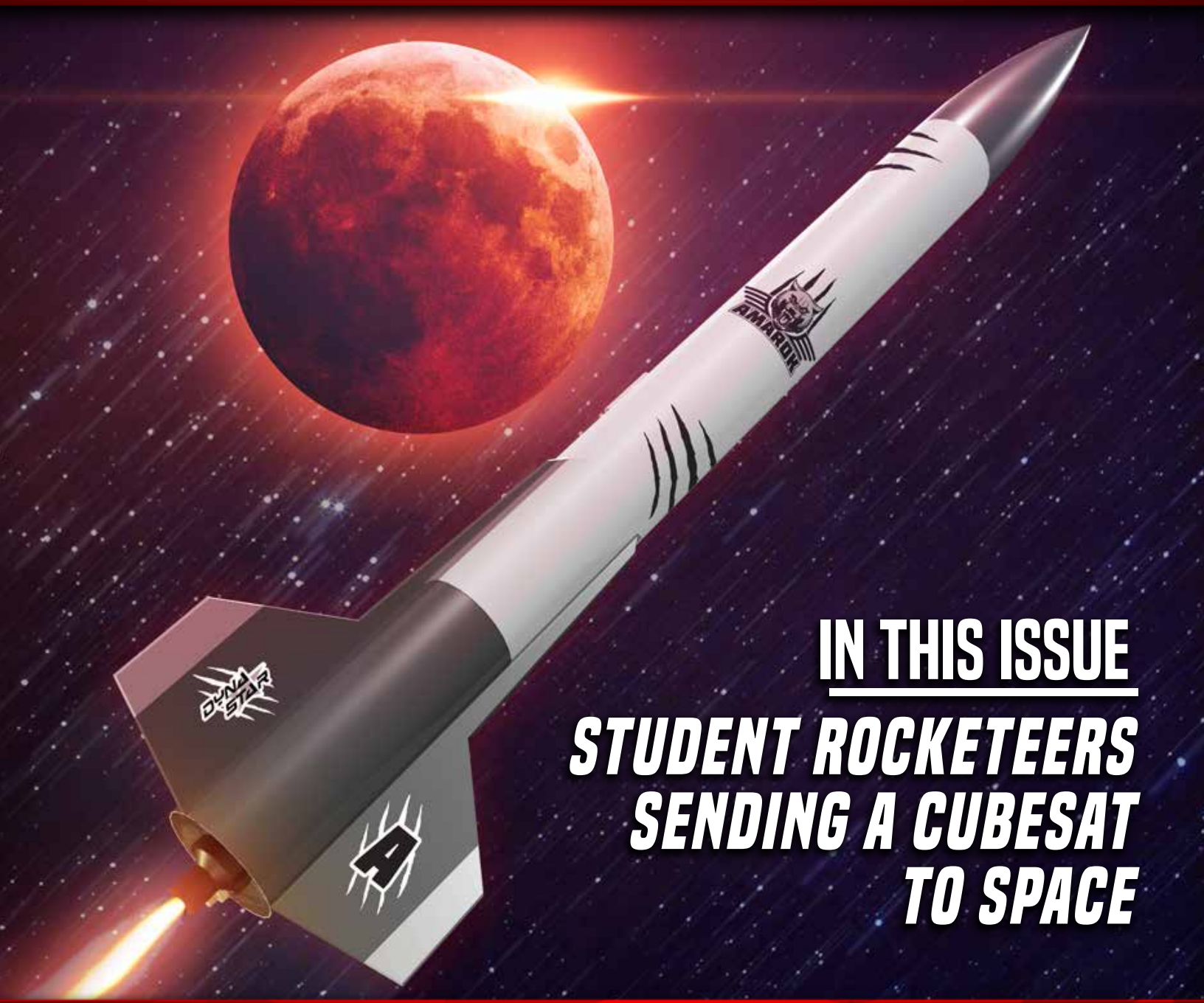
PEAK OF FLIGHT NEWSLETTER

ISSUE 532 / OCT 13TH 2020



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PEAK OF FLIGHT

Student Rocketeers Sending a CubeSat to Space

By Bobby Potter

The Portland State University is just a few months away from an important delivery date, the delivery of their OreSat to the company that will be putting it into orbit. Even though the team is sitting on a fully locked down campus, the Portland State Aerospace Society (PSAS) is hard at work and full speed ahead. They've figured out a way to continue progress while being unable to meet in person by using a full suite of digital resources, and just a person or two at a time meet to make the physical changes to the OreSat.

Unfortunately for the rocketry team at Portland State, NASA can't just put a hold on their launch schedule. They either make their deadlines and catch a ride to space, or they don't. New problems require innovative solutions, and the team at Portland State is bound and determined to get it done on time, safely, and at the highest quality they can deliver. They are the perfect case study for a team working smart to keep everyone safe, while still plowing ahead to their lofty goals.

Their stated two main goals are the OreSat, and the Base 11 Challenge.

The Importance of the OreSat

FIGURE 1: ORESAT RENDER

Back in 2017, PSAS received approval from NASA to build Oregon's first Cubesat, and it has been under development since that time. A Cubesat is a small satellite, measured in "units" (being 1U, 2U or 3U typically) designed to reduce the cost of access to space. Each unit is a 10cm x 10cm x 10cm cube, so a 3U satellite would measure 30cm x 10cm x 10cm.

These satellites are small enough that they can usually be launched alongside other cargo, and are typically used by universities to be able to put a functional satellite in space at low-cost.

Originally the goal was to launch their satellite in 2020, but due to various delays (namely a pandemic) the launch date has been pushed until 2022, with a demonstration satellite to be launched in Q2 of 2021. The first will serve as a technology demonstration, while the second will provide the full working infrastructure to accomplish the OreSat's goals.

The first of the CubeSat deployments will be Oregon's first satellite in space, and has led the team to their name, the OreSat.

This CubeSat is designed to accomplish two tasks. First, it will be using a camera, provided by Dr. Greg Bothum and Eryn Congi from the University of Oregon Physics department, which is designed to track cirrus clouds in the upper atmosphere. Cirrus clouds are important to the understanding of climate science, as they absorb infrared light (and therefore energy and heat) from the sun. The ability to more accurately track their movements can make climate models more accurate. PSAS has contributors from all around the country, and this camera will make the OreSat not just functional, but add real value to the scientific community.

FIGURE 2: ORESAT PROTOTYPE

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Second, the OreSat will work as an inspirational device for the students of Oregon. Using a relatively simple design, Oregon students will be able to build a device that will allow them to connect to the OreSat and use that high-power camera to take a selfie from space. Students will be able to use a student-built device to connect to a student-built satellite, and the goal is to show young minds what is possible with a STEAM-based education.

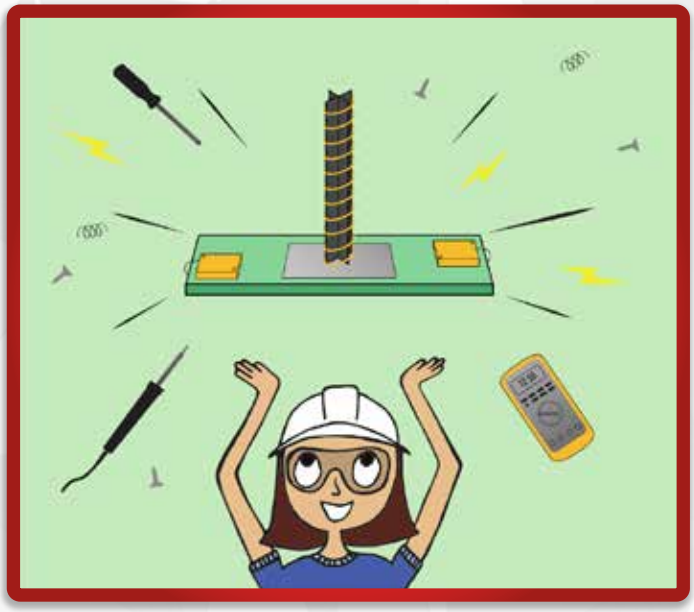

FIGURE 3: THE STUDENT DEVICE

They will connect through a long-range wifi signal, which will also take the record for the longest distance a wifi connection has ever been established. Current testing on their long-range connection system has shown it is viable to at least 125km. This is tested at ground level, where the curvature of the earth can eventually impact your signal, but that limitation won't occur from a satellite aiming down from space. It utilizes helical antennas (one on the ground, from the students, and one mounted on OreSat) and a system called DxWifi to establish these connections at long-ranges.

For power it will utilize standard solar panel configurations, and lithium ion batteries for storage.

The Base 11 Challenge

The Base 11 Challenge is a challenge to be the first university team to build and launch a liquid-fueled rocket to 100 km, otherwise known as the Karman line or the edge of space. The prize pool is just over a million dollars, and PSAS has already won $15k from their efforts in the first stage of the competition.

FIGURE 4: PSAS WINS THE FIRST STAGE

They have two rockets currently under development. The first, the LV3.1 (Launch Vehicle 3.1), is a rocket currently used for the development of a cold-gas reaction control system (or RCS). Although often RCS systems are used primarily for stability, the goal here is a little different. Their RCS system is going to be used to balance the rocket at the peak of its flight, when the air is the most thin, for a

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full 360 degree video from ground to apogee.

FIGURE 5: THE REACTION CONTROL SYSTEM

This will allow anyone to see what it would be like to ride on a rocket to high altitudes. Although the full flight has yet to take place, you can see what kind of imagery this system provides here: https://www.youtube.com/watch?v=Dklyg5MwBL4. You'll notice that at apogee (Otherwise known as the peak of the rocket's flight trajectory), the camera isn't really very stable. That is what this reaction control system will be correcting.

One particularly neat innovation they have made (and could be applicable to model rockets) is the removal of the need for pyrotechnic chute deployment. Instead, they are using surgical rubber, pulled taut but locked in place, to separate the nose cone for recovery systems deployment. You can see some of that subsystem functioning here: https://lh6.googleusercontent.com/48-pdnyqvjjce84YQzFU_3cX-rs9B4oVnUtAkm_PPA9d0ScWWpLnn2FH_myU0t0iKeneopOjwTpjEkImd3QoEK_

However, the primary purpose for this rocket is to test their new airframe design. It utilizes two carbon fiber layers with a Nomex honeycomb structure sandwiched between them. This structure should greatly increase the strength to weight ratio of their airframe, and will be an important component for their other project, LV4.

This airframe has more strength as a rocket than the LV2 program launched in some previous years, which bent under the pressure of ascent, and is lighter than that airframe by a factor of 5.

The second rocket is called LV4 (Launch Vehicle 4). The goal for this rocket is to win the Base 11 challenge. Upon completing their overarching objective, this rocket would make history by being the first liquid-fueled rocket built by a university, to reach the edge of space. They've developed a carbon fiber and Nomex honeycomb nose cone, and a fiberglass and nomex honeycomb airframe (similar to the one being tested on LV3.1) to greatly increase the strength to weight ratio. Currently this is undergoing some advanced dynamic flight analysis using a highly modified version of OpenRocket while it awaits a full critical design review this winter.

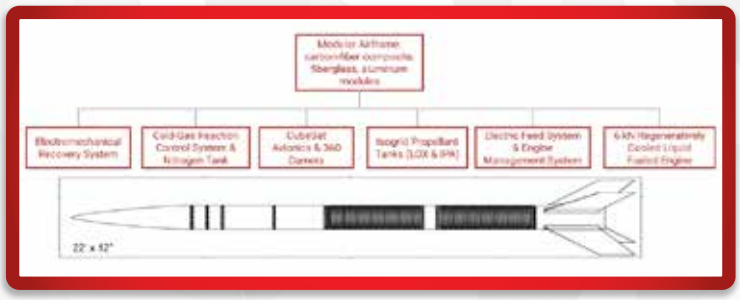

FIGURE 6: THE LV4 SYSTEM ARCHITECTURE

This also requires the development of a liquid propellant engine and test stand. Normally this would be a crazy

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dangerous endeavor, as there is much more power in liquid propellant than in their solid counterparts, and even the smallest spark could cause a massive explosion.

In the words of the adjunct professor assisting the team, “This is where the deep end is”.

FIGURE 7: THE DESIGN FOR THE LIQUID ENGINE TEST STAND.

They are working to build their engine and test stand, and are determined to make it one of the safest university attempts ever made. The entire system will be automated, meaning no one will need to be anywhere near the test stand or launch vehicle. Instead, their system will handle the entire process itself.

These engines are produced procedurally using a python script and printed from aluminum, plastic, or steel, depending on their purpose. Their current version, which is projected to produce 2.2kn and is ¼ scale, has been printed in aluminum and “hotfire” tests will be starting soon. The final engine, which will propel LV4 to the sky, will have to produce 6kn to achieve their goals. That engine will be 3D printed with stainless steel.

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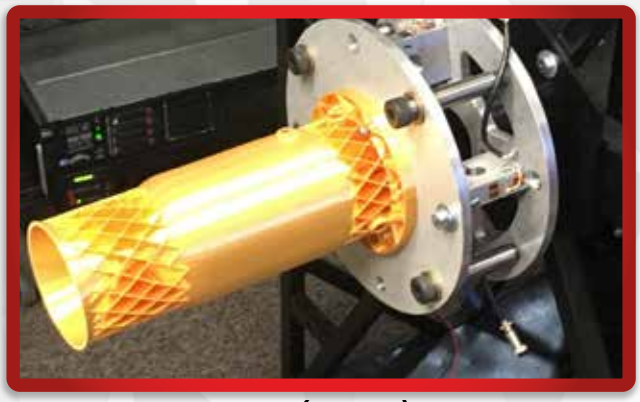

FIGURE 8: THE PROTOTYPE (PLASTIC) OF THE 6KN HEAT-SINK ENGINE.

Over the long-term, PSAS intends to use these innovations to become the first university to build and launch an orbital rocket.

How are they doing it safely?

It’s been a crazy year. Just part-way through their Spring semester, the coronavirus hit. Schools across the nation went into lockdown, classes were cancelled or moved digitally, and the hard engineering work that needs to be done hands-on became nearly impossible. After all, how can several people work 6ft apart when the project is a cubesat measured in centimeters?

So they adopted a robust system of Google Calendars, Zoom Meetings, Trello Boards and Github repositories to accomplish their goals in a fully digital environment. For the actual labor and testing, they partnered with a local business who is allowing them to use their facility to continue their work on the CubeSat, allowing only one or two people to work on it at a time. With this system, they are greatly reducing the chances of spreading the virus among each

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other, while still able to continue their time sensitive work.

Not only is this system working today, it is also all open. You can visit their Github, Trello or website to track their progress (or, university and high school programs can look at this as a model they can emulate).

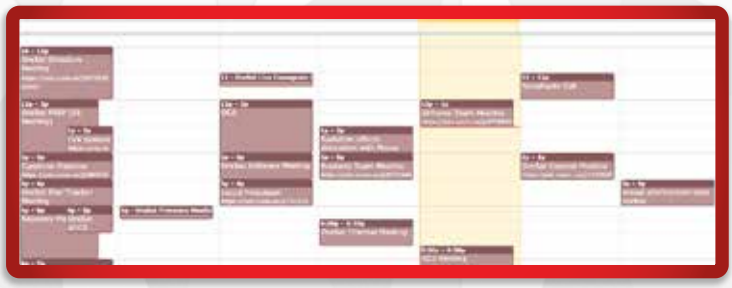

FIGURE 9: THE PSAS CALENDAR OF DIGITAL MEETINGS

The New Member Orientation was a great example of how they are forging a new path in this pandemic. It kicked off with a lively discussion of the Axelotl, a cute and interesting looking fish with legs. It was a lively discussion on the possibility of creating a deep fake video of an Axelotl with the face of one of their fellow engineering students. It was a lighthearted way to kick off the meeting.

FIGURE 10: THE AXELOTL

Then they got into the work. They introduced the team leads one by one, and they each went over the specific aspects of the projects they are working on. They talked about how each person can get involved, and how each project fits into their larger goals.

After, they broke into smaller rooms, so anyone new could go and talk with the various team leads, ask questions, and figure out what role they could play. They talked about the skills they were looking for, what they needed the most, and how you can catch up to their understanding and progress. This was a great opportunity for prospective students to get into lively discussions regarding the many different systems at play.

In attendance there was everyone from current industry professionals looking to aid in their goals to high school students looking into various collegiate programs.

Are you a student or professional, and want to get involved?

PSAS lives by the philosophy that everyone is needed. Their team consists of engineers, mathematicians, chemists and software developers, like you'd expect, but also those interested in project management, digital artists and soon-to-be marketing professionals. They conduct the organization like a business, and anyone who wants to provide value to the space industry is welcome. They have contributors from schools all over the state, and in every discipline.

And now is the start of a new semester. The seniors have graduated, and their tight deadlines require new talent. Just last week, they hosted their "New Member Orientation" in an effort to get more people involved, but it isn't the last chance to do so!

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The team gathers on Zoom for a weekly meeting. Here they discuss the progress on each of their projects, and what the goals for the coming weeks will be. This meeting is their full group and everyone is welcome, with each project then breaking off for other meetings throughout the week to discuss the more nitty-gritty details of each project.

These meetings are the best place to get involved. Send a blank email to aerospace+join@pdx.edu, join the meeting, and just listen, learn, and jump in when you find an area where you can add value. They need all the help they can get. If you can't make a meeting, check out their page on getting involved (https://www.pdxaerospace.org/get-involved).