56	1007.67	680.70	16.56	22.25	5902.92
	[I284W-10]	2510.94	473.40	447.00	11.99	22.66	2510.37
	[L1500-15]	8341.17	1567.93	1583.73	17.98	27.76	8335.47
	[J400SS-12]	3201.11	598.44	435.69	13.17	29.74	3195.61
	[K445-17]	5760.96	722.17	333.31	18.19	88.46	5632.28
	[K445-17]	5761.02	722.09	333.31	18.19	87.57	5632.48

        - The other possible engines do not provide consistent enough altitudes with slightly varying weights
            - The K445 launched the rocket only 4 feet lower when 4 pounds of payload weight were added.

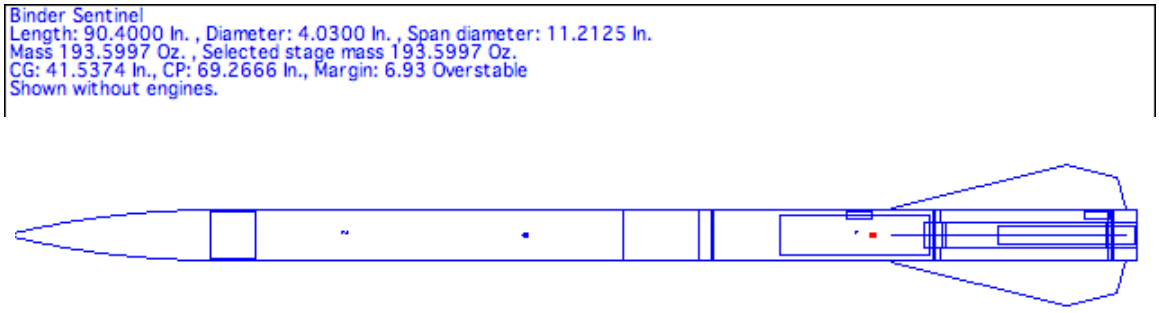
Subsytems

- The following subsytems are required to accomplish the mission goals:
    - Rocket Airframe
        - The rocket airframe is made of epoxy impregnated cardboard (phenolic tubing) and will be reinforced with fiberglass. It is expected to withstand speeds beyong Mach 5, although this rocket will not exceed Mach 1.
        - The rocket airframe is stable, as verified by RockSim v8.0.
        - The overall rocket will reach the expected altitude – verified by RockSim.
        - Risks
            - Airframe may not be stable after assembly
                - Solution: all parts will be weighed and the data will be plugged into the simulator to insure stability.
            - Airframe will not be strong enough to stand up to thrust of the K445 rocket motor.
                - Solution: the rocket will be tested at the Lucerne Dry Lake Bed prior to the final flight in Huntsville.
    - Rocket Engine
        - The K445 engine is a commercially available engine made by Cesaroni. Cesaroni is an expert at making both hobby and military rocket motors.

- The K445 engine is certified by the NAR, and the thrust has been verified by a plethora of 3rd party tests.
- Risks:
  - The K445 engine may CATO.
    - Solution: the K445 propellant will be carefully inspected for cracks and fractures prior to loading into the rocket
  - The K445 engine may not light or the electric match may fail.
    - Solution: a secondary electric match will be ready to replace the original.

- Recovery System
  - We will use two rip-stop nylon parachutes. They will be made by Top Flight Parachutes.
  - To deploy the parachutes, we will use one ARTSII Flight Computer and one Perfect Flight altimeter.
  - Risks:
    - The parachutes will shred due to a high speed deployment
      - Solution: The ARTSII flight computer will deploy the drogue parachute when the rocket's velocity is zero.
    - The flight computers will fail to deploy the parachute.
      - Solution: Two flight computers by different companies are used to insure a safe deployment.
  - Thorough RockSim analysis has been performed to determine the perfect size for the drogue and main parachutes with two goals in mind:
    - Minimize drift
    - Ensure a safe recovery

Performance Predictions



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Payload Integration

- The payload will be placed in the avionics bay, which will be reinforced by Fiberglass.

Launch Operation Procedures

- A launch rod will be used. The rocket's deployment charges will be installed and the rocket will be put on the pad. Once the rocket is on the pad, one person will approach the rocket and arm the flight computers. The rocket is then ready to launch.

Safety and Environment

- Ian C is the Safety Officer
- Possible Failures:
    - Airframe failure
        - Airframe shreds during flight. Spectators will be far enough away (NAR Regulations) to insure their safety.
    - Motor failure
        - The rocket will be located away from spectators during flight
    - Recovery failure
        - The rocket will never fly over spectators.
    - Payload failure
        - The bacteria may leak out, but the bacteria will be inert and harmless to the environment.
- Personnel Dangers:
    - Launch Dangers
        - NAR Regulations will be followed
    - Assembly dangers
        - When using power tools, all team members will remain aware of the situation.

Payload Criteria

Payload Experiment

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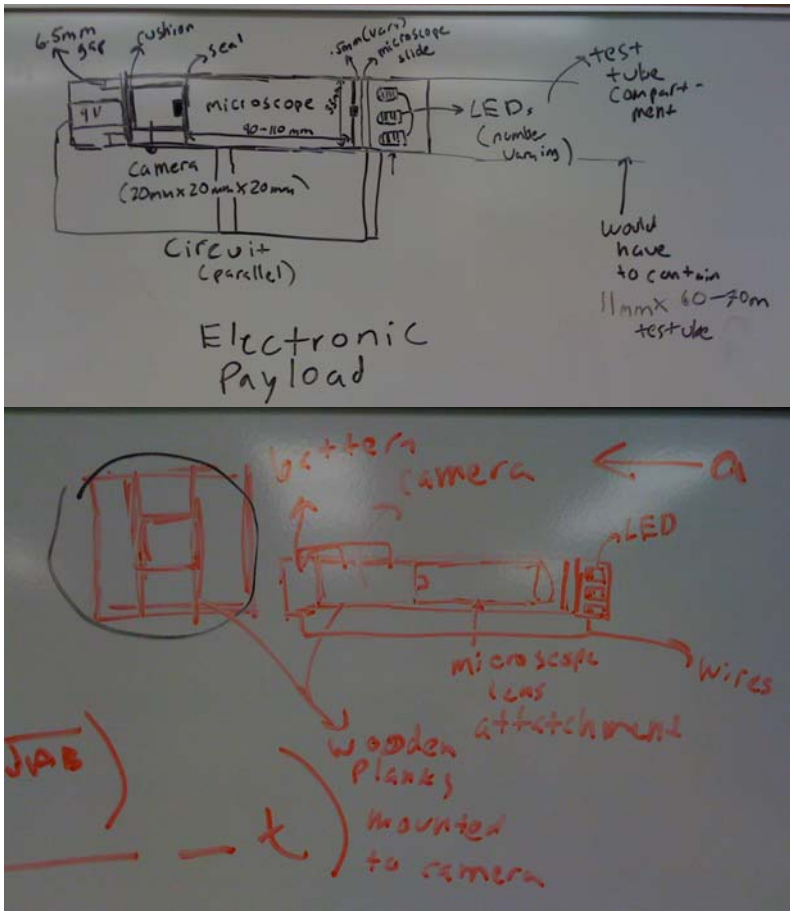

Integration

- We will use a BoosterVision wireless camera to beam live images from the microscope to the ground. We will retrofit a USB microscope to the camera to insure quality video.

Verification

- We will ground and flight test the payload system before the final Huntsville flight.

Payload Features

- The payload is original, as it tests both acceleration and altitude at the same time.
- This will help when designing future missions where bacteria may be involved.
- There is a moderate challenge in ensuring all three aspects of the experiment are successful.

Science Value

- The bacteria sample results can be used to determine how well a given bacteria will survive a rocket flight. We hope to be able to view live images of the bacteria as well as compare the control to the experimental.
- Success Criteria:
    - Successful Flight
    - Full High-Quality live video
    - Successful comparison of control sample to experimental sample.
- First, we will prepare two identical samples, a control and an experimental. Next, we will prepare a third smaller sample on a microscope slide. The control will stay on the ground while the other two are mounted inside the avionics bay. After launch, the main experimental sample will be recovered and compared to the control sample.
- Controls: sample on ground, microscope testing
- Variables: test tube sample in rocket, microscope slide sample in rocket
- Accuracy: since this is a qualitative test, it will be nearly 100% accurate.

Safety and Environment

- Safety Officer: Ian C
- Failures:
    - Bacteria leaks
        - Solution: use plastic test tubes
    - No streaming video
        - Use two video receivers
- Personnel Hazards:
    - None
- There are no environmental concerns. The bacteria are harmless.

Activity Plan

Status of Activity

- We are on track – the rocket and components have been ordered and the fins have been pre-cut. We will begin assembly as soon as it arrives.
- We have begun planning out outreach and we are planning to contact the Boy Scout troops in the next couple of weeks.