Post Flight Data Analysis

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ABSTRACT

We successfully launched and recovered our rocket after it reached an altitude of 2,617 feet, however, there were a few areas where we needed some fine tuning and further analysis.

Aerodynamics/Stability

The day of the launch had great conditions with little to no wind at the time of the launch. This optimized several features including aerodynamics and stability margins on the rocket. During our pre-flight check there was concern over the quality of epoxy on the launch lugs, the epoxy did not harden the way we expected it to. As a result as we were putting the rocket on the launch rod, the bottom lug fell off. The two members of the team on the pad at the time brought electrical tape and were able to make a quick fix. However, this greatly diminished the stability of these components and as a result, it can be concluded that energy was lost during launch as that lug was eventually displaced and hung over the motor (perhaps thrust was even affected as well). Additionally, we believe this to be one of the causes for the exhaustive spin on the rocket as it ascended. The consequences of this hurt the team in terms of apogee since the rotational energy used up the trust we needed to get to 3,000 ft. Another potential cause of the spinning could have to do with the construction of the fins, if there was a precision error we did not notice that could cause an aerodynamic instability causing the rotation. Another issue that arose due to the construction of the fins was the adhesive applied. We did not mix enough hardener with one of our fillets so the epoxy still had a tacky texture during flight. Structurally the fins were sound but this could have increased the coefficient of drag. The static margin was sufficient before flight and resulted in a stable flight to apogee. From a weight standpoint, the 3-D printed canister did not need to be filled with any bebees after one last simulation was run with openrocket in the field before launch. Next year, we would like to pursue wind tunnel testing in order to get a more accurate coefficient of drag as well. This will improve the simulations thus a more accurate prediction can be gathered. Lessons were learned, and we look forward to next year to improve upon what can be considered a solid foundation to build off of.

Structural Problems

When we arrived at the competition, our rocket underwent a safety test. Everything went fine except for two problems. One was the coupler was too loose between the two sections of the rocket. The problem that could arise from this is that the section of the rocket could twist inside and get stuck when it was time for the ejection charge to fire, resulting in the rocket returning ballistic. This was a quick fix though; we just wrapped tape around the coupler until it was tight enough. The next problem was the biggest problem that arose. The tube that held the motor in place was too short for the motor, so our retention system would not work. The motor stuck out half an inch from where it should be. In order to fix this, we came up with a few ideas. One was that we were going to have to dremel out part of the tube in order to fix it. Luckily, one of the guys that helped us throughout the entire planning and building process had an adapter that fit perfectly inside our tube. This lengthened the tube, and allowed our motor retention system to work.

Altimeters

In order to launch, we had to mount the altimeter given at the competition. To do this, we had to drill holes for nylon standoffs, and then we could use nylon screws to mount the altimeter onto the sled. We then drilled four holes, and zip tied a nine-volt battery onto the bottom of the sled. We had to run wires outside one of the vent holes. These wires made a connection we twisted together that turned the altimeter on. When we were ready for launch, we would twist the wires together and insert the wires into the vent hole.

Our main altimeter, the one used to fire the ejection charges, malfunctioned during the flight. It was supposed to live stream data down to our laptop that would give us data during the flight. For some reason, the data was not streamed. We do not know if this was because the signal was not strong enough, or our antenna was not powerful

enough, but anyways we do not know the solution to the problem. We had connection to the altimeter on the launch pad before the launch. Our altimeter still fired the two ejection charges. It fired the first charge at apogee, but this did not separate the rocket. The backup motor ejection charge separated he rocket and pushed out our drogue chute, and this saved our rocket. Our second charge fired and pushed out the main chute, and our rocket landed safely.

Recovery

The recovery process was successful. However, the primary ejection charge from the altimeter couldn't separate electronic bay and main rocket frame properly at the apogee. The amount of the black powder was measured precisely both during the ground test and pre-launch check, which makes the most likely cause of the separation failure is due to the shear pin that was taped before the launch. Once it is taped, the pin loses its freedom to be pushed off from the rocket frame horizontally (During the ground test, the shear pin was never taped on the body). Fortunately the decision upon using the secondary ejection charge on the rocket engine as a fail-safe mechanism tore shear pins completely and deployed the parachute safely.

First lesson to fix the problem Ad Astra II experienced during the recovery is simple. When using the shear pins, they have to be installed only by the friction within the hole drilled on the rocket frame, or even use the pins with threads so that they could be used as screws to hold the electronic bay and the frame together.

Second lesson is that fail-safe mechanism is requirement, not an option. Without extra charge from the motor, Ad Astra II could never have been safely recovered. The model rocket with high power configuration is prone to all kinds of factors and failures unexpected, jeopardizing the safety of any personnel within launch area. Therefore, having one fail-safe mechanism is requirement, more than two is not a waste.