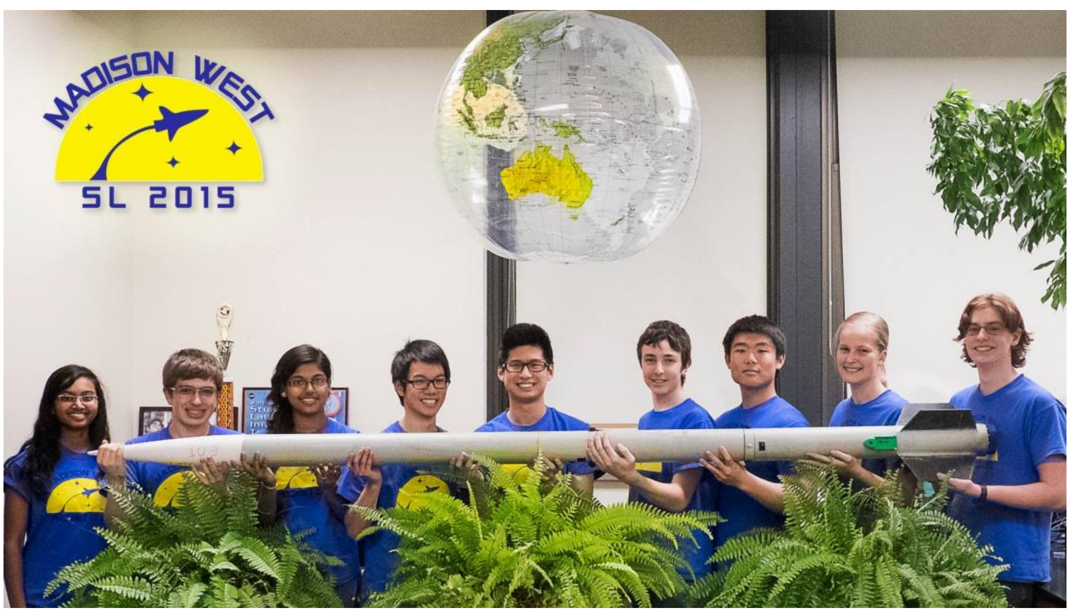
A Rocket Delivered Small Scale Earth-Observing Instrument

Post Launch Assessment Review

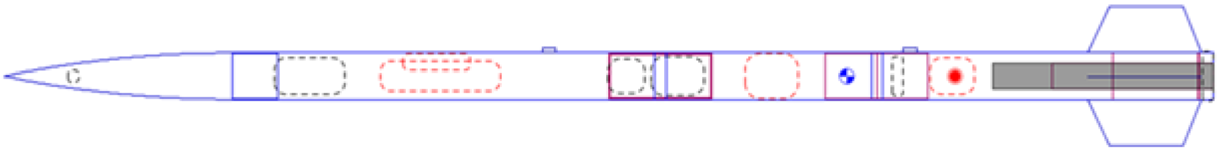
Madison West High School, Madison, WI

MADISON WEST

SL 2015



VEHICLE



Vehicle Design:

The center of pressure is 87.5 inches from the tip of the nosecone. The center of gravity is 75.1 inches from the tip of the nosecone. The rocket had a liftoff static stability margin of 3.11. The rocket's stability and robustness was verified both by a scale model flight and by 3 successful full scale test flights.

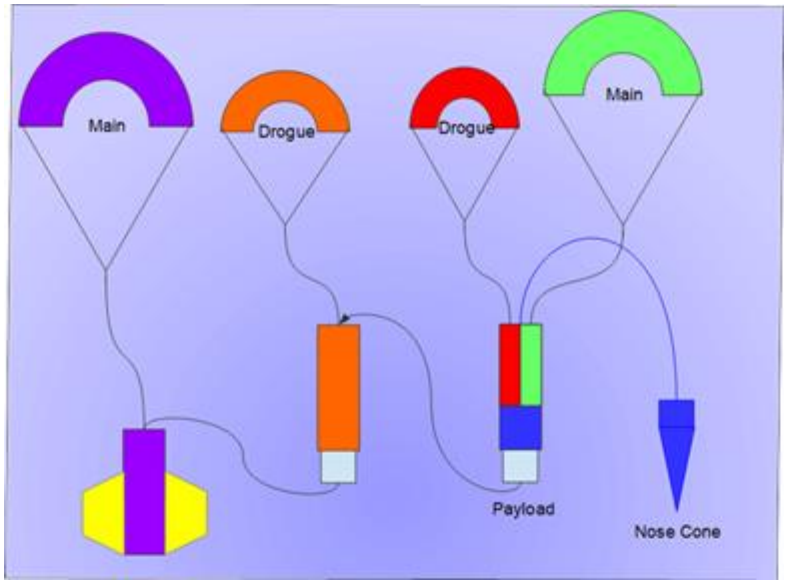
The rocket has a height of 111 inches, a diameter of 4 inches and a mass of 24.4 lbs

FLIGHT DESCRIPTION

The vehicle left the launch pad as expected, and flew on a K1085 WT to an apogee of approximately 4,200 feet. Both drogue parachutes deployed as planned, and the rocket descended as two separate sections. At approximately 700 feet above ground level, the booster section's main parachute deployed.

The payload section's main parachute failed to deploy due to a dual power failure to the deployment electronics. This was caused by the battery connections not being properly secured prior to the launch. The shock from the payload drogue caused a momentary loss of power to the deployment electronics, which had no bypass capacitor. The payload section of the rocket descended under drogue, and impacted the ground. The payload suffered damage to some of the cameras, however, the internal electronics were undamaged. The vehicle had very minor damage in the form of zippering, as well as cosmetic damage to the paint.

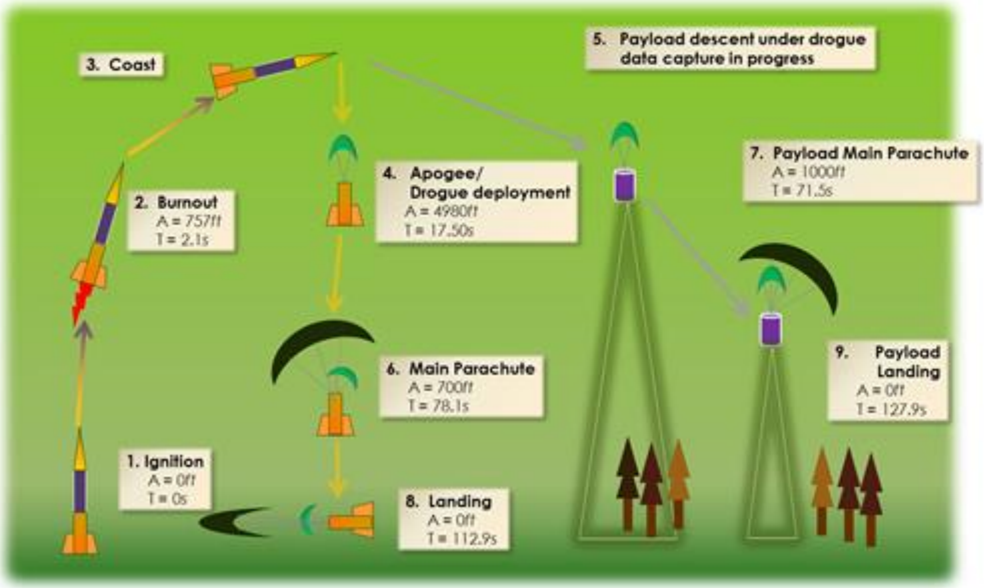
DEPLOYMENT



This image depicts our deployment system. At apogee, the vehicle separates into two untethered sections. The payload's drogue parachute is ejected directly below the nose cone, and the booster drogue is ejected out of the booster's upper tube, just below the camera array.

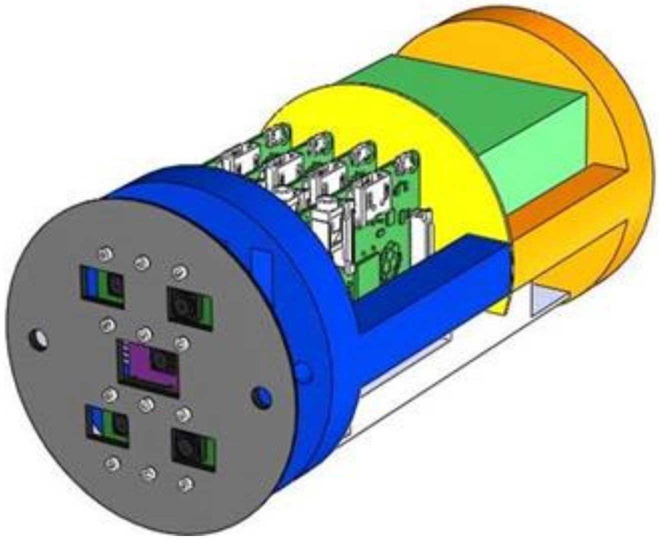
At 1000 ft AGL the payload's main parachute is deployed. This parachute is ejected at the same separation point as the payload drogue. The two parachutes are separated by a fiberglass divider inside the rocket. At 700 ft AGL the booster main parachute is deployed. The booster uses standard dual deployment, and does not use the parallel tube design seen in the payload.

FLIGHT SEQUENCE



This image shows our flight profile. After liftoff, the motor will burn for 2.1 seconds, and then coast to an apogee of approximately 4,200 ft, where the payload will separate from the booster, and both drogues will deploy. At 700 ft AGL the booster’s main parachute will deploy, and it will land slightly before two minutes after lift-off. Meanwhile, the payload descends under drogue while imagine the ground. At 1000 ft AGL the main parachute deploys, and the payload lands after two minutes of flight.

PAYLOAD



INTRODUCTION/OVERVIEW

Our payload is designed to image the ground in five spectral bands: red. green, blue, near infrared and thermal. These spectral bands are captured using 4 raspberry pi camera modules, and thermal imaging is captured with a FLIR Lepton thermal imaging camera.

RATIONALE

Earth observing satellites play a very important role in detecting changes on Earth’s surface. Thorough analysis of the images produced by the satellites can show potential problems on the ground. Situations such as deforestation and severe environmental changes can be examined, and the cause, rate and scope of the damage can be found.

HYPOTHESIS

We hypothesized that our land observing instrument payload will be able to accurately tell us various statistics about ground cover of the observed land.

PROCEDURES

1. Check electronics for functionality.
2. Ensure that deployment batteries have the correct charge. (<4.5 Amps, 9 volts)
3. Insert payload electronics
4. Attach end caps to payload bay.

POST FLIGHT PROCEDURE

After recovery, we turn off the payload. We then remove the payload from the rest of the rocket and disconnect it from the switches. Once we are back from the launch, we remove the Raspberry Pis from the payload and remove their microsd cards. We then boot an unflown

Raspberry Pi on the microsd card and transfer all the pictures taken to a flash drive so that they can be analyzed on a desktop computer.

COLLECTED DATA

No meaningful data was collected on our Huntsville flight due to overheating. A reflight is scheduled for the weekend of March 23/24 in Princeton, Illinois.

ANALYSIS

DISCUSSION

SOURCES OF POSSIBLE ERROR

Our payload began experiencing a previously unseen heat dissipation problem the night before the launch, when the voltage regulators began overheating. This necessitated a series of last minute cutbacks to the scope of the payload in an effort to mitigate the new challenge. Our payload was changed so that only two Raspberry Pis were present in the flight configuration, and we changed the image capture mechanism to a less precise but much simpler version that ran only on the Raspberry Pis. This solution did not involve an altimeter. Unfortunately, the payload gradually overheated on the pad as it was taking pictures of the inside of the tube. After about 20 minutes on the pad, the Raspberry Pis lost power due to heat. As a result, there were no pictures taken during flight.

POSSIBLE IMPROVEMENTS

We are planning to have a reflight of our rocket on May 23/24 with fully functional, redesigned payload. This time, we will only design it for two Raspberry Pis. They will be mounted more securely and will receive power over MicroUSB instead of header pins. The power for the payload will not come from a bank of AA batteries, but instead from a commercially available USB phone charger. We expect these changes to solve our heat dissipation problem.

FURTHER QUESTIONS

In order to attain more data, we are planning on launching our rocket again at Princeton, Illinois on May 23/24. The launch site at Princeton has a flight ceiling of 16,000 feet. In order to take advantage of this opportunity for a wider field of view, we will be launching on a much larger motor.

OUTREACH

We have reached out to over 4,000 members of the community. Outreach is very important to our club. We have participated in many local science fairs and school events. We had displays from current and past Student Launch projects, as well as some of the larger rockets our club has built. Our main attraction was our pneumatic rocket construction and launch. Visitors can build and launch small paper rockets. The rockets are launched from a pneumatic launcher built by club members.

LESSONS LEARNED

Several errors occurred on the day of our flight in Huntsville. We are learning from these problems and will be reflying to get usable data from our payload. In order to ensure a successful reflight, we are going to triple check all deployment connections to make certain that a physical shock will not cause a dual power failure. We will also put electrical tape around the 9-volt battery in the vertical direction in order to ensure that the cap stays securely connected to the battery. In addition, we are going to redesign our payload in order to mitigate the heat buildup that caused our previous problem.

After this reflight is complete, we will resubmit the PLAR with data acquired from our reflight.