

Project Valhalla

Post Launch Assessment Report (PLAR)



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Team Name

Cedar Falls High School

Motor Used

Cesseroi K660

Brief Payload Description

Payload Title: **AARPS** (Autonomous Aerial Recovery parawing-System)

The parawing recovery system, as it is currently defined, consists of a parawing sheet (with an area of approximately 5 m²), two separate servos each with cords connecting each side of the parawing to their respective side's servo, an on-board power source, and lastly, a flight controller. There will be GPS connectivity between the flight controller and the radio controller on the ground, as GPS data is what the flight controller will use when relaying information to the servos to, in turn, direct the payload down to the target area. There will be a safety backup of a manual override that will allow a person to take control of the flight controller and direct the parawing down by controlling the servos via radio remote control.

Vehicle Dimensions

The launch vehicle was a 5-inch diameter body tube, and was 100 inches in height. The weight on the launch pad was 26 lbs.

Altitude Reached

The actual altitude reached was 4285 feet.

Target Altitude

The team's target altitude was 1 mile (5280 feet).

Vehicle Summary

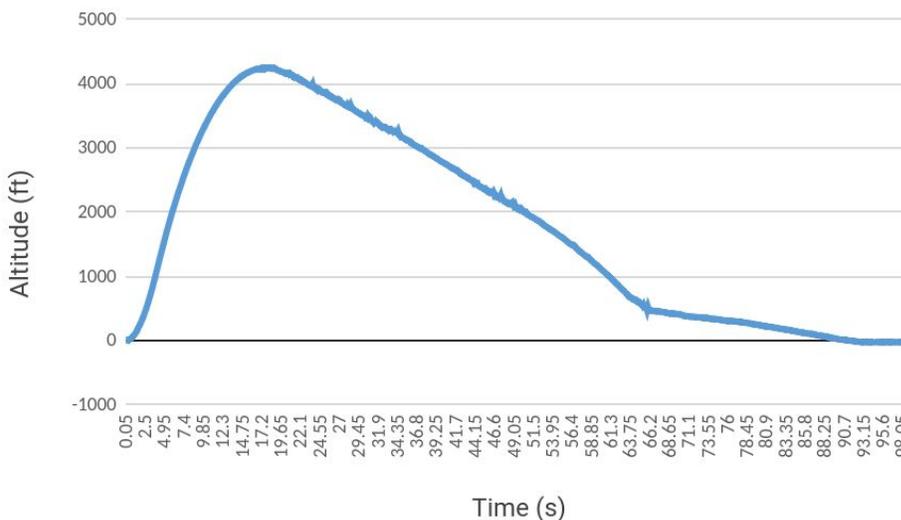
All flight events occurred successfully. At apogee the drogue chute was deployed successfully, and then at 700ft, the main parachute was also deployed successfully. The launch vehicle itself

was successfully recovered with no damage to any parts of the vehicle. However, the altitude reached was less than expected. The team believes this could be contributed to the added weight of the paint on the rocket as well as the higher temperatures and higher humidity than was expected on launch day. Our motor was also changed after the full-scale test launch and the new motor had not been flown so the predictions were less reliable because of the lack of actual flight data.

Data Analysis & Results of the Vehicle

The vehicle reached a maximum altitude of 4,285 feet. The drogue chute also deployed successfully and brought the vehicle down at approximately 65 mph. Once the main parachute deployed successfully the vehicle was able to descend at approximately 13 mph.

Flight Chart



Payload Summary & Data Analysis

The AARPS achieved the appropriate release points. At 700 ft it was released from the main body tube along with the main parachute and the two recovery systems did not tangle. Unfortunately, upon separation from the airframe, the payload's pilot chute experienced a higher than expected jolt because the drogue chute of the launch vehicle had become twisted during descent and therefore brought the launch vehicle down at a higher velocity than desired. This higher velocity deployment of the pilot chute cause the tether of the pilot chute to the payload to break. Once the pilot chute separated, the parawing descended at a higher velocity than expected. Because the team had to follow FAA regulations that required the parawing to be secured in a folded up position until 400ft AGL or less, there was not enough time for the parawing to fully deploy and inflate due to the higher descent velocity and therefore less time of

descent from 400ft to 0ft AGL. After the team was able to recover the payload it was evident that all components of the payload (ie flight controller, servos, etc.) were not damaged, but they had all successfully performed their functions.

In summary, all of the electronics performed as expected and desired, but they parawing did not have sufficient time to fully inflate because the pilot chute was separated and therefore the payload descended at a higher velocity giving it less time to deploy.

Scientific Value Achieved

The payload was unable to perform its functions in a manner that would give the team scientific value directly related to the parawing design and functions. However, the team does want to note that they still activated all electronics, flight controller functions, and tracking equipment with great success. The team also plans to perform more test launches over the coming months.

Visual Data Observed

During the launch we had a successful flight and recovery. We had successful separation of drogue at apogee and successful separation of the main and deployment of the payload. The payload did have some troubles with the pilot chute getting separated, which was discussed more in depth earlier. Overall the majority of the flight was successful.

Lessons Learned

Throughout the nearly year long project, the team has learned many valuable lessons. Two of the first skills we acquired were time management and distributing workloads among the team during reports and presentations. With an increase of team members compared to every year past, this year's team had enough members to be able to divide the workload more comfortably and accomplish much more in-depth successes in many more aspects of the project. There were times when team members disagreed with each other and they learned to come to compromise or come up with another solution that was acceptable to everyone. There was even a time when some team members felt that other members and subgroups were causing the team to be questioned whether they should continue the project during one of the review presentations. It was a point of contention, but the team captain and team educator stepped in and mediated the situation to finally get everyone working towards the same goal again. It was a great life lesson that you can place blame on other people in a group for not doing their work, but ultimately blame doesn't get the job done. Rather, communication and teamwork will prevail. It ended up that the members upset at certain subgroups of the team did not realize that those subgroups had done significantly more work than they thought they had and it was just a matter of the NASA review panel experts having a lot more questions that the students did not anticipate. Once students from both sides of the argument were able to communicate all

information, everyone felt a better understanding of the situation and the problem was finally resolved. The team also learned about the importance of precision especially during the launch vehicle construction. Only four of the team members had every worked with high-power rockets, but every student was able to be at least some part of the construction and flight readiness process. It takes more than one or two people to be a successful team. Lastly, the team learned about how to adapt and make last minute decisions. During Launch Week in Huntsville, we experienced a few last minute technical difficulties. The team brainstormed several ideas and worked together to develop an effective solution.

Summary of Overall Experience (what you attempted to do versus the results; how valuable you felt the experience was)

All in all, the NASA Student Launch was an incredibly valuable experience. We attempted to send our launch vehicle to 5,280 feet and have our payload, which was the nose cone and electronics inside it, separate at 700 feet, and then have a parawing deploy at 400 feet with a successful and safe recovery of both the payload and launch vehicle. On launch day, the launch vehicle went to 4,285 feet with everything going smoothly, and the payload separated from the rest of the launch vehicle at 700 feet. The pilot chute of the payload deployed successfully at separation, but it ended up separating from the payload. The manual chute release was then triggered once the payload hit 400 feet. The parawing deployed, but due to the pilot chute separating from the payload, the parawing didn't have enough time to really demonstrate the autonomous recovery system. Everyone on the team felt as though this launch still had several successes. It was evident from other team's launches that just getting the rocket off the pad and back down safely isn't always guaranteed. So even though the payload did not perform as desired, it was still a very successful launch. And as was mentioned previously, the team also plans to do more launches over the summer and get a 100% successful launch.

STEM Engagement Summary

Our STEM Engagement was incredibly successful with outreach to almost 1,000 different people by means of attending multiple different events to inform others of our project and payload design. With the Engineers Week Showcase presentation at John Deere, students attending were able to engage with our members and discuss our payload with dynamic questions. Our team had the opportunity to broaden people's horizons in rocketry at other events including a local restaurant and the Cedar Valley STEM Festival with hundreds of people in attendance. This event is comprised of many different booths covering topics of STEM related projects and information pertaining to these sciences. Overall the team was able to expand our STEM engagement significantly due to several reasons. One reason was because our team grew to 14 members which enabled us to be able to designate specific team members to the STEM outreach area. More time was able to be dedicated by team members and more

opportunities were also afforded to the team because of our incredible success in the previous year's 2018 SLI project.

Final Budget Summary

The receipts are still coming in so the exact budget and final costs of this year's project are not 100% finalized, but we are able to confidently estimate the total expenses of the project to be approximately \$10,500. The total cost of materials, electronics, payload equipment, motors, and travel to test launches came to \$4,750. The travel expenses from the trip to Huntsville are estimated at \$5,500 including \$3,500 in hotel costs and \$2000 in gas for vehicles. The team was able to use the \$1,000 that was in the club account to start the year and then raise \$10,000 more throughout the year using multiple fundraising strategies. The team was able to secure some larger local company sponsorships along with multiple smaller company donations as well as several donations of materials, time, and discounted services. Because the team won the "Judge's Choice" award and with it the generous donation of \$2,000, the team will be able to carry over approximately \$2,500 to start next school year.