WSGC Competition 2013
Post Flight Report

University of Illinois at Urbana-Champaign

Team Soaring Squirrels

This document describes in detail the launch of 4/27/2013 and compares flight performance data from the rocket launch to the predicted performance. The differences between the actual and predicted values will be discussed and explained.

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1	**Operation**	
	Launch	Successful
	Drogue Deployment	Successful
	Main Deployment	Successful
	Recovery	Successful
	Flyable Condition	Successful
2	**Maximum Altitude (ft)**	3091
3	**Peak Acceleration (ft/s2)**	368.17
4	**Time to Apogee (s)**	13.75
5	**Descent Velocity on Impact (m/s)**	17.7

Launch Conditions

The launch took place at the Richard Bong Recreation Area on April 27th, 2013. The high temperature was 68° F, with an average wind speed of 11.28 miles per hour. The atmospheric pressure was 30.22 inches of mercury, and the visibility was good at 9.8 miles. There was no precipitation.

Operation

Before the rocket was taken to the launch pad, the altimeter batteries were changed, the ejection charges were loaded, the parachutes packed, and the motor installed. When the rocket was taken to the launch pad, the first thing that was done was arming the altimeters. This is a safety precaution in case the rocket accidently launches before it is supposed to. Then, the igniter was installed in the motor, and the range was cleared. When everybody was at a safe distance, and the sky was clear, the rocket was launched. The velocity when the rocket reached the end of the launch rod was approximately 76.7 ft/s, which is sufficient to maintain stable flight. The rocket reached a maximum altitude of 3091 feet above ground level.

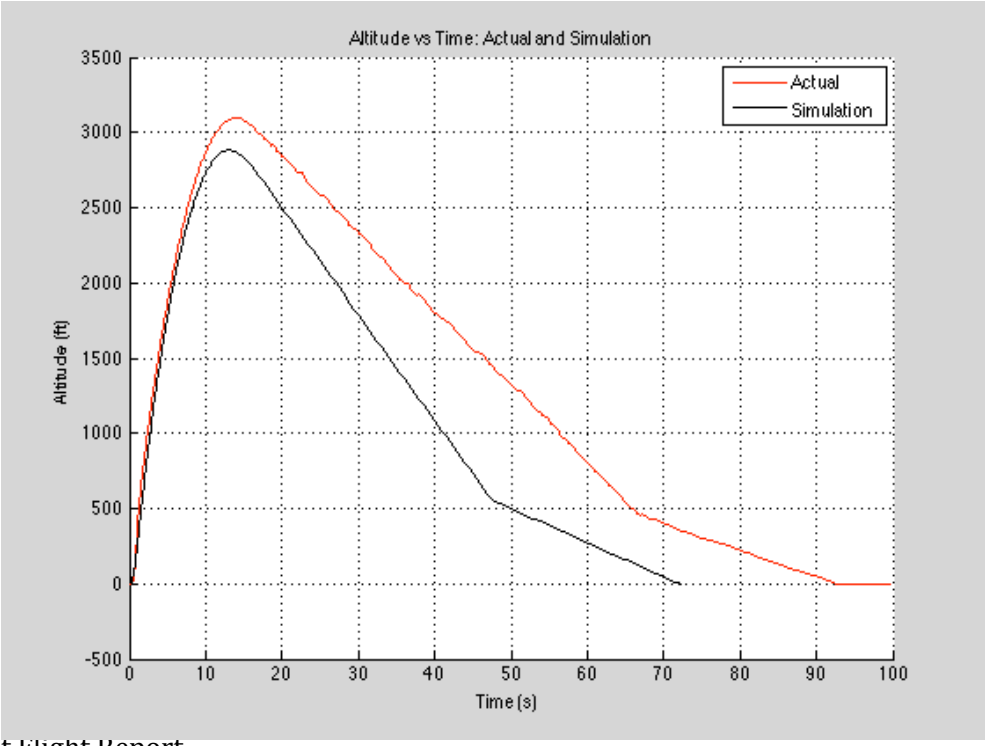
The altimeter controlled ejection charge deployed the drogue parachute at apogee, which opened almost immediately as can be seen in the graphs. Another shock can be seen in the acceleration graph around 26 seconds. This is the backup motor ejection charge being ignited. This charge wasn't actually used to deploy a parachute, because the primary electronically controlled parachute worked correctly. The rocket descended at approximately 50.4 ft/s under the drogue parachute until it reached an altitude of 600 ft above ground level. Then, the main

parachute was deployed, and the rocket descended at approximately 16.77 ft/s until it reached the ground. The rocket landed fairly close to the launch site and was safely recovered.

	Max Acceleration (G)	Max Velocity (ft/s)	Max Altitude (ft)
Predicted	15.5	497	2894
Actual	37.53	481	3091

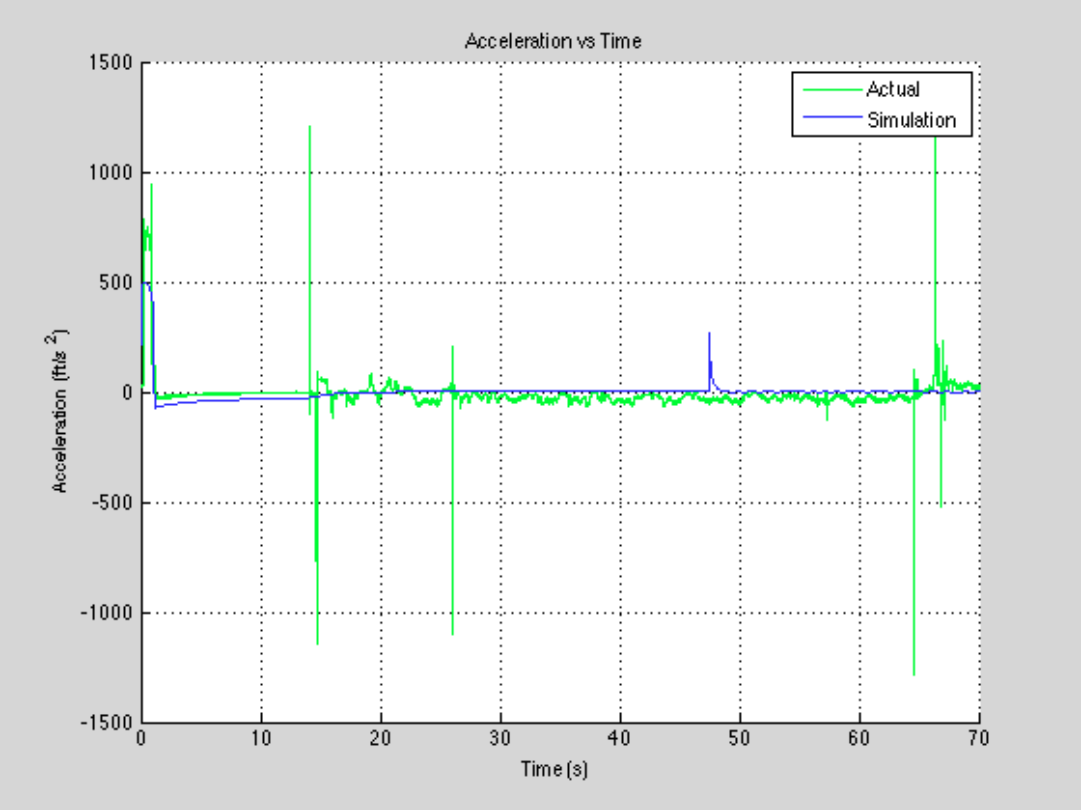
Maximum Altitude

The theoretical apogee calculated with the OpenRocket software predicted a maximum altitude of 2894 feet. This calculation was based on the assumption of a total drag coefficient of 0.57. This value was unchanged since a test flight did not occur before the competition date to compare simulation results with an actual flight. Since the overall mass and geometry of the rocket were consistent with the model, the drag coefficient was altered in OpenRocket until the predicted maximum acceleration, velocity, and altitude was comparable to that of the actual flight. It was found that a drag coefficient of 0.44 yielded results very similar to that of the actual launch.



Peak Acceleration

Based on OpenRocket, the predicted max acceleration of the rocket at launch was 499 ft/s^2. This value turned out to be quite a bit lower than the actual of 750 ft/s^2 but the shape of the curves closely matched each other. Both accelerations closely mirror the profile of the thrust curve from the I540 engine since thrust is just the mass times the acceleration except that the curve of the actual data was about 40% greater than the simulated. This could be partially due to variations in the motor. After the initial burn of approximately 1.2 seconds, the rocket quickly decelerated to apogee until the Raven next recorded a large spike in acceleration when the first ejection charge was ignited, deploying the drogue parachute 14 seconds after launch. The main parachute was deployed 65 seconds after launch again characterized by a large spike in acceleration caused by the force of the parachute being ejected and opening up. Once the main chute was fully open, the acceleration became a constant at approximately 28 ft/s^2 before hitting the ground.



Descent Rates

As shown by the graph of Altitude v. Time, the actual descent rates were slower than those simulated. Weight of the rocket was well accounted for and known precisely, so it is likely this discrepancy comes from lift on the parachute generated by wind. Also, because both the drogue and main parachutes experienced a slower than predicted descent rate, it is not likely the error lies in the simulation, but rather in wind that would be near impossible to simulate. For reference, the observed descent rates were calculated as 17.7ft/s for the main parachute, and 50.4ft/s for the drogue parachute, which deployed at apogee.

Conclusion

The most glaring opportunity for simulation error lies in the calculation of the drag coefficient. Given the resources and time, wind tunnel testing would have proved invaluable. This would have solidified the rocket's drag coefficient and allowed us to add/remove weight accordingly. Additionally, experience gained from a test flight would have helped work out any issues encountered in launch preparation. Both of these are plausible options, and given effective time management, are options that can be explored for future builds.

In conclusion, a launch to 3% above target altitude is to be considered a success given the relatively limited simulation options and build methods. As there were no active altitude control mechanisms used, a certain element of the launch's success does hinge on luck and weather conditions. Fortunately, the launch went well enough to claim the altitude proximity title, and the overall results should provide guidance for future competitions.