Pioneer Rocketry

University of Wisconsin - Platteville

Post-Flight Report

National Space Grant Foundation

Midwest Regional Rocket Competition

April 2014

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	(*ft.*)	3004	2,822	✓
3	Peak Acceleration	(*ft/s*^{2})	428	443	✓

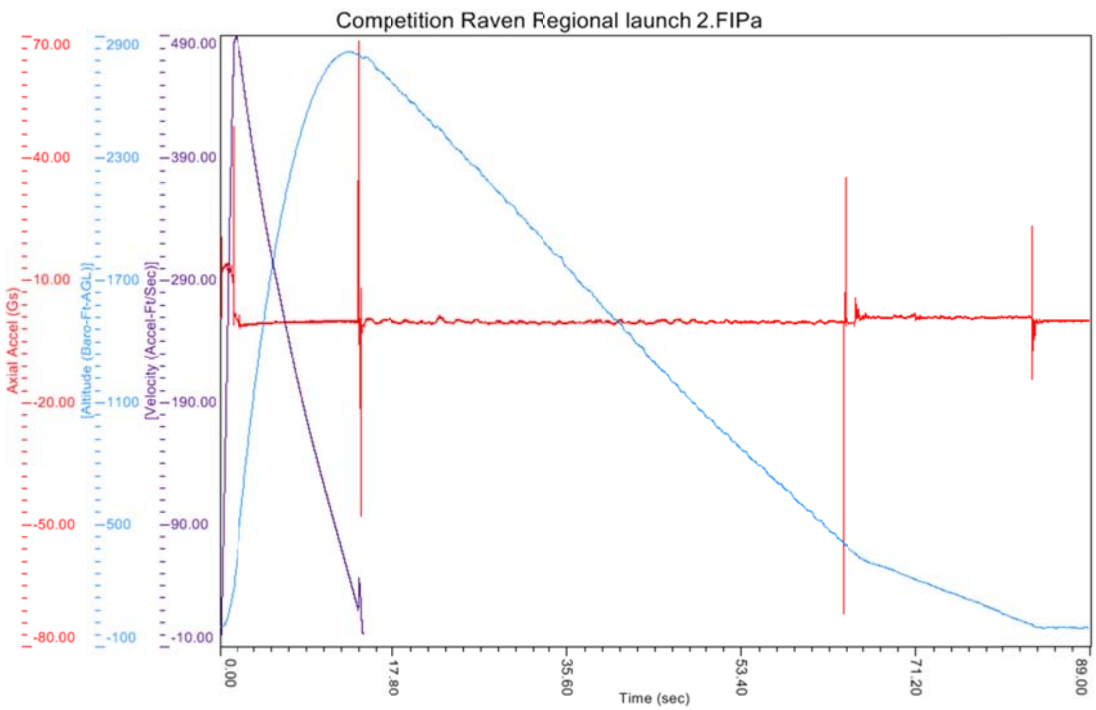

FIGURE 1:COMPETITION LAUNCH CURVES

Actual vs Predicted Performance

Estimating Drop-Zone Locations

Triangulation:

A method of approximating the location of the rocket's landing site was needed for the competition. Our team - like many others - was not initially prepared to approximate the GPS coordinates of our intended drop-zone (without being aided by on-board electronics). However Pioneer Rocketry has made a history of problem solving under time-critical conditions, and a viable system was created.

The approximate landing site of the rocket was triangulated using readily available tools including smartphones, compasses, and a laptop computer. The GPS coordinates of the Launchpad were recorded, and with the use of smartphones applications, the field-positions of six PR members were also recorded. From these fixed positions, team members stood and watched the rocket launch. Upon landing, team members would then radio in their heading (in degrees from north) to the rocket's current location to another team member waiting to input their data into the desktop application Google Earth. Using the datums of heading, and location from each team member, along with the known location of the launch pad, lines of intersection could be drawn to determine the approximate location of the drop zone as seen in figure1. Table 1 provides our predicted coordinates, actual coordinates, and error (in feet). The "ad hoc" method which we had developed narrowed our actual landing zone to a radius of under 300 feet. It is our determination, that with better coordinative efforts and a wider spread of PR members across the field we will be able to improve this method of prediction.

Drift:

Also used was a rocket drift model to predict the rocket drift distance. The model was applied in the form on an excel spreadsheet. The model took into account empirically derived parameters (like how long chutes were deployed until landing) from prior launches to predict the drift distance. The model's assumptions were that the main factors were drift due to wind when the chutes were deployed, with the horizontal drift velocity being assumed equal to wind drift velocity, and the wind drift velocity being considered constant for the duration of the flight. Other factors such as weathercocking, and drift due to launch angle were assumed to be negligible.

The model worked well for the first launch, with the predicted drift distance being within 100 feet of the actual. The models predictions were invalid (and also way off) for the 2nd launch however, because due to a controller error during the 2nd launch, both the main and drogue chutes deployed at the same time. This changed the actual flight parameters, and caused the drift model's prediction to be invalid.

FIGURE 2: TRIAGULATION OF LANDING ZONE, LAUNCH 2

TABLE 1: DROP ZONE DATA WITH ERROR

Estimated Landing Site	Actual Landing Site	Error
45.542090; -92.935541	45.541862; -92.936691	SW 298 ft

Data Analysis & Comparisons

Apogee, max velocity, apogee time:

For the 2nd launch at the regional competition, the predicted Apogee of 3004 feet was off by about 200 feet from the measured apogee of 2823 ft, and the measured max velocity was under the predicted max velocity; these were probably due to the rockets mass being underestimated for the 2nd flight. The time to apogee was accurate though, with both the measured and predicted being about 13.4 seconds.

For the second flight, the predicted max acceleration was significantly different from the measured, as can be seen by the predicted acceleration curve on the graph being significantly different from the measured acceleration line on the measured graph. However, by viewing the thrust-acceleration without the outlier “spikes”, the numbers appear to be much closer, as seen in table 2 below.

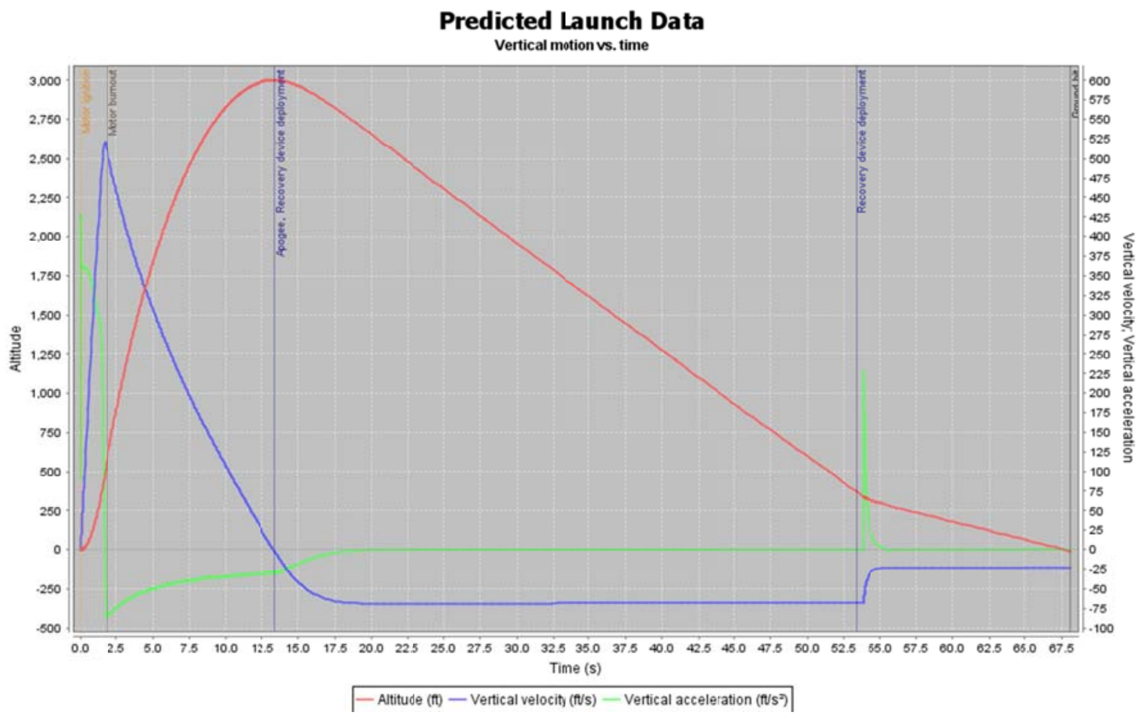

FIGURE 3: PREDICTED LAUNCH CURVES

TABLE 2 FLIGHT V SIMULATION PERFORMANCE CHARACTARSITICS

Predicted Data							Launch 2 Measured Flight Data			
Motor	Stability (Cal)	Apogee (ft)	Time to Apogee (s)	Max velocity (ft/s)	Max Accel (ft/s^2)		Apogee (ft)	Time to Apogee (s)	Max velocity (ft/s)	Max Accel (ft/s^2)
J357	1.14	3004	13.4	527	431		2823	13.4	490	443

Rocket Operation Assessment

Performance of Electronics Systems

Expected Outcomes

The goal of our electronics bay was to capture in-flight video, log velocity and acceleration, and finally to send our ground team GPS coordinates. Our two methods of measuring velocity were intended to be our Raven III's accelerometer as well as a custom pressure logging board.

Actual Outcomes

Overview

Our electronics systems worked much more consistently than they had at the Wisconsin state competition just several weeks ago. The improvement was mainly due to the extra few weeks we had to learn from our failures at the state competition. All systems were up and running properly by the time we made it to the launchpad. Unfortunately the rocket was sitting on the launch pad for quite some time and the battery in our Raspberry Pi that was taking pictures died. After the launch we also learned that the secondary barometric system for measuring velocity had failed. After a little investigation we assume that the system accidentally detected a second launch and overwrote the data stored on the chip. Again we were able to use the GPS data as our redundant system, which logged velocity as a function of altitude and time, instead. Data from the GPS can be seen in figure 4 below.

By the time that the rest of our team regrouped after our first launch, it was decided that our rocket needed to drop weight. In an attempt to lighten the rocket we ended up pulling our camera system, two batteries, and custom logging system off the board. The electronics that were left in the rocket were 2 Ravens and the GPS system. This allowed us to still record velocity using two methods and also hopefully achieve our desired altitude. We were very pressed for time and were rushing to get our rocket to the launch pad before the 4:00 deadline. We did not have an apogee deployment during this launch and after investigation we discovered that the drogue chute's ejection charge was not properly connected to the Raven. Overall the electronics team gained some valuable experience and we hope to continue to learn from our mistakes as we compete in the future.

Barometric Measurement System

The Data logger built by the electronics team did not save data to the flash memory at the state competition. In an attempt to get the data logger to function, the team rewrote the code so that it would save data to the RAM. Our concerns regarding our dependence on volatile memory were realized. On the day of competition, loose wiring in the avionics bay caused the barometric pressure logger to reset when the rocket was handled during the recovery.

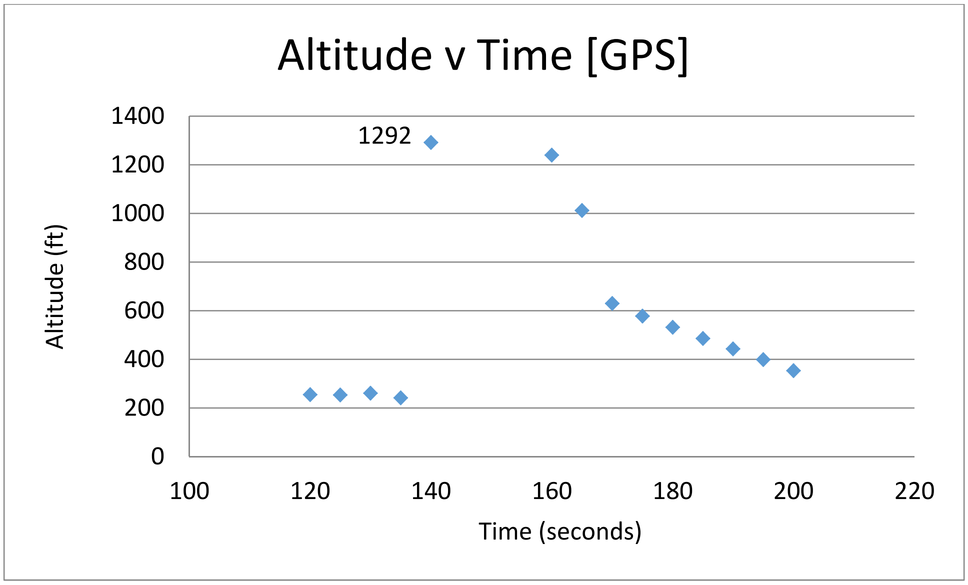

FIGURE 4: FLIGHT-2 DATA AS RECORDED BY GPS SYSTEM.

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