Harvard-Westlake School
Flight Readiness Review

Summary

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

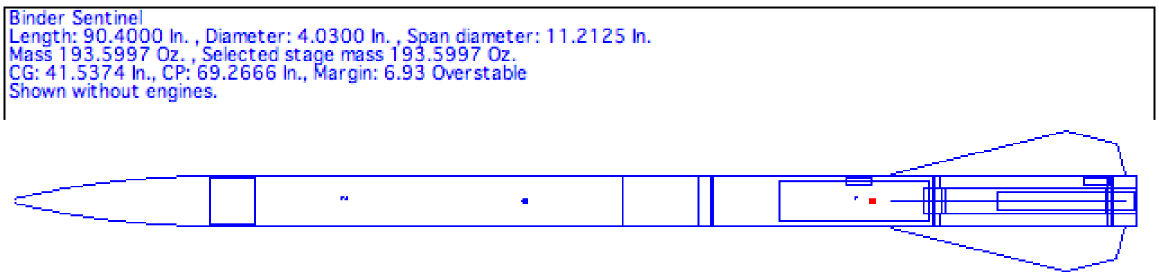
Launch Vehicle
- 4” Diameter, 90” Length
- AMW K445
- 24” Drogue Parachute, 60” Standard Parachute Deployed at 500’ AGL
- Standard Rail Buttons

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 Critical Dse Design Review

Vehicle Criteria

- The rocket is still based off the Binder Design 54mm Sentinel, but a safer dual deployment system will be used.
    - o The Drogue parachute will be a 24” Rip-Stop Nylon parachute.
        - ▪ The rocket should fall at approximately 60 feet per second
    - o The Main parachute will again be 60”. In the event that the main fails to deploy, the oversized Drogue parachute should minimize damage to the rocket.
        - ▪ The rocket will hit the ground at less than 30 feet per second.
    - o Redundant flight computers and electronic ejection charges will be used:
        - ▪ One ARTS II Flight Computer
        - ▪ One PerfectFlite HiAlt45K



Payload Criteria

- A sealed plastic test tube will also be used as a redundant experiment in the event that the camera fails
- Foam cushioning will be used to prevent damage to the test tube, camera, and 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

Testing

- Four Tests:
  - Static Scale Test
    - Completed, CG/CP relationship is worst case 1.5, best case 3.0
  - Live Scale Test
    - Aerotech G64-4 Motor
    - Complete success, launched twice with CG/CP relationship at 1.5 (to test minimum stability)
    - Video at: youtube.com/watch?v=bADwhTEmT2o
  - Static Test
    - Success, Worst CG/CP relationship is 1.5 (assuming scientific payload weighs 0 grams)
  - Payload Test
    - To be completed next week

Materials Analysis

- Nose Cone:
  - Standard Molded plastic
    - Considered the rocketry "standard" able to withstand supersonic flights
- Fins and bulkhead:
  - ¼" 5-Ply Plywood
    - Able to withstand supersonic flights
- Airframe:
  - Cardboard 4" frame
    - High vertical strength, can withstand supersonic flights

Strength of Assembly

- Assembled with Wood Glue, reinforced with epoxy
- All critical components use ¼" thick steel (eye bolts, quick links, etc)
- Airframe acts just as a frame, internal strengthening from plywood centering rings, motor mount tube, and recovery harness.
- Motor secured by two wing nuts (positive motor retention)
- Fin shape and style is manufacturer's default. Extra payload weight increases stability.

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:
  - o 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.
  - o 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:
  - o Minimize drift
  - o Ensure a safe recovery

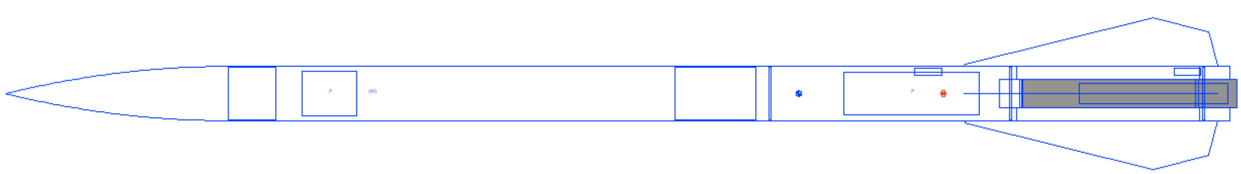
Performance Predictions

- Rocket exceed 5,280 feet AGL
- Record or stream microscope video of live bacteria sample during flight
- Safely recover rocket
- Analyze test tube sample
- Find correlation between acceleration and bacteria death
- Simulations:

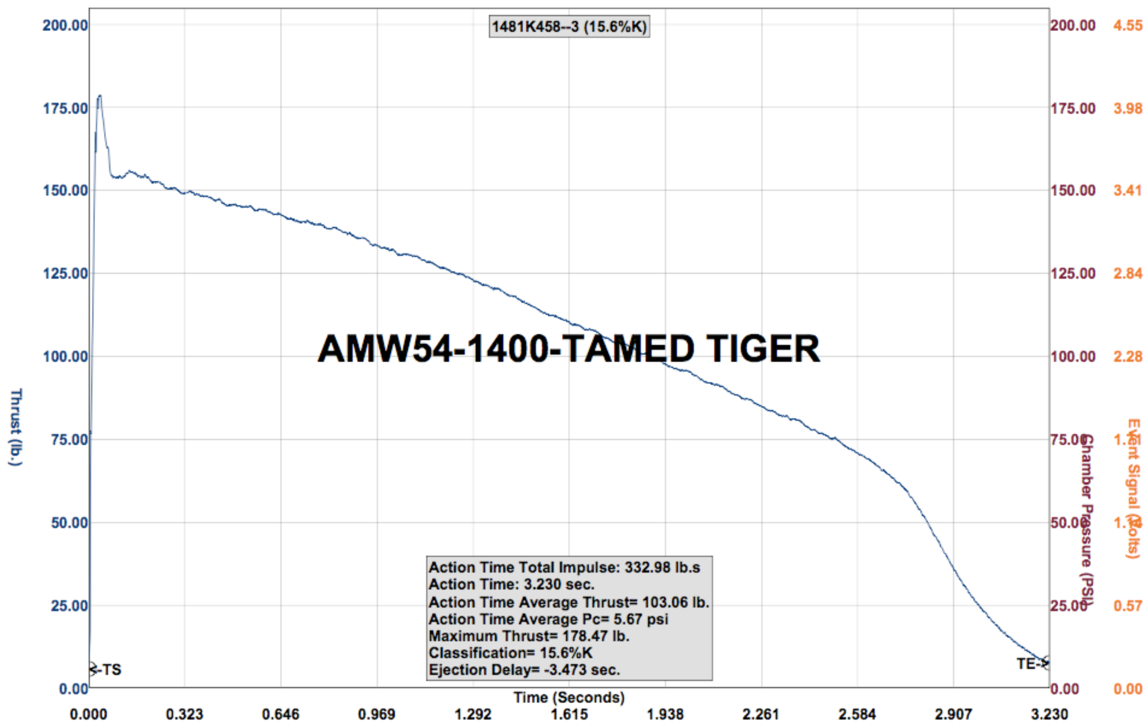
	Simulation	Results	Engines loaded	Max. altitude Feet	Max. velocity Feet / Sec	Max. acceleration Feet/sec/sec	Time to apogee	Velocity at deploy Feet / Sec	Altitude at deploy Feet
1	0		[K475WW-None	5239.27	756.56	335.36	17.08	8.48	5239.26
2	1		[K475WW-None	5241.54	756.57	335.34	17.08	0.12	5241.52

  - o Simulation 1: Low winds (3-5 mph); Drift: 124'
  - o Simulation 2: High Winds (15+ mph); Drift: 103'
- Vehicle Dimensions and Weights (based on actual masses):

Binder Sentinel
Length: 90.4000 In. , Diameter: 4.0300 In. , Span diameter: 11.2125 In.
Mass 182.2462 Oz. , Selected stage mass 182.2462 Oz.
CG: 58.5578 In., CP: 69.2666 In., Margin: 2.68 Overstable
Engines: [K475WW-None,]



- Thrust Curve:



- Drag Analysis:

Cd type	Percent of total drag		Cd
Nose + body:		46%	0.3948
Base:		1.2%	0.01053
Fins:		50%	0.4341
Lugs:		3%	0.02552
Predicted Cd:	0.865		

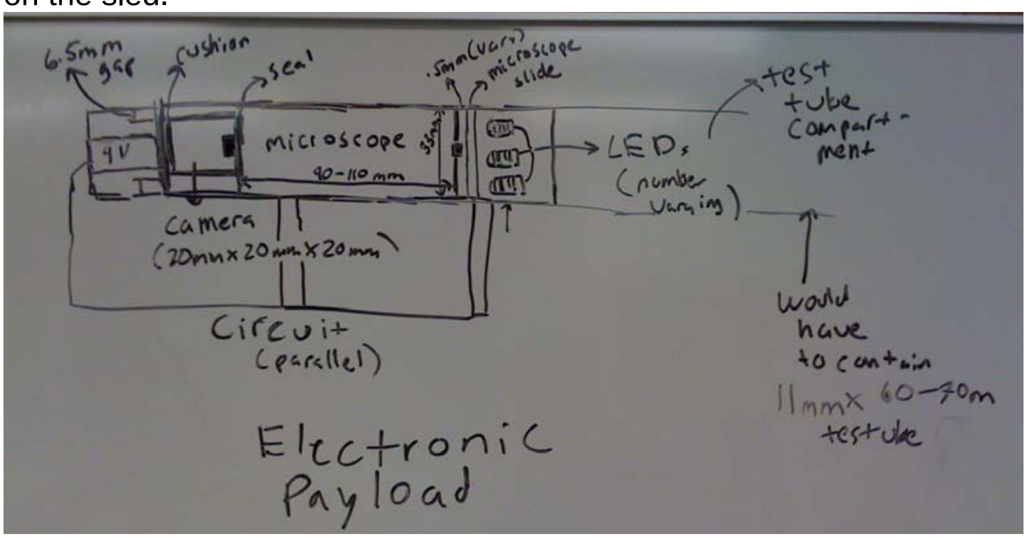
- CP/CG relationship
    - o >2 calibers of stability
    - o ranges from "stable" (1-1.5 calibers) to "overstable" (>2 calibers)
- Risks:
    - o Sudden mass change, Center of gravity moves back, rocket loses stability
        - ▪ Parachutes will be stuffed as far down the airframe as possible to prevent and mass changes

Safety and Environment

- Safety Officer: Ian C
- Failure Modes:
    - o Rocket fails to take off
        - ▪ Wait 2 minutes
        - ▪ Approach rocket
        - ▪ Remove igniter power
        - ▪ Disable electronics
    - o Rocket becomes unstable
        - ▪ Declare a "Heads Up"

    - Make sure all spectators are aware of the possibility of falling debris
  - Electronics deploy parachutes on the pad
    - Remove igniter power
    - Disable electronics
    - Analyze problem
    - Repack parachutes, rearm electronics
  - Electronics fail to deploy parachute
    - Declare a "Heads up"
    - Make sure all spectators are aware of the falling rocket
- Personnel Hazards:
  - APCP is dangerous to handle
    - Members will wear nitrile gloves when handling
  - Rocket may fall and harm a spectator
    - Two members will hold the rocket at all times
- Environmental Concerns:
  - Plastic test tubes will be used to insure sharp glass will not be left on the field

Payload Integration

- The payload will be located in the electronics bay
- In addition to the scientific payload, the two altimeters will also be located on the sled.
- 

Payload Criteria

Experiment Concept

- 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.
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Science Value

- As man tries to expand into space, we will need to know exactly how everything we bring out of the earth's atmosphere will react to a rocket launch.
- Scientific Approach:
  - Problem: How do bacteria react to a spaceflight?
  - Solution: Take two samples of the same bacteria. Put one on a rocket flight simulating a space shuttle and leave the other on the ground, as a control. Observe the differences.
- The data will be accurate: there is one control and one experimental group.
- Process:
  - Put bacteria sample into two plastic test tubes
  - Seal both test tubes
  - Put one test tube in rocket electronics bay test tube holder
  - Launch rocket
  - Retrieve test tube, observe both control and variable under a microscope and observe the ratio of dead to living bacteria
- 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.

Experiment Design of Payload

- There is no instrumentation, a simple test tube is used. If time is found, we will install a microscope streaming its live images to our computer.
- We think a small number of the bacteria will die from the high stress flight, but most will survive the ordeal.

Assembly

- The plastic test tube will be secured to the electronics bay sled and sealed with a standard rubber stopper.
- The microscope will also be mounted to the sled. Light will be provided by one white LED. A small plastic microscope slide will hold the sample.

Safety and Environment

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

<u>**Launch Operations Procedures**</u>

Checklist

- Recovery:
    - Lay both parachutes out on a large, clean surface
    - Fold the parachute in half
    - Flip upside down so the shroud lines run down the center
    - Fold in half twice more, securing the shroud lines in place
    - Roll the parachute into a tight cylinder, insert into airframe
    - Install black powder charges
- Motor:
    - The motor will be assembled by the L3 NAR Mentor, Mr. Dickinson
    - The students will instruct the mentor and follow the motor's directions.
    - After assembly, the motor will be considered "live."
    - The igniter will not be inserted at this point.
- Igniter:
    - Once the rocket is at the pad, the motor's igniter will be installed
    - The igniter will not be hooked up to the launch leads at this point
- Launcher:
    - Load the rocket onto the rail
    - Turn on electronics, listen for "ready" beeps
    - Attach launch leads to igniter
- Launch Procedure:
    - All members will move to the spectator area
    - If a microscope is used, members will make sure a strong signal is found.
    - The members will give the RSO and LCO a thumbs up
    - Countdown begins, rocket launches
    - All members visually track rocket.
    - Once main has deployed, recovery team proceeds to find the rocket.
- Troubleshooting
    - Rocket fails to take off
        - Wait 2 minutes
        - Approach rocket
        - Remove igniter power
        - Disable electronics
    - Rocket becomes unstable
        - Declare a "Heads Up"
        - Make sure all spectators are aware of the possibility of falling debris
- Post flight inspection
    - The safety officer will approach the rocket and disable the electronics

  - The black powder charges will then be disconnected, and the test tube will be removed and put into an ice bath.
  - If the sample remains cool, microscopic inspection can be delayed.

Safety and Quality Insurance

- Recovery
  - Black powder will be installed by the NAR L3 mentor and the electronics will be unpowered.
- Motor
  - The motor will be assembled by the NAR L3 mentor.
- Igniter
  - The igniter will not be hooked up until the rocket is on the pad, ready to launch.
- Setup on Launcher
  - Two students will hold the rocket during installation onto the rail
  - One student with safety goggles will arm the electronics.
- Launch Procedure
  - All members will be in the spectator are and will not approach the rocket until both parachutes have fully deployed.
- Troubleshooting
  - Members will wait two minutes before approaching the rocket
- Post Flight Inspection
  - Electronics will be disabled before approaching the rocket
- Ian C is the safety officer

Activity Plan

Status of Activity

- We are on track – the rocket has been built and the scale model has successfully flown.
- We have used less money than expected. The remaining money will help pay for the travel fees to Huntsville
- We have set a date to teach students at Harvard-Westlake Middle School about aerospace and rocketry.

Conclusion

Harvard-Westlake Rocketry Club is thrilled to be able to be part of SLI 2008-9. We are on progress, and the basic full scale rocket is complete. The payload is in progress, and we are currently scaling down our design for the ¼ scale test flights.