**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)

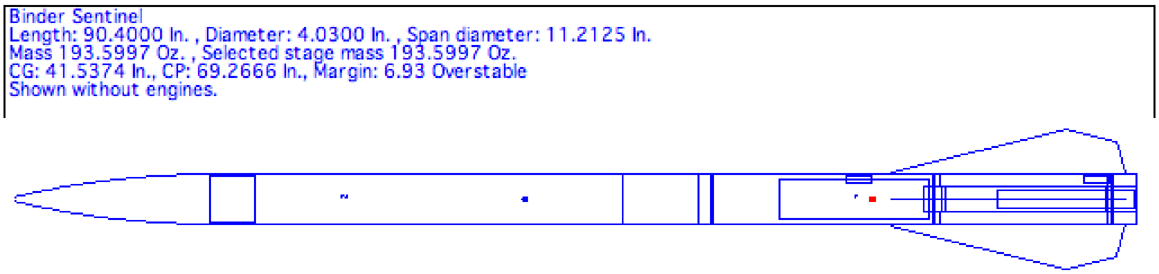
### Launch Vehicle
- 4” Diameter, 90” Length
- Pro54 K445 Standard Propellant
- 48” Drogue Parachute, 48” Standard Parachute Deployed at 500’ AGL
- Standard Rail Button

### 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.

# <u>Changes from Preliminary Design Review</u>

## Vehicle Criteria

- The rocket is still based off the Binder Design 54mm Sentinel, but a safer dual deployment system will be used.
    - The Drogue parachute will be a 48” Rip-Stop Nylon parachute.
        - The rocket should fall at approximately 50 feet per second
    - The Main parachute will again be 48”. In the event that the main fails to deploy, the oversized Drogue parachute should minimize damage to the rocket.
    - Redundant flight computers and electronic ejection charges will be used:
        - One ARTS II Flight Computer
        - One PerfectFlite HiAlt45K




## Payload Criteria

- A USB interface board will be created that records images from a commercial USB microscope.
- 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

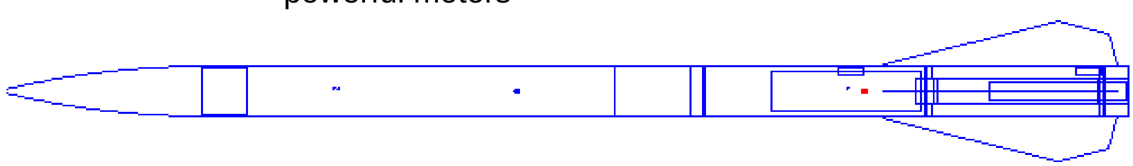
# Vehicle Criteria

- Harvard-Westlake will test the effects of acceleration and high altitude on a live bacteria sample

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

- Schedule
  - o Completed:
  - o November 16: Project Initiation Complete – Design finalized
  - o November 20: Components ordered
  - o December 6: Parts Arrive
  - o December 14: Begin Construction of Motor Mount
  - o January 4: Finish motor mount, attach fins, make e-bay
  - o January 11: Reinforce fins with foam, attach positive motor retention screws and T-nuts
  - o To Do:
  - o February: Create and test fly scale and full model
  - o March: Outreach program, ground test experiment

- Vehicle Design
  - o 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



  - o 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 |
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    - 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.
    - The ability to exceed the altitude goal allows for design changes later on in the process.

**Testing**

- Three tests will be completed before the final launch of the rocket
    - Small Scale Test
        - ¼ Scale model will be flown at Santa Fe Dam Recreational Area.
        - Scientific Experiment ground testing will be performed in the workroom (school).
        - Final rocket testing
            - The full size rocket will be flown at the Lucerne Dry Lake Bed on February 14th.

**Integrity of Design**

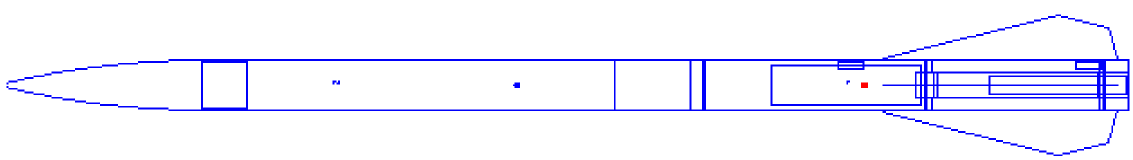
- The four fin system allows for increased stability as well as a smaller footprint
    - The smaller footprint minimizes risk of damage to the rocket during shipping and landing.
    - Increased stability provides additional safety during the flight of the rocket.
    - Fins and centering rings are made out of Aircraft-quality ¼" thick 5-ply plywood.
    - All connection points (fins to motor mount, motor mount to airframe) are reinforced with multiple layers of Wood Glue. Additional reinforcement is provided by liquid foam.
    - Positive motor retention is provided by T-Nuts and Kaplow Clips

## 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

Binder Sentinel
Length: 90.4000 In. , Diameter: 4.0300 In. , Span diameter: 11.2125 In.
Mass 193.5997 Oz. , Selected stage mass 193.5997 Oz.
CG: 41.5374 In., CP: 69.2666 In., Margin: 6.93 Overstable
Shown without engines.



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## Payload Integration

- The payload will be placed in the avionics bay, which will be reinforced by Fiberglass.
- Foam will be used to protect the plastic test tube, microscope, camera, and slide.
- All components will be mounted securely to a sheet of plywood.
- All payload components will fit in the electronics bay, simplifying on-the-field installation.

**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.
- The parachutes will be individually packed by a team member who has practiced packing parachutes previously
- The igniter will not be installed into the rocket motor until the rocket is on the pad, ready to launch.
- Troubleshooting Steps
    - Remove Igniter
    - Power Down all Systems
    - Power on Scientific Payload
        - Test Camera Reception
    - Power On PerfectFlite computer
        - Wait for "ready beeps"
    - Power on ARTS II computer
        - Wait for "ready beeps"
- Post Flight Procedures
    - All spectators will remain 30 feet away from the rocket until all electronics are powered down.  This will prevent injury in the event a black powder charge failed to detonate during descent.
    - After all systems are powered down, the test tube will be placed into an ice bucket for post-flight analysis.

**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.

<u>**Payload Criteria**</u>

### Payload Experiment

- 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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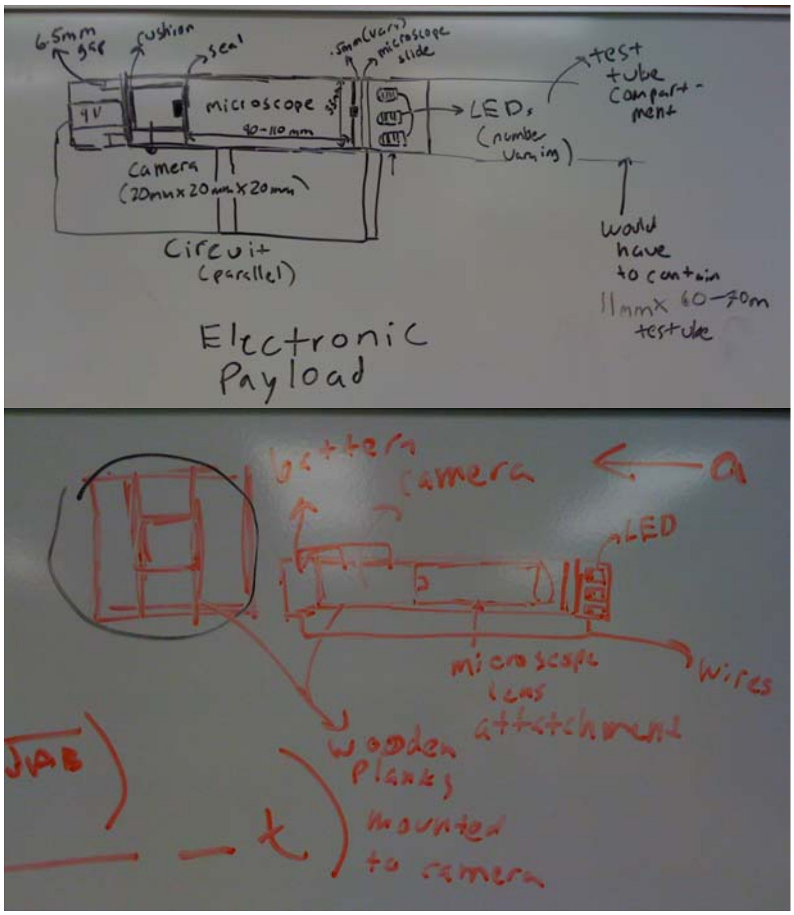


### Integration

- 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
    - Record video directly to onboard FLASH memory chip
- 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 this week.

## 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.