PEAK OF FLIGHT NEWSLETTER

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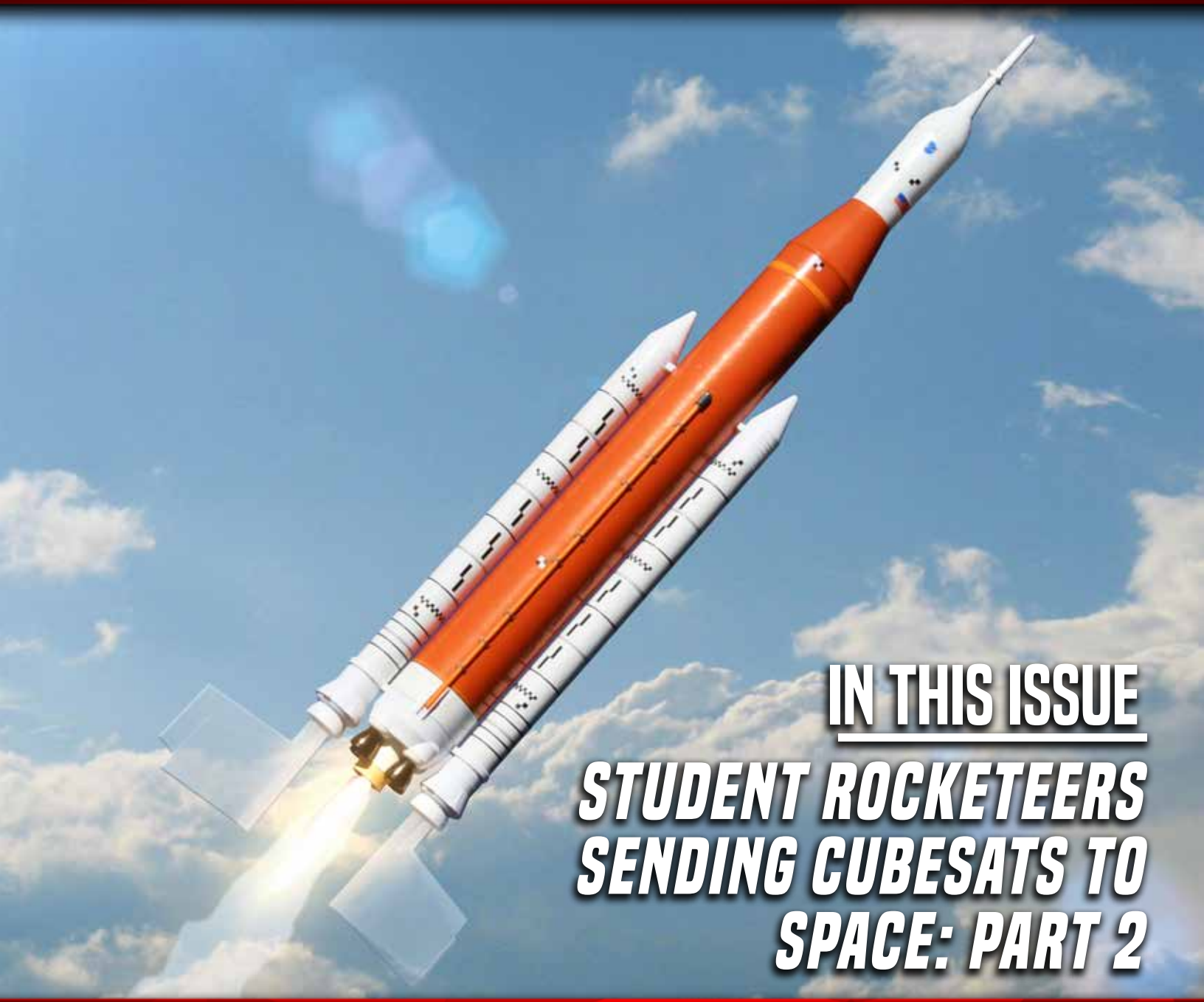

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APOGEE COMPONENTS

PEAK OF FLIGHT

Student Rocketeers Sending CubeSATs to Space: Part 2

By Bobby Potter

In Peak-of-Fight Newsletter #532 (https://www.apogeerockets.com/education/downloads/Newsletter532.pdf), we reported on some serious rocket projects from a few collegiate teams around the country. In this issue, we thought we'd update you on these students so you could see their progress, and the accomplishments of some other historically innovative teams.

FIGURE 1: THE ORESAT0!

Vanderbilt University

Vanderbilt University has had another exceptional year in regards to their university rocketry team. This year they won (for the 7th time) NASA's Student Launch Initiative (SLI) competition, which takes place each year in Huntsville, Alabama. This leaves them solidly ahead of the competition in titles won for a single university team.

This year, the competition held an interesting component. Each year the teams are required to design and launch a complex payload, but this year that payload was extra interesting. Their rocket was required to carry a UAV (Unmanned Aerial Vehicle) or rover which, upon the safe landing of the rocket, was required to collect a core sample from a sample of "lunar ice".

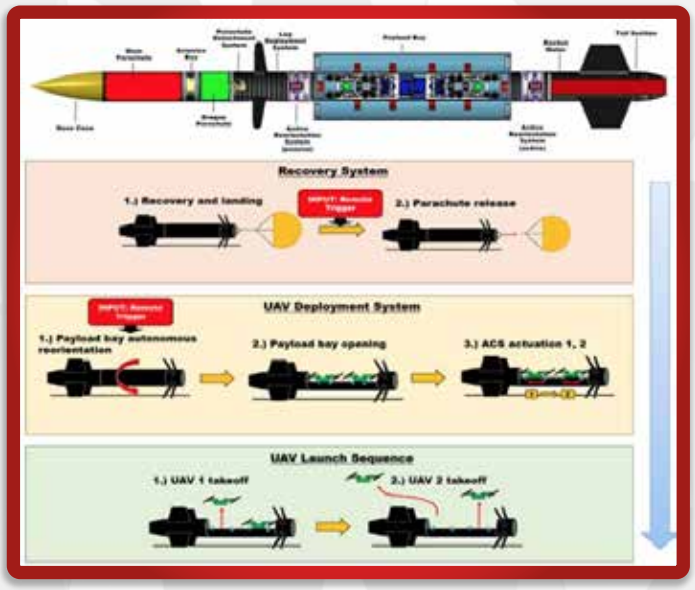

FIGURE 2: GENERAL SYSTEMS ARCHITECTURE FOR THE WINNING ROCKET.

Though the final launch of this competition was scrubbed due to the Coronavirus pandemic, the competing teams were able to use their "Full Scale Launch" test which they conducted in February 2020. During that test, Vanderbilt's rocket reached an altitude of 3,463ft (just narrowly missing their goal of 3,500ft, despite extremely windy conditions) and successfully deployed their UAV. The UAV also completed its objective twice. It collected 2 samples of about 15mL of the simulated lunar ice while under manual controls.

Although the competition ended there, they were months ahead of their competitors and were the clear victors. By the time the competition was scrubbed, they were well on their way to completing the software and hardware that would allow that drone to complete its mission with autonomous navigation and sampling, without any intervention from the ground team.

Portland State Aerospace Society

Portland State are currently just about a week away from their delivery date to NASA for OreSat0. The delivery of the OreSat0 was originally scheduled for January 20th.

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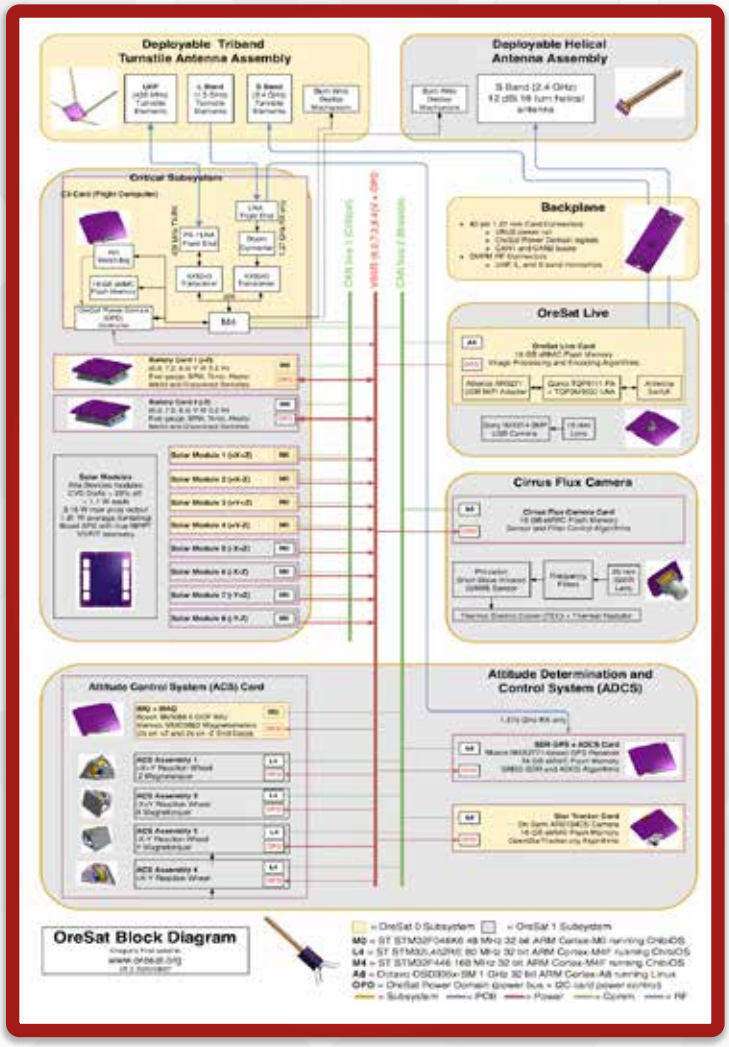

FIGURE 3: SYSTEMS ARCHITECTURE FOR THE ORESATO IS EVERYTHING IN YELLOW. EVERYTHING IN GREY AND YELLOW WILL BE PRESENT IN THE 2U ORESAT IN LATE 2021 / EARLY 2022.

Now that the deadline is fast approaching, I reached out to their program manager with the simple question "Where are we at? Will it be ready for the January deadline?"

It seems things have changed a little bit on the timeline, but everything is going well otherwise. Here's what Risto Rushford, a systems and electrical engineering graduate student, had to say:

"OreSat0 is looking good! Our rideshare provider has pushed the launch back until "no earlier than" June 2021, and so our hand-off to them is now scheduled for April 5th (just after our Spring Break). On the mission management side of things we're right on track: we have our coordination letter from the IARU (a prerequisite for an FCC license since it's an amateur satellite), and we just reviewed our submitted paperwork with the rideshare provider today and they said we were looking good! We expect our FCC license some time in the next month or so."

To learn more about the OreSat, and the other projects Portland State is currently involved in, check out our Peak-of-Flight #532 (https://www.apogeerockets.com/education/downloads/Newsletter532.pdf) or Oresat.org.

University of Michigan Rocketry (MASA)

The University of Michigan completed the third static fire test for their new liquid-fueled rocket engine for the Base 11 Challenge (back in February). Unfortunately, progress was halted there shortly after, as the pandemic set in and universities were forced to go digital.

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This liquid-fueled engine is intended for their new rocket system called the "Tangerine Space Machine", one of the better names in the space game today.

FIGURE 4: LIQUID ENGINE FOR THE TANGERINE SPACE MACHINE IN THE MIDDLE OF THEIR THIRD STATIC FIRE TEST.

MASA took the first place prize, just above the Portland Aerospace Society, for the first stage awards of the Base 11 Challenge. They hope the Tangerine Space Machine will be the system to get them the grand prize in the competition - $1 Million for the first liquid-fueled university rocket to reach the Karman Line (or the internationally defined edge of space).

You can see this most recent static fire test on Youtube here: https://www.youtube.com/watch?v=2v1LnBObIhM&t=8410s. Static fire starts at 2:18:00.

San Diego State University

San Diego State University had a big year, launching the first university built liquid bi-propellant rocket. This occurred in February, and achieved an altitude of more than 13,000ft.

"Lady Elizabeth" is a methane and liquid oxygen rocket, and more than 100 students at the university contributed to the project. It utilizes an intelligent 2-stage recovery system and their own liquid engine can generate up to 510 lbs of thrust.

This rocket was designed to compete in the FAR-MARS challenge, a joint venture by the Friends of Amateur Rocketry and the Mars Society.

FIGURE 5: THE TEAM AT SDSU AND THEIR "LADY ELIZABETH"

Texas A&M Sounding Rocket Team

Texas A&M is another university that managed to make great progress despite the setbacks. This fall, in one semester, they managed to design and construct their own liquid powered engine, complete with testing and static fires. Their new engine called "Vulcan" is set to be paired with a new airframe design they call "Lazarus".

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Lazarus is primarily a carbon fiber airframe, though it houses aluminium bulkheads and an ebay constructed from fiberglass. It is optimized for a 30,000 ft AGL flight, will be propelled by the Vulcan engine, and should reach speeds of Mach 1.4, putting significant stress on the airframe.

The Vulcan engine can generate up to 1.3k lbs of thrust. Uniquely, this engine uses a vortex injection system, which is the act of introducing the liquid oxidizer near the nozzle and at a perpendicular angle from the flow of the propellant through the nozzle. This cold gas then swirls around the outside of the engine toward the injector plate, before pairing with the propellant and igniting near the top of the combustion chamber.

Vortex injection systems have been used a few times in the past, but it is a relatively new way to handle the heat of the combustion chamber. It is a form of regenerative cooling, as it uses the liquid oxidizer being constantly pumped into the combustion chamber to cool the system. The real downside to this cooling system is that it does not cool the nozzle. I'm unclear if this is their only form of engine cooling, but it is nice to see it implemented into practical application. This great video will give you a better idea of how this system works: https://www.youtube.com/watch?v=tqEfbJRKzeQ

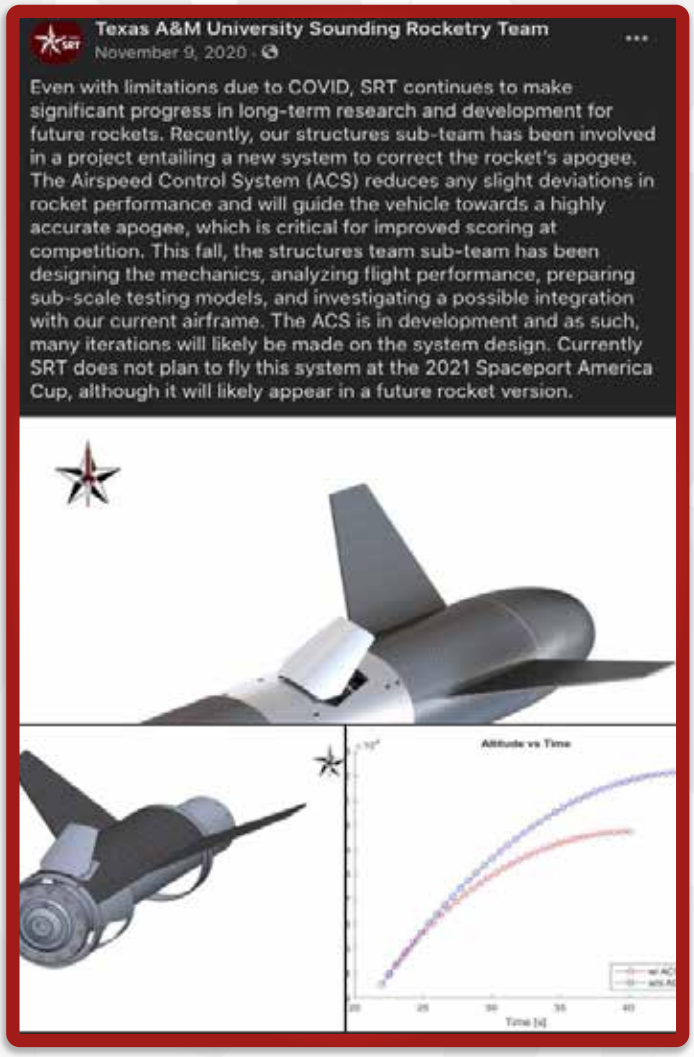

FIGURE 6: TEXAS A&M DISCUSSING THEIR PROGRESS ON LAZARUS.

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Ongoing Competitions in 2021

Student Launch Initiative (SLI)

SLI contestants for the next year of the competition have been selected. There are 46 teams who made the cut, and the rules for the coming year have been adjusted slightly to account for the limited face-to-face interactions that this new year will surely bring for some time.

This year, the payload-based competition challenges students to design a lander that can jettison from the rocket during the initial stages of descent, right itself within 5 degrees of vertical, autonomously land, and then take a 360 degree photograph and transmit that to the ground team.

FIGURE 7: UNIVERSITY STUDENTS PREPARE THEIR ROCKET FOR LAUNCH AT SLI.

This challenge is similar to last year's, where they had to deploy a rover or UAV to autonomously collect ice samples from a lunar surface. In my opinion, the hardest part of this challenge will be to get the lander to autonomously perform its duties, specifically the challenge of an autonomous upright landing sequence.

The Base 11 Challenge

The Base 11 Challenge is a $1,000,000 grand prize challenge, with the goal of launching a university built liquid-fueled rocket to the Karman line.

The first university to do so will take home the grand prize, but it isn't quite as simple as all that. First, designing and launching any rocket to the Karman line is quite a feat. That's 60 miles up, the international definition of space.

On top of that, this challenge requires the design and construction of a liquid-fueled rocket. There are several delivery stages, some of which have been adjusted to account for Covid-19 delays, but that require an aggressive timeline of design and iteration, static fire tests, and detailed reporting to be delivered for review by NASA periodically.

In the first stages of this challenge, both PSAS and Vanderbilt took home additional cash for the quality of their design and plans.

Friends of Amateur Rocketry's DPF (Dollar-per-foot) Competition

Designing, building and launching a liquid fueled rocket is such a hard task that the Friends of Amateur Rocketry are willing to pay you $1 for every foot of altitude you can manage. So far, one team has stepped up to claim the prize. With their rocket, Lady Elizabeth, San Diego State University has set the bar at 13,205 ft, taking home just as much in cash toward their goals.

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Interestingly, there is no requirement for a second rocket if the teams are also participating in the Base 11 Challenge, and so I imagine as those teams are starting to find

FIGURE 8: LADY ELIZABETH TAKING OFF FOR HER 13K FT FLIGHT!

more and more success in their designs, we will see more universities give this an attempt leading up to the Base 11 final launch day. It's like a paid dress rehearsal.

There is no scheduled launch date for this competition, and universities can enter it at any time. FAR needs at least 2 weeks notice, including all appropriate paperwork submitted prior to any launch.

To learn more about the Friends of Amateur Rocketry DPF Challenge, visit their website here: https://friendsofamateurrocketry.org/dpf-challenge/.

FAR-MARS Challenge

The Friends of Amateur Rocketry and the Mars Society have teamed up to reward university teams who are attempting to push the technology forward that will enable travel to and from Mars. This challenge is broken into two pieces.

1) Build a liquid bi-propellant rocket and launch to as close to 45,000 ft as possible. The closest team to that goal will take home a $50,000 prize.
2) Build a methane and liquid oxygen powered rocket and launch to as close to 45,000 ft as possible. The closest team will take home a $50,000 prize.

If one team, and one rocket, meets both of those objectives, they can take home the entire $100,000 prize pool.

There is no scheduled launch date for this competition, however historically it has occurred in May.

Spaceport America Cup

This year, like the other competitions mentioned above, Spaceport America has a category for liquid engines. It seems to be the push for NASA and therefore all the collegiate teams. Top prizes for the cup this year will be going to the teams that can research and develop a liquid-fueled rocket that can reach 30,000 ft above ground level.

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FIGURE 9 : THE UNIVERSITY OF WASHINGTON RECOVERING THEIR HARDWARE AFTER THEIR TOP-PRIZE WINNING FLIGHT IN 2019. (UW-SARP VIA FACEBOOK)

There is also a smaller payload competition in conjunction with the design and construction of a purpose-built rocket. The payload for each rocket can earn the team extra take-home capital based on its relevance to the scientific community, the design and construction of the payload, and how the payload actually performs on launch day.

The launch dates scheduled for this competition are June 22 - 26, 2021.

Conclusion

Overall, we are in for an exciting year for collegiate rocketry, and I hope to see some more great things early into the year. Is your collegiate team (or do you know of one) making some impressive innovations or hitting big milestones lately? Use our contact form here to let us know!

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