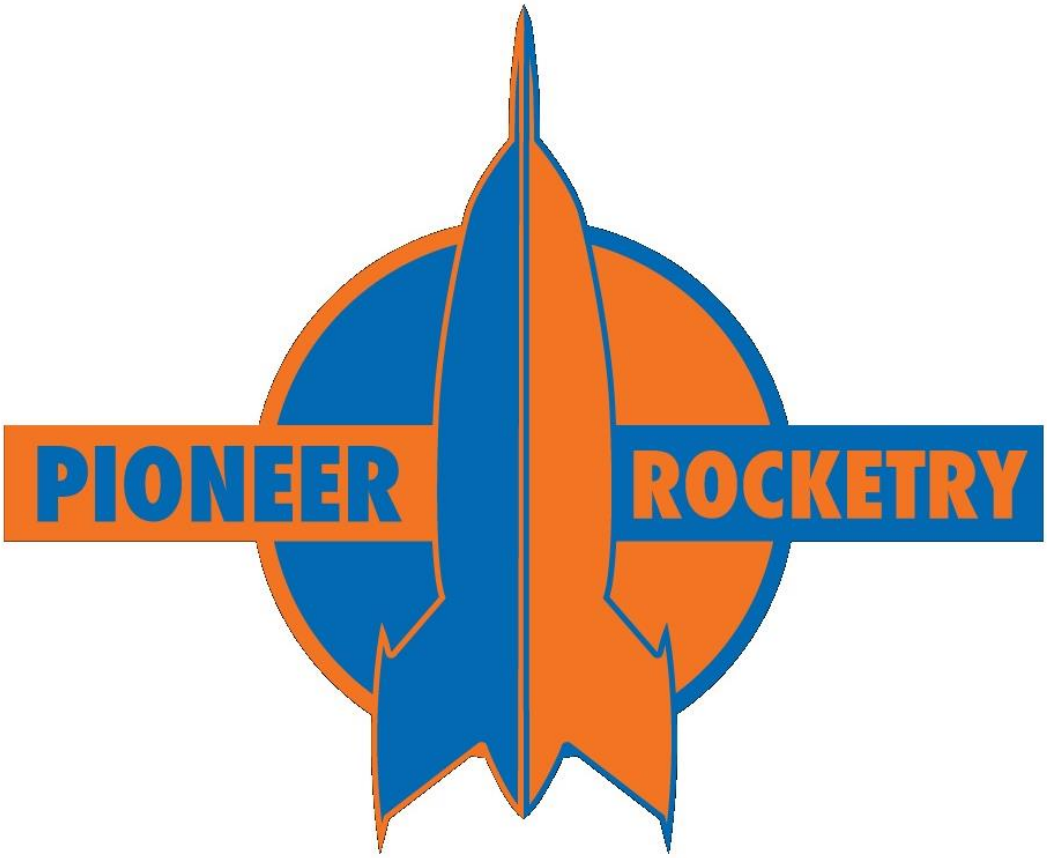

Pioneer Rocketry

University of Wisconsin - Platteville

Post-Flight Performance Report

NASA's Space Grant

Midwest High-Power Rocket Competition

May 2015

Flight Performance Reporting Sheet

SCHOOL **UW – Platteville** **Team** **Pioneer Rocketry**

1	Operation (determined by RSO or designee)	✓
	Launch	✓
	Parachute deployment	✓
	Recovered	✓
	Determined to be in flyable condition	

			Predicted	**Actual**	
2	Maximum Altitude (Dart)	(*ft*)	5700	4492	✓
3	Maximum Altitude (Booster)	(*ft*)	2700	4492	✓

Flight performance data is shown in Figures 1, 2, and 3

Rocket Operation Assessment

Introduction:

The 2015 Midwest Regional Rocket Competition was Pioneer Rocketry's fifth attempt at a boosted dart style rocket. Earlier attempts were met with stability, material, and computer hardware issues which each resulted in a damaged rocket. Every flight was viewed as a learning experience and continuous improvements were made between flights. The flight at the regional competition was complicated by a separation failure between the booster and dart sections of the rocket. Additionally, parachute deployment from the dart did not occur, even though the ejection charge was deployed.

Flight Anomalies Analysis:

Separation did not occur as expected for the launch, as the dart and booster became locked together delaying the separation until 13.4 seconds. This was believed to coincide with the booster section's parachute deployment. This was our first incident of failed separation, and significantly different from the expected separation at motor burnout which occurs at a time of 1.1 seconds. It is believed that locking was caused by the compression of the dart's fillets into the transition coupler, which increased friction between the mating parts.

Propulsion System Assessment:

The motor performed exactly as expected. This was determined retroactively, by simulating an OpenRocket launch in which the two rocket stages did not separate. It can be seen in Figure 1 that the simulation of a no-separation launch aligns well with the data collected. Table 1 shows key data corresponding to Figure 1.

Flight Path and Recovery System Analysis:

Overall, the staging and timing for the flight was exactly what was expected. The booster relied on motor ejection for parachute deployment which performed as expected. The parachute on the booster ejected as expected, and the booster landed in good condition. The dart's parachute ejection was electronically deployed, and while the timing of the ejection charge performed as expected the positioning of the physical charge proved to be troublesome. The ejection charge pushed itself past the parachute and protective Nomex, and upon the detonation of the charge only the tailcone ejected. This resulted in the

parachute not ejecting from the body tube. The drag on the tailcone lacked sufficient force to pull the parachute bundle out the back of the rocket.

Rocket Location and Recovery Analysis:

The Dart landed 1,780 ft from launch pad and the Booster landed 2420 ft from launch pad. Interestingly, the booster followed a heading of 73 degrees from North while the dart had a heading 92 degrees from North. The difference between these two measurements is expected to have resulted from the booster's deployment of its parachute. Having a deployed parachute allowed the wind to impact the booster's descent to a much greater as compared to the dart. The dart was lost from sight during the launch; however, members of the team were able to keep visual contact with the booster during its descent. The retrieval team sent to recover the booster found the dart imbedded into the ground while searching the booster.

Pre and Post Launch Procedure Assessment:

Pre and Post flight checklists were created and implemented during this launch. The purpose of the pre-flight checklist is to ensure all electronics are properly wired and powered prior to launch, and that parachutes are packed and protected properly. The post flight checklist mainly deals with the safe retrieval of the rocket from its landing sight. It also details what to do in the case of motors or ejections charges which did not deploy.

As previously mentioned, the dart failed to separate from the booster at motor burnout and because of this the rocket failed to reach the predicted 5700ft altitude. In order to compare this flight with the open rocket model, a new simulation was run with the dart remaining attached to the booster. Below in Table 1 and Figures 1, 2, and 3 the flight data will be compared side by side to this modified OpenRocket simulation.

Altitude data from the barometer matched very closely to what was measured during flight with the predicted apogee differing from simulation by only 6ft. The velocity data gathered from the accelerometer seemed to be less in magnitude and lag behind the simulated values. By differentiating the altitude data from the barometer a different source for velocity data can be found. While noisy this barometer data matches the simulation better than the

accelerometer data. The acceleration data closely matches the simulation in shape but the magnitudes are quite a bit different.

TABLE 1 FLIGHT CHARACTARISTICS OF UNSEPARATED ROCKET

	Apogee [ft]	Peak Acceleration [G]	Peak Velocity [ft/s]
Predicted	4498	30	837
Measured	4492	26.86	730

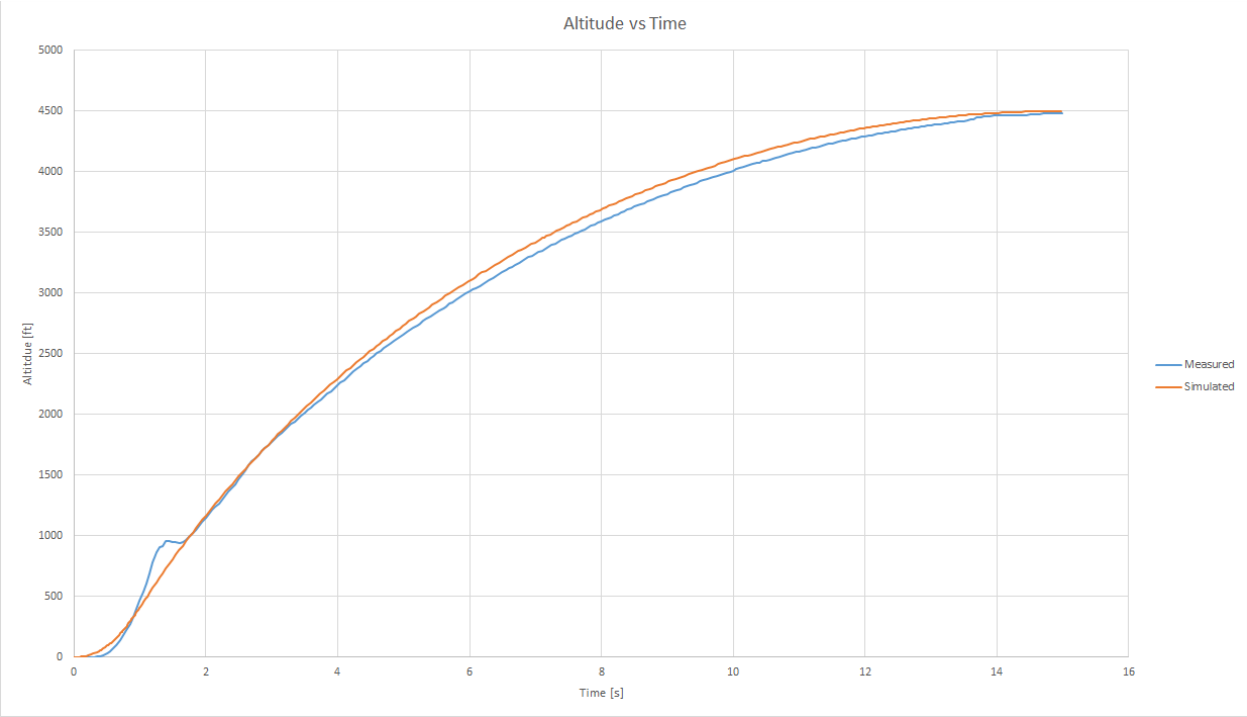

FIGURE 1: PREDICTED AND MEASURED DART ALTITUDE VS TIME.

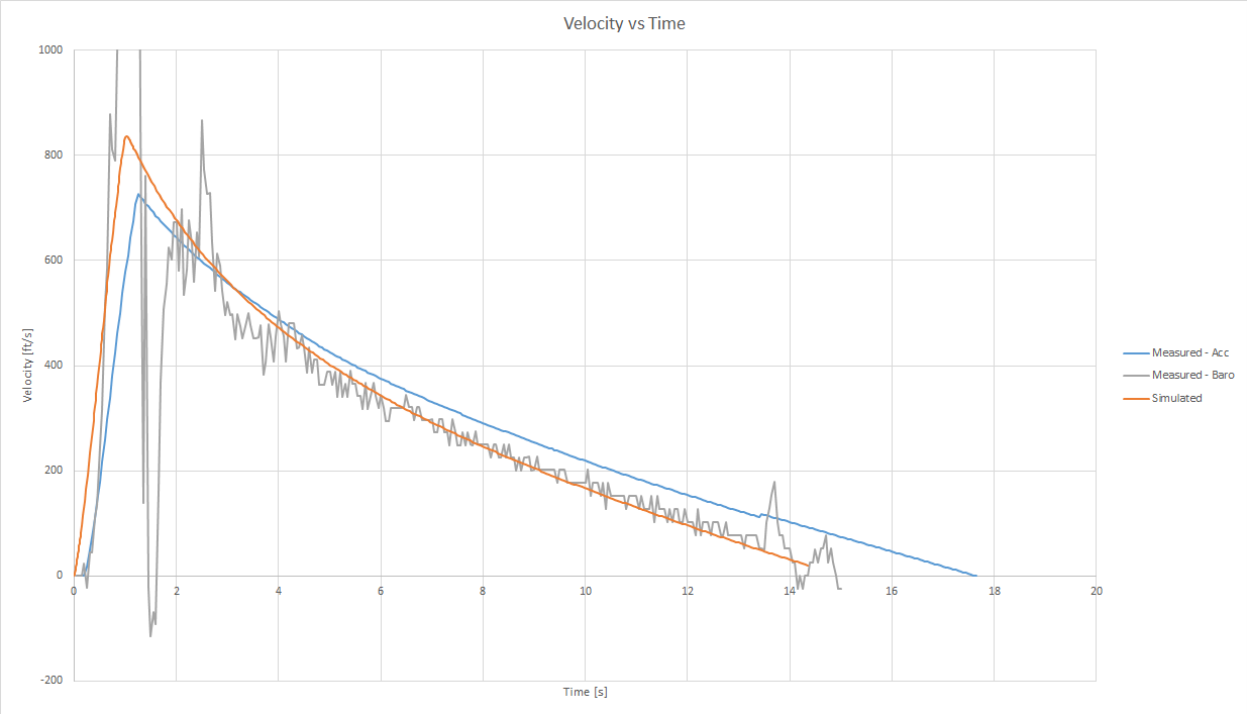

FIGURE 2: PREDICTED AND MEASURED DART VELOCITY VS TIME.

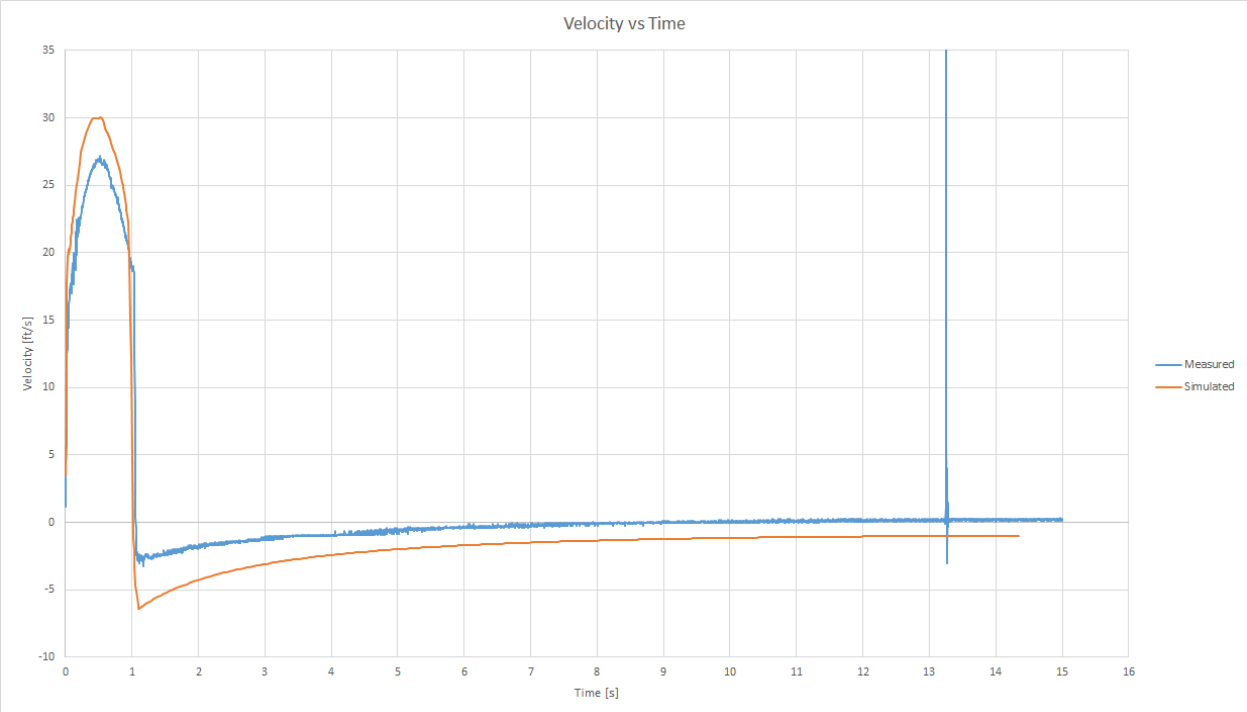

FIGURE 3: PREDICTED AND MEASURED DART ACCELERATION VS TIME.

Data Collection

The Data collected for the rotational sensor and the camera unfortunately did not perform as expected. At some point during the crash of the dart, the Micro SD card was forcibly ejected from the rotation sensor. This card then shattered into several pieces. Regretfully, no data was recoverable.

To further complicate the data collection, the camera also did not perform as expected. More specifically, the apparatus designed to allow the camera to see in the boost phase did not provide as clear of an image as had been hoped for. In fact, the image was mostly obscured aside from blurry green images that are presumed to be the ground. This coupled with the fact that the booster did not actually separate until close to apogee, did not allow for any good video footage of the flight. Even after the dart reached apogee, the camera pod was ejected and the parachute was not. As the dart fell to the ground, the camera, attached to a string behind the dart, appeared to violently swing back and forth until its Micro SD card was also ejected. Thankfully this SD card remained intact.

The camera's failure was mainly due to inadequate testing. The mirror apparatus was designed a week before the launch during the University of Wisconsin-Platteville's final exam week. This did not allow much time for testing. Minor test were performed to ensure the mirrors were correctly aligned, and the video appeared to be acceptable. However, these tests were performed inside a building where the lighting was much dimmer than what was seen at the launch site. With this significant difference in brightness, the camera focused primarily on the inside of the apparatus meaning the image of the ground was washed out by the excess light.

Clearly, a comparison cannot be made between these two forms of data, so there is very little more than can be determined from the rotation sensor or the camera.

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