2019 First Nation Launch

Post Launch Assessment Report

For Wisconsin Space Grant Consortium

University of California, Los Angeles
5-13-2019

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1 Team Information

School Name:	University of California, Los Angeles
Location:	Los Angeles, California
Team Name:	UCLA Bearospace
School Advisor:	Dr. Audrey Pool O'Neal
NAR/TRA Mentor:	Frank Nobile
NAR/TRA Membership:	Tripoli Rocket Association TAP (Technical Advisory Panel) for TRA #04077
NAR/TRA Certification:	Level 3

2 Summary of PLAR Report

2.1 Launch Vehicle Summary

The launch vehicle this year was 65.915 inches in length with a 3.9-inch diameter and weighed around 11 pounds on launch day. The final motor selection on launch day was the 54mm Aerotech J450DM disposable motor as it worked the best with the final design, detailed in prior reports. Our target altitude was 4145 feet AGL calculated with no wind speed. On launch day, the actual altitude was 4020 feet AGL, mainly due to added weight and additional windspeed between 10 and 15 miles per hour at the launch site.

2.2 Payload Summary

The payload this year was designed to solve the challenge presented by the competition. The payload was incorporated into the avionics bay to centralize all electronics in the rocket. The payload contained an Arduino, a gyroscope/accelerometer module, a barometric pressure sensor, an SD card module, and a 9V battery. Data was processed by the microcontroller and outputted to an SD card using the SD card module. The challenge required that 3 data types be recorded during flight; however, the payload recorded 5 data types (rotation, acceleration, pressure, altitude, and temperature). Only 3 types of data displayed comprehendible trends whereas the acceleration and rotation illogically varied as a function of time.

3 Vehicle Criteria

3.1 Vehicle Summary

All components of the rocket performed as expected during launch except for the shear pins responsible for securing the main parachute in the rocket until it was 500 ft above ground level and one of the four fins.

During our launch, the main parachute deployed at apogee along with the drogue chute. This caused the rocket to have a much longer descent time than expected; since the winds were very high on launch day, the rocket landed very far away from the launch site and was not in view when it hit the ground. When recovered, a fin was noted missing; since visibility was not high enough during launch, it is impossible to know at what point it got detached. It is expected that there was a flaw in the attachment interface and the rocket landed near directly onto that fin, causing the detachment.

We expect that the main parachute was deployed at apogee due to failed shear pins. In past launches, we have used four to secure the upper body tube and nose cone together, thus holding in the main chute, but this year we decided to only use two. Also, due to the structural aspects of the shear pins, a hold had to be drilled and then the pins inserted afterwards. Our team did not have the correct size drill bit, and used one that was close to the diameter of our shear pin. Even so, the shear pin did not fit snugly into the hole and could have fallen out during ascent.

To fix these problems in the future, our team will conduct a more thorough visual inspection of all adhered interfaces to check for visible flaws, go back to using four shear pins to hold in the main parachute, and purchase a drill bit that is the exact diameter of the shear pins we plan to use.

3.2 Data Analysis and Mission Performance Summary

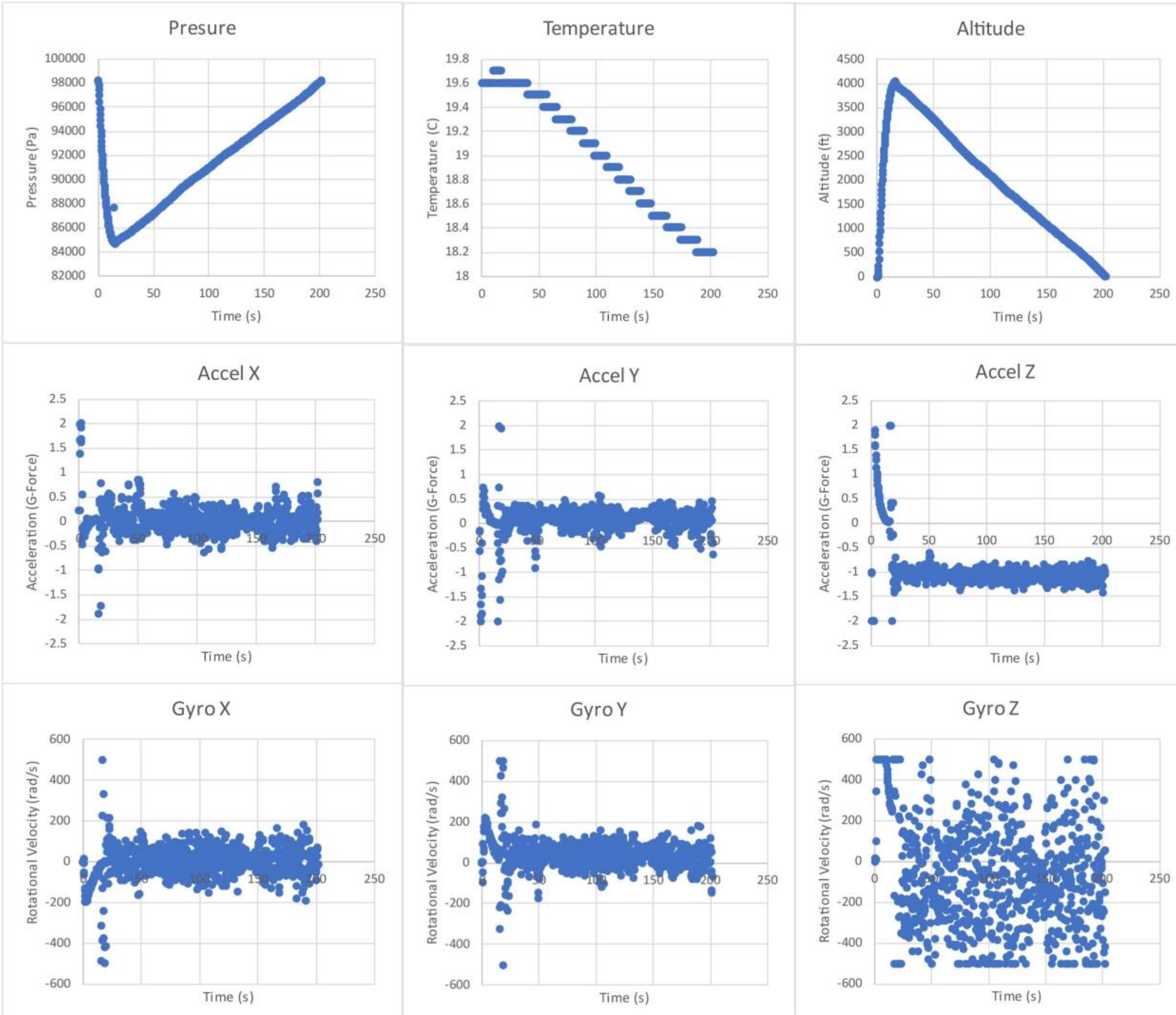

Figure 3.2.1*: Data capture from BMP180 (top row) and from MPU6050 (middle and bottom row) plotted as a function of time. Only pressure, temperature, and altitude as a function of time display comprehendible trends.*

Table 3.2.1: *Comparing predicted data from simulation with actual data from the payload.*

Data Ranges	Simulation	Payload
Pressure Range (Pa)	85252-98454	84684 - 98226
Temperature Range (°C)	5.6-13.5	18.2 - 19.7
Apogee (ft)	3904	4013

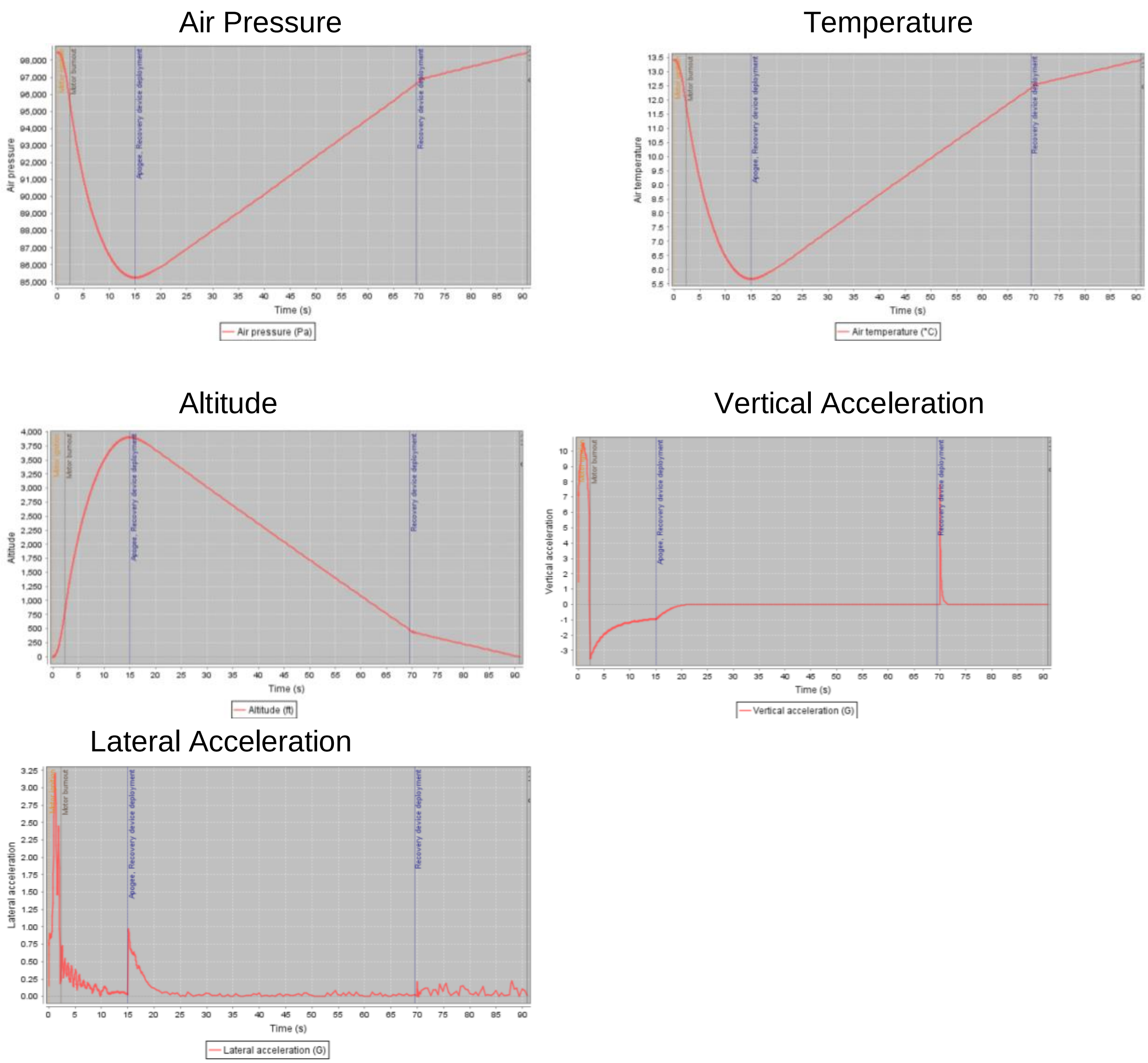

Figure 3.2.2*: Data predictions based on OpenRocket simulations.*

4 Payload Criteria

4.1 Payload Summary

The payload performed all of its operations as expected. Errors in data were due to poor orientation of modules in payload. Specifically, the MPU6050 was not angled correctly, so the acceleration data is not coherent. The module was oriented using tape, which was a poor decision since it rendered the MPU6050 useless. As for gyration in the MPU6050, the sensor is very sensitive, so any vibration during launch would spike data values, which was expected. The BMP180 performed its tasks and data shows a clear trend. This is due to the module not needing to be oriented to acquire data.

The payload performed as expected, however, certain data types did not perform as desired. Gyration was expected to produce useless data, however, acceleration was expected to produce useful data and failed. This was due to module orientation and the module not being fastened securely. Tape was used to fasten the module onto the sled, so the MPU6050 could change orientation during flight

There was no unexpected behavior exhibited by the payload. Data errors were expected since modules were not fastened correctly.

4.2 Data Analysis and Payload Performance Summary

5 different sets of data were collected. The BMP180 collected pressure, altitude, and temperature readings. The MPU6050 collected acceleration and rotational velocity in 3 axes. All modules procured data. However, when plotting the data, there was an anomaly for pressure vs time. Some of the pressures would drop then increase then drop again, following the general trend. Regardless, pressure vs time displayed a clear trend. All data acquired by BMP180 showed clear trends. This is due to the static nature of the data being required (meaning there is no velocity dependence). Due to lack of orientation, acceleration in the x and y component exhibit initial anomalous behavior. Assuming the rail and the MPU6050 are completely vertical, there should be no x and y acceleration. More surprising however, is that acceleration in the x and y axis were of the same magnitude as in the z direction. It should be expected that there should be a much greater acceleration experienced in the z direction than in the x and y direction.

5 Project Outcomes

5.1 Lessons Learned

Avionics

Our electronics sub team learned the importance of cable management and how to design a better avionics bay. At the competition, they were able to see other teams' cylindrical avionics bays that allowed them to stack modules on top of each other. This allows for better space usage and prevents stray wires from interfering when sliding the avionics subsystem into the rocket. Our electronics lead also learned the importance of delegating tasks and giving more opportunities to other team members.

Systems

Our systems sub team will be more prepared next year to create a reasonable timeline to complete the rocket. While, everything was completed on time, the team fell short on time to test the vehicle and the tests themselves weren't very thorough. After, speaking and listening to other teams, they learned about different methods to test different aspects of the rocket to prevent the malfunctions that occurred this year.

5.2 STEM Engagement

UCLA Bearospace hosted a wind tunnel workshop during AISES's Youth Motivation Day (YMD), in which attending middle school students teamed up in pairs to design their own cardboard rocket, and simulate flight in a wind tunnel built by UCLA Bearospace members. YMD is an AISES event in which local LA middle schools participate in to have middle school students come to UCLA and learn and engage in STEM focused workshops, with the intent of promoting STEM in local middle schools.

5.3 Budget Summary

The final project budget totals approximately $2,936 (accounting for donations and fundraising sources of money) in comparison to the preliminary budget given in the PDR, totaling approximately $2,573. Total final expenses equal $5,076 mostly due to the expenses of paying for 5 more airplane tickets to bring the whole team, as well as 2 rental cars for travel within Illinois and Wisconsin, with $2,140 (designated as negative amounts in the outlined final budget in the appendix) in money obtained from fundraising opportunities and UCLA organization donations from the Engineering Alumni Association (UCLA EAA) and the Community Activities Committee (UCLA CAC) Leadership Development Fund. Having obtained this donated money to spend, we were able to spend more for travel and supplies to expand the opportunities for our membership, leading to an almost 100% (~$5,000) increase from the predicted expenses (~$2,500) with a reflection of only approximately a 20% increase (~$500) in the final budget. The predicted and actual final budgets can be seen in Tables 5.3.1 and 5.3.2.

Table 5.3.1: *Final budget for this year.*

UCLA Bearospace

2018-2019 Budget

	Expense	Company	Projected Units	Projected Unit Price	Projected Total Price
Structures	*Totals:*				$475
	Body Tube	Public Missiles	1	$216	$256
	Coupler	Public Missiles	1	$45	$55
	Motor Mount & Ring/Epoxy	Apogee Components	1	$100	$100
	Phenolic Tube	Apogee Components	1	$15	$15
	RocketPoxy	Apogee Components	1	$49	$49
Electrical	*Totals:*				$123
	RRC3 Sport Altimeter	Missile Works	1	$70	$70
	SR44 Silver Oxide Battery	Amazon	2	$6	$11
	Battery Cell Holders (N-type)	Newark	2	$1	$2
	MPU6050 3 Axis Accelerometer (	Amazon	1	$5	$5
	SD Card Player Modules (x5)	Amazon	1	$6	$6
	LR44 Button Cell Battery	McMaster-Carr	3	$2	$11
	Arduino Uno	Amazon	1	$17	$17
Tools	*Totals:*				$137
	Dremel Rotary Tool & Kit	Dremel/Amazon/HD	1	$130	$130
	Dremel Blades	Home Depot	1	$7	$7
Safety	*Totals:*				$108
	Gloves (100 pack)	Fisher Scientific	1	$31	$31
	Masks	Fisher Scientific	4	$15	$60
	Goggles		2	$9	$18
Travel	*Totals:*				$4,233
	Uber from MDW to Airbnb	Airbnb	1	$25	$25
	Plane Tickets (Round Trip)	Southwest	2	$410	$820
	Plane Tickets (Round Trip)	Spirit	4	$174	$697
	Car Rental 1	Enterprise	1	$444	$444
	Car Rental 2	Enterprise	1	$377	$377
	Shuttle to LAX	FlyAway	6	$10	$60
	Uber to UCLA	Uber	2	$60	$120
	Plane Tickets (Round Trip)	Southwest	4	$410	$1,640
	Gas	Exxon Mobil	1	$50	$50
Fundraising	*Totals:*				-$2,140
	Supplies and Materials	UCLA EAA	1	-$500	-$500
	Plane Tickets (Round Trip)	UCLA CAC Fund	4	-$410	-$1,640
	Grand Total				**$2,936**

Table 5.3.2: *Previously predicted budget for this year.*

	Expense	Company	Projected Units	Projected Unit Price	Projected Total Price
	UCLA Bearospace				
	2018-2019 Budget				
Structures	*Totals:*				$431
	Body Tube	Public Missiles	1	$216	$256
	Coupler	Public Missiles	1	$45	$55
	Motor Mount & Ring/Epoxy	Apogee Components	1	$100	$100
	Screws	McMaster	1	$20	$20
Electrical	*Totals:*				$112
	RRC3 Sport Altimeter	Missile Works	1	$70	$70
	SR44 Silver Oxide Battery	Amazon	2	$6	$11
	Battery Cell Holders (N-type)	Newark	2	$1	$2
	MPU6050 3 Axis Accelerometer (	Amazon	1	$5	$5
	SD Card Player Modules (x5)	Amazon	1	$6	$6
	Arduino Uno	Amazon	1	$17	$17
Tools	*Totals:*				$137
	Dremel Rotary Tool & Kit	Dremel/Amazon/HD	1	$130	$130
	Dremel Blades	Home Depot	1	$7	$7
Safety	*Totals:*				$108
	Gloves (100 pack)	Fisher Scientific	1	$31	$31
	Masks	Fisher Scientific	4	$15	$60
	Goggles		2	$9	$18
Travel	*Totals:*				$1,785
	Toolbox	Arline	1	$25	$25
	Rocket Box	Airline	1	$25	$25
	Uber to LAX	Uber	1	$25	$25
	Plane Tickets (Round Trip)	Airline	5	$275	$1,375
	Baggage Fees	Airline	1	$25	$25
	Bus tickets	Coach USA	5	$50	$250
	Uber to hotel	Uber	1	$20	$20
	Uber to bus stop	Uber	1	$20	$20
	Uber to UCLA	Uber	1	$20	$20
	Grand Total				$2,573