Post Flight Performance Report

(07/17/17)

2017 Minnesota Space Grant Consortium
Regional High Power Rocket Competition

Raider Rocketeers

Milwaukee School of Engineering

TEAM MEMBERS:

Team Mentor: Frank Nobile - maxq3@aol.com
Faculty Advisor: Dr. Anand Vyas - vyas@msoe.edu
Team Lead: Nicholas Paul - pauln@msoe.edu
Sam Nolan
Eric Rasmussen
Muffi Kaiser
Joshua Furey
Alex Van Dyck

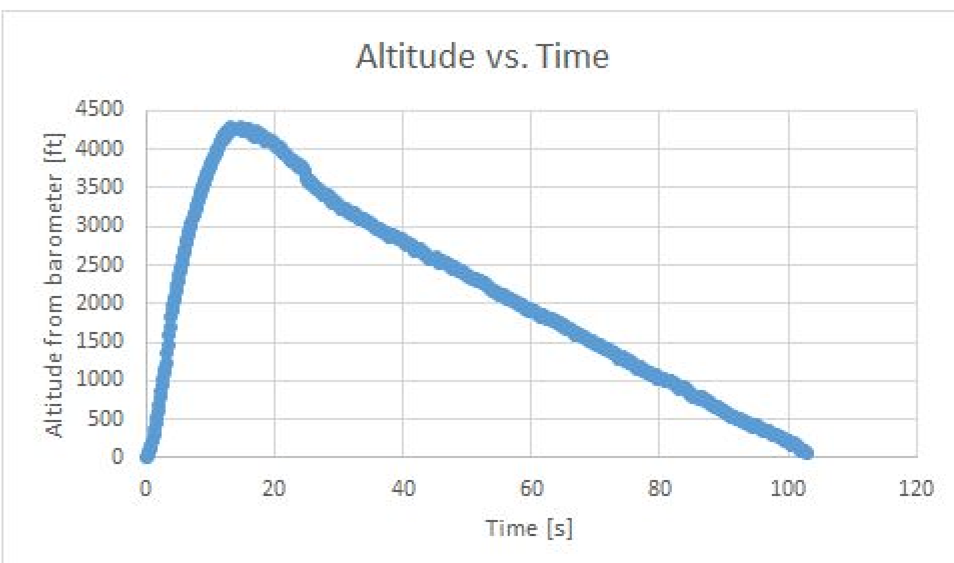
Flight Characteristics

	Aerotech J-415	Aerotech K-540
Rocket Mass (kg)	4.46	4.53
Max Altitude (ft)	4960	6590
Max Velocity (ft/s)	518	946
Impulse	1201	1593

Table 1: Flight characteristics of the two motors used in the competition

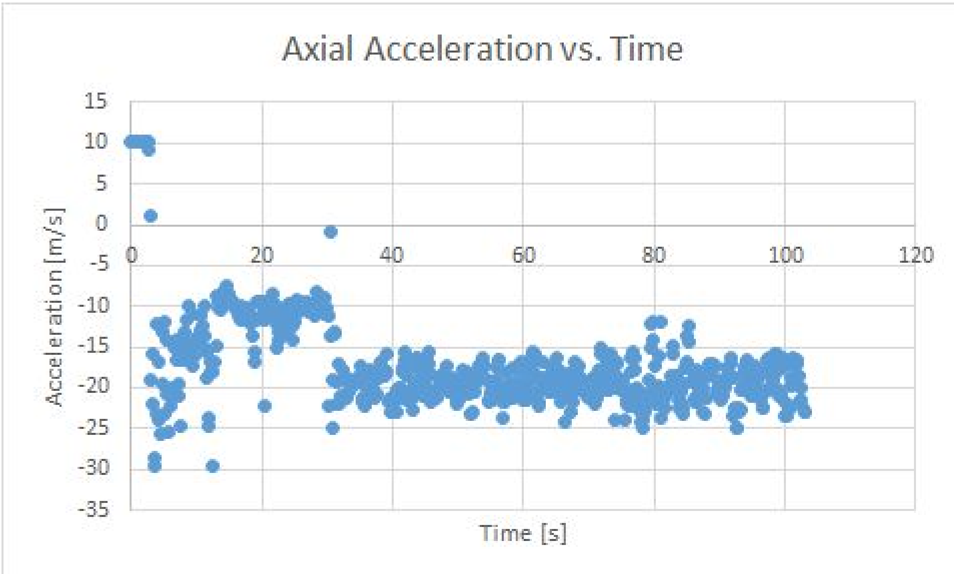
Non-Commercial Graphs

The following four graphs are from the initial J-Motor flight. This was the only data recovered from the rockets electronics, the reason for this is explained in following sections.

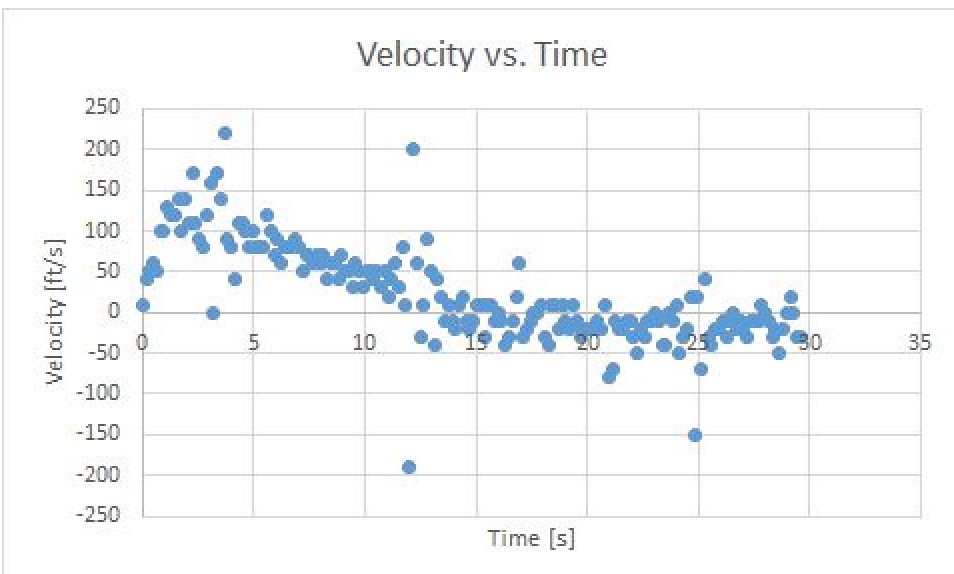


Graph 1: A graph of altitude generated by the barometer.

- Apogee of 4424 ft according to the non commercial barometer
- Apogee of 4919 ft from open rocket at 10.8 lb

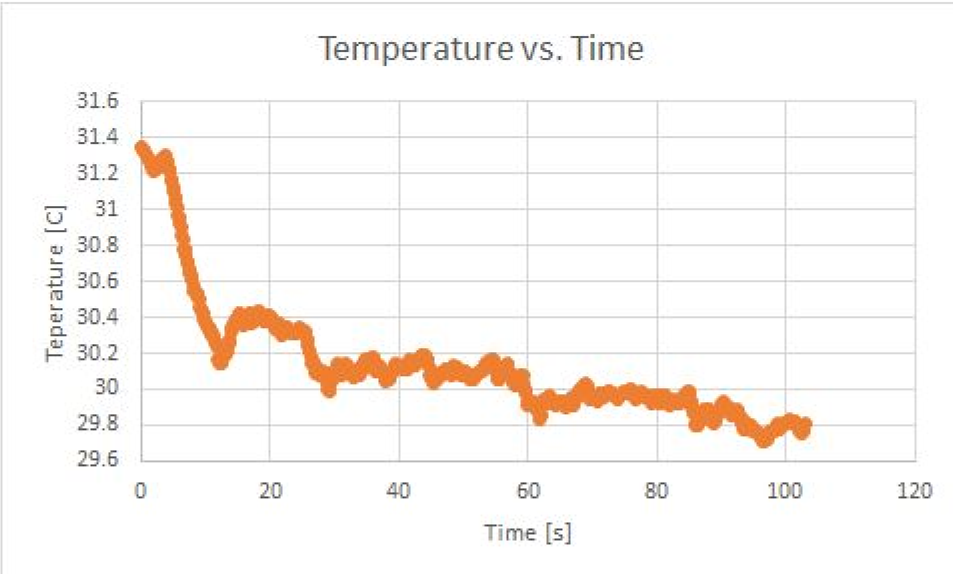


Graph 2: Axial acceleration was determined using LSM 303DLHC accelerometer



Graph 3: A plot of the *linearly adjusted velocity derived from the change in pressure vs. time using a BMP 280 pressure sensor. *The values in the table were multiplied by 1000

Other Data - Temperature



Graph 4: As the rocket ascended during the J-Motor flight the temperature dropped as expected

Comparison of Data

Altitude

From our non commercial data acquisition system a peak velocity of 4424 ft was recorded, unfortunately we were unable to compare this to anything other than our openrocket model as our commercial altimeter failed and the competition did not supply us an altimeter for our competition launch at Bong. After entering the weather data recorded at the launch site into open rocket and the launch weight an altitude of 4919 ft should have been reached. This discrepancy is hard to defend as we do not have any other data to compare it to other than the theoretical.

Acceleration

Due to the electronics issues we were unable to compare the axial acceleration data gathered by the non commercial data acquisition system to the commercial system. However the trend of the data looks correct as there is a large acceleration spike at launch followed by another acceleration spike from engine cutout.

Velocity
Overall, the velocity plot follows the general motion of a rocket with reaching peak velocity quickly and then proceed to slow down as time goes on. The velocity was calculated from the change in pressure matched with the change in time between measurements. The values calculated by the code were alarmingly low in the range of 0 to .22 ft/s. The root cause of this low number calculated is likely to come from the time difference between measurements because the barometer proved to have accurate data and was used to determine the apogee of the rocket. This leads us to believe the problem is in the code that calculated the velocity of the rocket.

Direct Velocity Results

To directly measure velocity our team used a pitot tube attached to a pressure sensor. Unfortunately the pitot tube system malfunctioned and the data acquisition proved to be unsuccessful. The pitot tube and pressure sensor were tested prior to launch and data was found to be recorded to the sd card. The root cause for our velocity measurement failure was found to be when the data was recorded to the sd card. Problems with storing the data to an sd card could result from a large number of possibilities ranging from a corrupted card to the card working itself loose during launch. Between flights, the data was not looked at due to time constraints and that the battery life of the data storage system for the pitot tube was sufficiently long enough to last all day as it was independent of any of the main electronics.

Camera System Results

The raspberry pi zero was the operating system for the cameras. One of the pi zeros was shorted out a few days before the launch and was deemed unusable. The second camera was unable to record video. The reason for this is still being determined but some causes could have been that the camera connection was broken or detached, or the delicate operating system was damaged in some way.

Overall, the raspberry pi system could be very useful in the future. A reason for its failure in this launch is that the team was inexperienced with the operating system. Now that the team has experience with raspberry pi systems, it will be considered in future rocket competitions.

Commercial Altimeter Results

The raven 3 was the commercial altimeter in the rocket. During the first flight, the raven did not detect that a flight had occurred so therefore no data was collected. The root cause of this problem is unknown. The raven was in the correct position and was programed with the proper parameters for the flight. Upon retrieval, the wires were still secured in the raven terminal block and more time would need to be spent to come to a conclusion.

The second flight did not prove to be any better as the raven faced the same problem as it did in the first flight. The altimeter was tested in our april test flight and successfully recorded that flights data. It is difficult to test altimeters in non flight conditions so problems were not detected between the successful test flight and our launch day.

Overall the performance of the raven 3 was unsatisfactory. This could have been to the lack of experience in the team using the raven 3 altimeter in addition to the possibility of it being damaged in the test flight. Also there was also a lack of documentation from the manufacture with the website being down and the inability to get a full manual from the manufacture. All of this compounded into a unsuccessful data recovery. As we launched at our home launch area we were not provided with a competition altimeter as a back up to our own system.

Electronics bay Analysis

Data Collection

For the first flight, the non-commercial data collection system worked as we had expected and was successful. The following data was collected during the flight; temperature, pressure, acceleration (x,y, and z), time, latitude, longitude, number of satellites, and sd card condition. The data was stored successfully onto an sd card inside the rocket and the data was also successfully transmitted down to the ground real time using the xbee network. The data was then successfully displayed on the computer and the status of the rocket was seen real time in addition to being redundantly stored onto the computer.

Electronics bay Performance

Overall, the electronics bay did have it’s triumphs. The transmission of the gps location of the rocket proved to be useful in locating where the rocket had landed. On our first launch the rocket landed in an area of the park that was very hard to visually locate the rocket, the gps coordinates lead us close to where the rocket was. All though the gps was extremely useful it was not quite as precise as we had hoped and was 40 ft off of the final location. Another success was the ability to detect which stage of the rocket flight the rocket was in. The electronics were able to detect liftoff, motor burnout, pre-apogee, and post-apogee. Looking forward, this is a good foundation to build upon.

Upon reviewing the data and variables that were saved to the sd card, there were some troubling finds. The calculation for the velocity was found to be extremely inaccurate. Values for the velocity were anywhere from 0 to a max of .22 ft/s. This was troubling due to the fact that the drag deployment control code for the second flight relied heavily on an accurate velocity calculation. The velocity was calculated from the pressure difference matched with the time difference between readings. Since the pressure difference was successfully measured and was accurate, this lends the problem to be the time between data collections that was problematic. Looking back, it would have been nice to store all of the variables calculated in the code onto the sd card as this would have aided the problem solving process to discover where the problem was.

Due to the velocity not being accurate and the time limitations to change the code, the decision was made to abort the control code that we had written because an accurate velocity reading was essential to the success of the control code. Instead a backup code was used to control the drag deployment on the second flight. This code just deployed the drag fins for a set amount of time after the motor had burned out and retracted the drag fins prior to apogee instead of an active drag system which was our original intent. Due to the data recording failure we were unable to establish the impact this drag system had on the rocket's altitude. However, based on our ground observations the rocket flew straight for the duration of its flight leading us to believe that the drag system did not disturb the rocket's trajectory which was very important to a successful flight. We also know that this system worked as we tested this minutes before the flight.

Overall, more testing would have improved the performance and success of the electronics bay. The team did as much as we could testing wise on the ground. We were able to test the lift off detection, gps, and many of the other variables measured. The team did find it hard to test the barometer which was critical to flight control. We tested the barometer using the elevator and a reasonable velocity was able to be calculated. But this was far from ideal compared to the different conditions and parameters of a rocket flight and riding in an elevator. If we were able to more extensively test the electronics to ensure we were getting good results, we would have had more success in the electronics system.