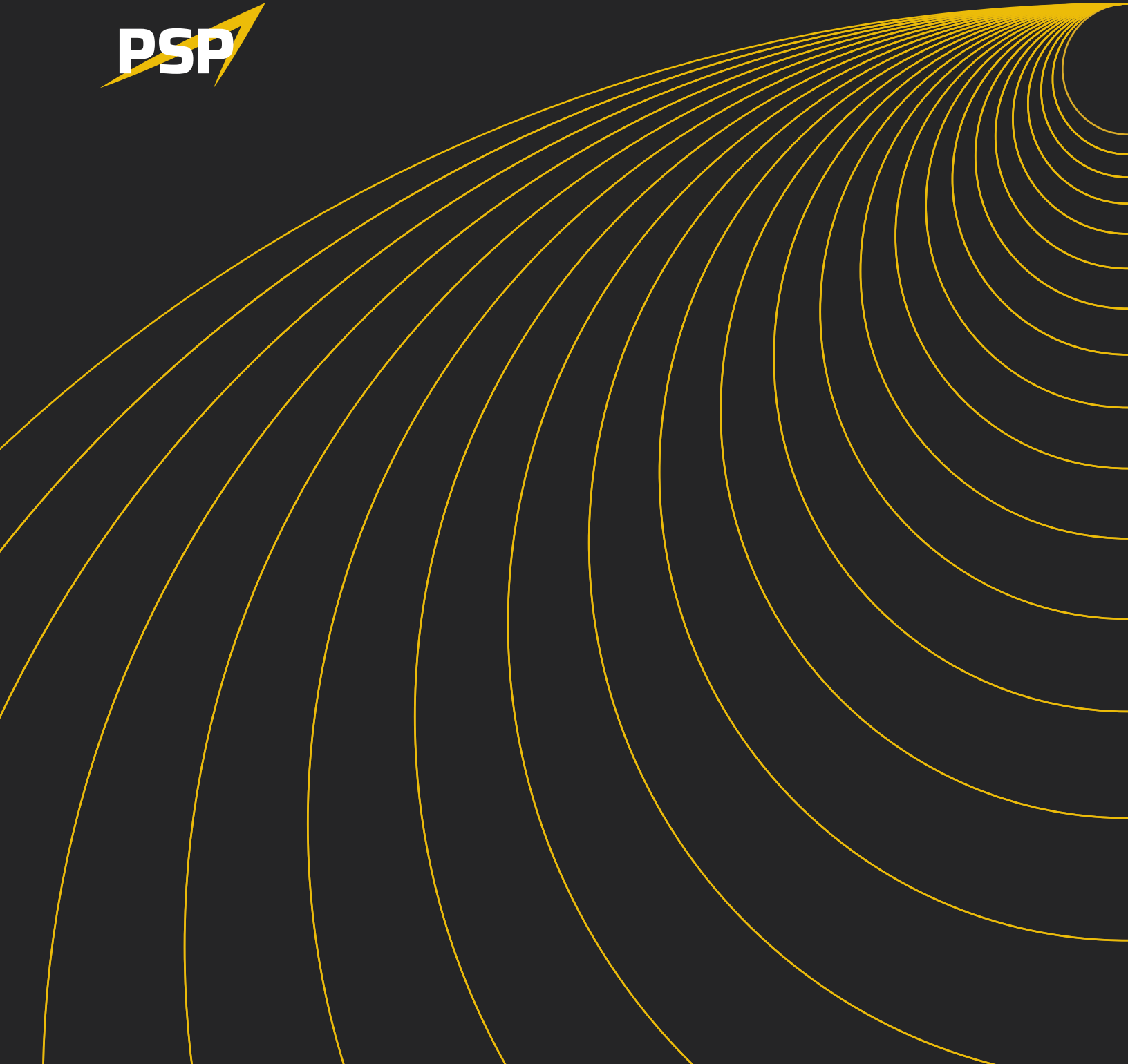


PROPEL

Chapter Report
2019-2020





We are PSP.

Purdue Space Program (PSP) is a student-led organization with the mission to empower students to innovate in space exploration. Our goal is to unite Boilermakers on campus and across the globe to investigate and develop the future of the aerospace industry. We are also one of the biggest chapters of the international organization Students for the Exploration and Development of Space (SEDS).

As part of our mission statement, PSP holds true two core values: Innovation and Empowerment. We create and drive innovation by providing students with opportunities to apply their classroom education to real-world problems and get industry-like experience. We accomplish this through our five technical teams focused on rocketry and satellite design. Each of our teams focuses on different forms of propulsion and initiatives, offering a wide range of options for students. Along with our competitive aspect, we focus on empowering others. Whether it's fellow Boilermakers or future space enthusiasts, PSP organizes many events. From outreach to local kids, to social events like stargazing and game nights, as well as high powered rocketry certifications, PSP always promotes others to discover their passion for space exploration.



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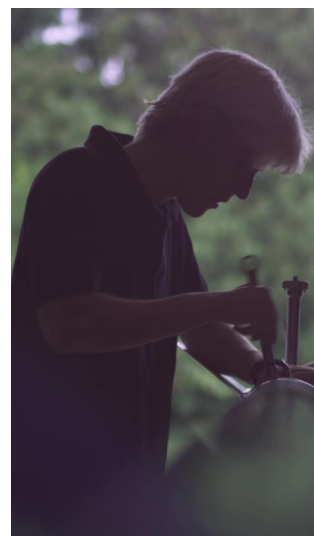
FROM THE PRESIDENT



As the 2019-2020 academic year draws to a close, I feel it is appropriate to reflect upon some of the many changes and accomplishments PSP has achieved over the past year. The most dramatic change we have seen is unprecedented growth. Over the past 3 years PSP has grown from an organization of a few dozen students passionate about space technology to a thriving and diverse community of over 200 students across many academic disciplines applying that same passion to real tangible projects that continually expand their knowledge and experience. To reflect this change, we have modernized our organization's constitution by adding new roles to the PSP Executive Board, allowing for each individual project within our organization to have a voice in our shared direction and adding guidelines to a sustainable path to future successes for following generations.

With so many amazing members and projects, it is challenging to select the highlight accomplishments of the year. However, some certainly stand out as exceptional in my eyes. First of all, the reformation of our SEDS-USA SSPI satellite design competition team. PSP has had a distinguished history in this competition with many top finishes over the years. Our new team aims to reclaim our prestige in this event as they research and investigate potential economic, societal and political impacts of space debris and analyze possible technical challenges and solutions to this growing issue.

Additionally, we have seen a revitalization of Purdue's presence in the administration of the national SEDS-USA organization with positions being filled by members of our organization. I know that they will use that platform to further spread their passion for applied learning and that their influence and experience can be the catalyst that gets other student projects across the country off the ground.



Finally, I would say our greatest accomplishment of all is the continued progress of all our amazing technical teams. To the extent of my knowledge, having 5 fully active design projects within PSP is entirely unheard of at universities around the country. I wholeheartedly believe that this is only possible because of our people. It is through that characteristic Purdue drive, ingenuity, and grit in addition to the support and expertise of the faculty and staff of the AAE, ME, and ECE departments and Zucrow laboratories that we are able to continue to push the boundaries of our knowledge and hopefully make our contribution to the development of space even more widespread.

I want to leave you with my most heartfelt sentiment regarding Purdue. The absolute variety of choice you find here at Purdue is unique. Regardless of a particular student's interest, we can all find something to be passionate about here. I feel unfathomably lucky to have chosen Purdue because I strongly believe that I would not have been provided the opportunities to expand my classroom learning that I have been fortunate to find here at Purdue. To all those out there who continue to support us and other organizations like us, thank you. You are helping create something very special to thousands of students like myself.

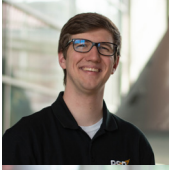
NATHAN GURGENS

President
Purdue Space Program

“Having 5 fully active design projects within PSP is entirely unheard of at universities around the country.”



EXECUTIVE BOARD



NATHAN GURGENS
President
AAE 2021



ALEX WARNER
Vice President (Fall 2019)
AAE 2021



ERIC WILLIAMSON
Vice President (Spring 2020)
AAE 2022



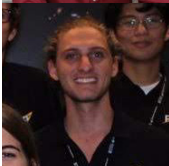
ANDREW DARMODY
Treasurer
Class of 2023



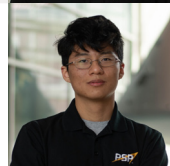
ELI MACKLEY
Secretary (Fall 2019)
MDE 2021



ETHAN COUNEN
Secretary (Spring 2020)
AAE 2022



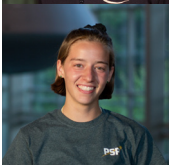
ERIK SALATA
Technical Director (Fall 2019)
AAE 2020



FORREST LIM
Technical Director (Spring 2020)
ME 2022



MAOR GOZALZANI
SEDS-USA Representative
AAE 2022



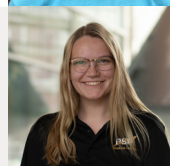
EMILY ENDICOTT
Social Chair (Fall 2019)
IE 2020



JUSTIN SMITH
Social Chair (Spring 2020)
IE 2022



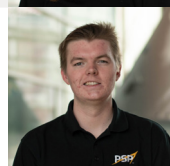
SAUNAK DEBNATH
Outreach Chair (Fall 2019)
AAE 2022



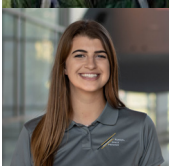
SKYLER HARLOW
Outreach Chair (Spring 2020)
ME 2022



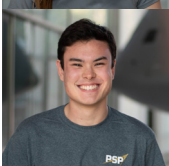
ERIC WILLIAMSON
Fundraising Chair (Fall 2019)
AAE 2022



DYLAN DILGER
Fundraising Chair (Spring 2020)
AAE 2022



BRYNNE HUNT
Social Media Chair
EE 2022



ANDREW LAPRADE
Branding Chair
CmpE 2022

TEAM LEADS

HYBRIDS

Jan Balk	Chief Project Engineer (Fall '19)
Elvin Garayev	Chief Project Engineer (Spr '20)
Austin Keck	Chief Design Engineer
Paul Adler	Aerodynamics Lead
Austin Nightenhelser	Avionics Lead
Dylan Graulich	Business Coordinator
William Gardner	Ground Systems Lead
Scott Creger	Manufacturing Lead
Cole Nielsen	Payload Lead
Dakota Jandek	Propulsion Lead
Arpit Agarwal	Structures Lead

LIQUIDS

Emily Endicott	Project Manager
Brynne Hunt	Co-Technical Lead
Will Ipsen	Co-Technical Lead
Andrew LaPrade	Avionics Lead
Maor Gozalzani	Business Lead
Nathan Gurgens	Controls Lead
Jack Costello	Fluid Systems Lead
Jeremy Casella	Manufacturing Lead
Matt Hoeper	Propulsion Lead (Fall '19)
Ben Worrell	Propulsion Lead (Spr '20)
Pat Yoon	Structures Lead

SOLIDS

Nate Yarger	Team Lead
Sam Hild	Avionics Lead
Ben Walbaum	Documentation Lead
Aubrey Mereness	Payload Lead
Erik Salata	Propulsion Lead
Cody Zrelak	Structures Lead (Fall '19)
Eli Harris	Structures Lead (Spr '20)

SSPI

Kyle Alvarez	Team Lead
Andrew Johnson	Junior Lead

STUDENT LAUNCH

Luke Perrin	Project Manager
Mike Repella	Assistant Project Manager
Katelin Zichittella	Avionics Team Lead
Natalie Keefer	Business Team Lead
Lauren Smith	Construction Team Lead
Zach Carroll	Construction Team Mentor
Hicham Belhesine	Payload Team Co-Lead
Josh Binion	Payload Team Co-Lead
Noah Stover	Safety Team Lead
Skyler Harlow	Social & Outreach Team Lead

FACULTY/STAFF ADVISORS

Scott Meyer	PSP	Zucrow Labs
Chris Nilsen	PSP	Zucrow Labs
Victor Barlow	PSP-SL	Purdue CIT



CHAPTER-WIDE UPDATE

Redefining Who We Are.

In Spring 2019, we renamed ourselves from Purdue SEDS to Purdue Space Program, as well as introduced a new brand identity. Fall 2019 marked the official pilot of the new brand identity to equally represent all the technical teams that were formed over the history of the organization.

The PSP Logo is the most significant element of our identity. It encapsulates the mission and vision of PSP and is designed to be easily identifiable in all sizes and mediums. Inspired by the unique architecture of Neil Armstrong Hall of Engineering, the PSP Logo represents our core values of innovation and empowerment. Dubbed “the vectors,” the graphical element of the PSP Logo points up and to the right, signifying forward-thinking and our desire to reach higher.

More information about the new brand identity can be found by visiting purdueseds.space/brand. ■



MIDWEST ROCKETRY FORUM

CHAPTER-WIDE UPDATE

Introducing the Midwest Rocketry Forum.

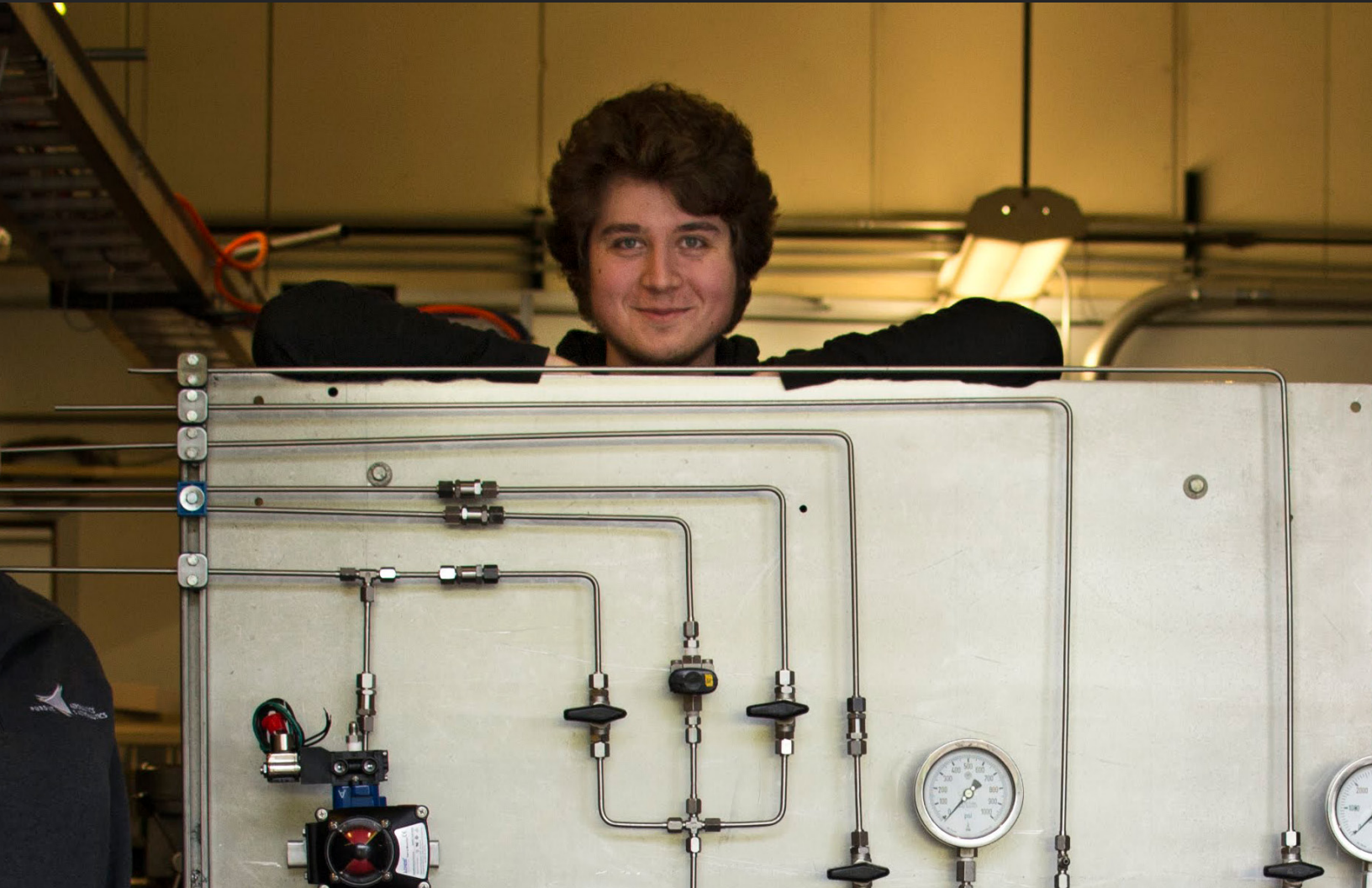
Midwest Rocketry Forum Organizing Committee

Jack Costello (*Chair*)
Bryce Castle
Ethan Counen
Dylan Dilger
Maor Gozalzani
Braden Grossfeld
Nathan Gurgens
Brynne Hunt
Ryan Jacobowitz
Nandini Krishna
Andrew LaPrade
Aidan Powers
Justin Smith

To celebrate rocketeers in the Midwest and spark enthusiasm for the space industry, PSP will be hosting the Midwest Rocketry Forum (MRF) with the support of the Purdue Student Fee Advisory Board. MRF invites all students, researchers, faculty, professionals, and teams passionate or curious about rockets to share, network, and discover the world of rocketry.

As a celebration of the 25th anniversary of Purdue Space Program, the theme for the inaugural year is *Footprints: Revisiting the Past to Step Toward the Future*. We will be looking at how we got here when it comes to space and rockets, looking at the monumental leaps that marked history, and what steps are being made now to shape tomorrow.

The Midwest Rocketry Forum is expected to take place during the Fall 2020 semester in a virtual format. In the future, expect the forum to be conducted in-person. For more information, visit forum.purdueseds.space. ■



CHAPTER-WIDE UPDATE

Celebration of Life for Kyle Runkle

At the end of the fall semester, our team received heartbreaking news. Kyle Runkle, a senior member of the Liquids team, and one of PSP's most dedicated members over the past four years, unexpectedly passed away. Kyle's passion for rocketry inspired many younger members and he was an integral part of the important projects during his time in PSP.

To honor Kyle's contributions and work for the team, PSP, together with the School of Aeronautics and Astronautics, organized a Celebration of Life event. The event featured Kyle's famous pulled pork, which our members smoked for over 18 hours using his recipe. More than 60 of Kyle's closest friends and PSP members came to share stories about their connection to Kyle, enjoy his delicious pulled pork, and celebrate the person he was. Professors Stephen Heister, Steven Collicott, and AAE Department Head William Crossley also joined to honor Kyle and share memories. The Purdue University Board of Trustees awarded Kyle a posthumous Bachelor of Science degree in Aeronautical and Astronautical Engineering. We would like to thank the School of Aeronautics and Astronautics for their support. ■

OUTREACH

1,300
People Impacted

Throughout the year, PSP has been able to host and participate in numerous outreach events that have reached around 1,300 students. This year, PSP Student Launch spearheaded the majority of the outreach events. One of the events was volunteering at Purdue Space Day. 20 PSP members volunteered for Purdue Space Day, and participated in a wide variety of events including Water Rockets, Moon Buggies, Mars Rover, Satellite Launch, Apollo 13, and were Group Leaders.

PSP also participated in PESC IDEAS, a one-day engineering interactive for elementary school students. Members worked together with elementary students to make stomp rockets.

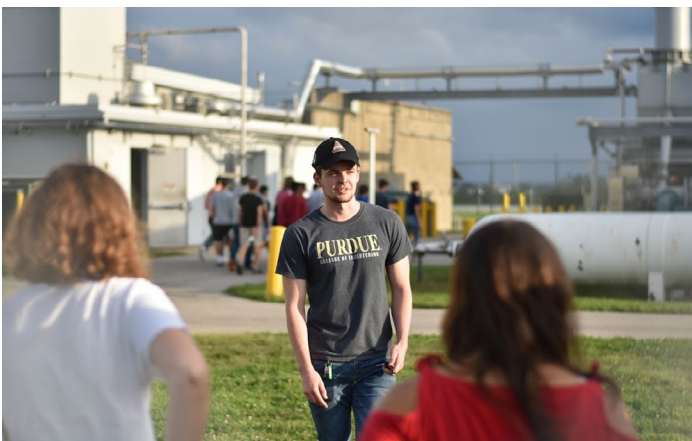
Throughout the year, PSP held several events with College Mentors for Kids to help teach students about rocketry and engineering. Additionally, PSP also participated in multiple events with the Purdue Space Day Ambassadors. PSP also helped a local Boy Scout troop obtain their Space Exploration Merit Badge. There were also several events at Imagination Station, a local children's science museum, where PSP made foam rockets with children. ■



Members Brady Beck and Dimitris Michalaros during a "strawkets" activity. (Purdue College Mentors for Kids)



Solids member Eli Harris leads a group of elementary students during Purdue Space Day. (Purdue Space Day)



Member Blake Kniffen giving a tour of Zucrow Laboratories.



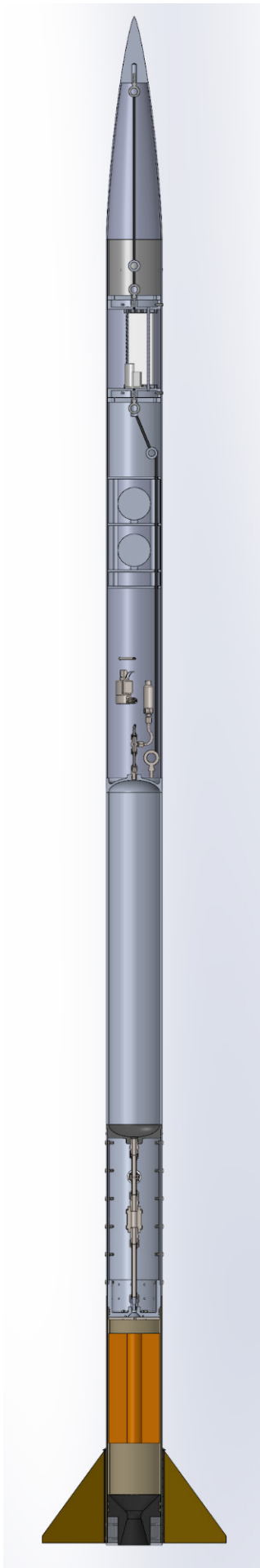
Student Launch members Jason Hickman, Skyler Harlow, and JJ Bagdan at the Imagination Station ready to build foam rockets with children. (Imagination Station)



PSP Hybrids

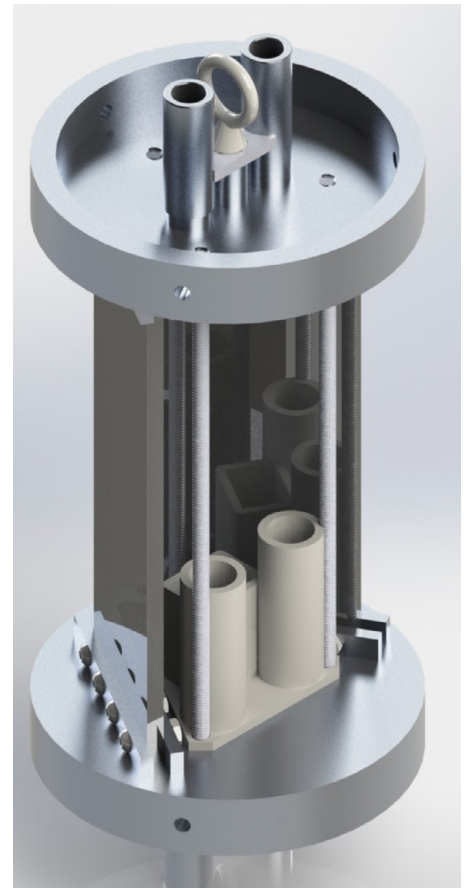
HAVOC (Hybrid Ascent Vehicle using Oxidized Candlewax) is a student designed and developed Hybrid rocket under PSP Hybrids. HAVOC's mission is to compete/conform to the FAR 1030 standards and launch to 10,000 feet with a 2.2 lb engineering payload. PSP Hybrids as a whole also puts a major emphasis on training and educating members in the science and engineering behind rockets through training sessions and a library of well documented resources.

Hosted annually in the Mojave Desert near California City, the FAR 1030 competition promotes the development of fully student-researched and built experimental launch vehicles, along with complex engineering payloads.



PSP Hybrids has completed a Critical Design Review and has moved towards manufacturing. Avionics and Aerodynamics have already begun manufacturing their components (bulk plates, fin can, fins to name a few) while the other subteams have finalized their designs and have begun creating plans for future manufacturing. Also, the Structures subteam has also been conducting Finite Element Analysis to confirm and help refine the design of critical load bearing components. Additionally, the Payload subteam recently had to start their design from scratch due to change in competition. They currently have a preliminary plan and have begun testing of the implemented cameras and designing the full assembly on CAD. Finally, Propulsion and Ground Systems hosted a second Critical Design Review to get the final approval to begin manufacturing and testing. Propulsion and Ground Systems are moving forward to develop refined plans for manufacturing and testing.

The original plan was to finish manufacturing and testing during the Spring 2020 semester and have a demo launch October 2020. Due to the recent COVID-19 outbreak, the plans have shifted towards having a January 2021 demo launch as all the manufacturing and testing will have to occur during the Fall 2020 semester. The team is still on track to compete in the FAR 1030 competition for June 2021 as originally planned. ■





Controls lead Nathan Gurgens (center) and Propulsion lead Ben Worrell (right) test the valve actuators on the launch trailer in preparation for launching Boomie Zoomie.

PSP Liquids

PSP Liquids is Purdue's liquid bi-propellant rocket team participating in the FAR-MARS competition, which challenges a collegiate team to reach 30,000 feet with a LOx/Methane rocket. PSP Liquids has manufactured and tested their first rocket, Boomie Zoomie (BZ), and are hoping to launch in the near future. PSP Liquids is currently designing our second iteration, Boomie Zoomie B (BZB), in hopes to win the competition by 2021.



Mobile trailer transformation for local launches and testing

This past year, the Liquids team has focused efforts on launch preparations for Boomie Zoomie, which includes the completion of a functional and mobile launch trailer, and design work for BZB.

The mobile launch trailer was designed to have the capabilities to launch BZ from a launch site in Indiana. The trailer is intended to serve as the launch trailer for both BZ and BZB, as well as serve as a test stand for an upcoming BZB engine test campaign initially slated for the Summer of 2020. The original trailer base was used by a past Purdue Hybrids rocket team in the mid 2000s and was restored and prepared for piping and instrumentation installation in late 2018 to early 2019. The team manufactured lines and installed tube lines, fluid components, and necessary instrumentation beginning in the Summer of 2019 and ending that following Fall semester.

Additionally, the team has worked on preparations for launching BZ including finalizing procedures and conducting a Flight Readiness Review in the early Spring semester. Due to the COVID-19 outbreak, cold flow and launch plans for BZ have been postponed to Fall 2020 or whenever it is deemed safe for groups to assemble again.

PSP Liquids has also been working on designing BZB, another LO_x/Methane rocket that aims to improve on the original BZ design and compete in the FAR-MARS competition at the FAR site in Mojave, CA. With kickoff beginning this school year, the BZB project has passed the preliminary design stage and the team is continuing to work remotely to complete design work with the goal of having a critical design review as soon as we return to Purdue and can begin manufacturing. ■



(Left to right) PSP advisor Chris Nilsen and graduate students Robert Groome and Madie Melcer review launch procedures for Boomie Zoomie.



Structures lead Pat Yoon describes the proposed structural design for Boomie Zoomie B during an internal design review.



PSP Solids is dedicated to the manufacturing and flight of a solid-fueled student built rocket. The team aims to compete at the Spaceport America Cup every year in June at Spaceport America in New Mexico. For the year and a half, the team has worked on developing, mixing, and casting our own solid propellant rocket motor for use on our currently unnamed rocket, which will fly to 30,000 feet at a future Spaceport Cup in the “Student Research and Developed” (SRAD) category.

PSP Solids has worked with professors and researchers at Zucrow laboratories to ensure that the motor is mixed in a safe manner following recommended safety procedures. In addition to the motor, the rocket, which is fully designed and built by members of our student team, will carry a remotely controlled drone that will deploy after the rocket has reached apogee and is on its descent. This drone, which has seen several iterations in design by our payload team, currently utilizes spring-loaded wings that will deploy after it slides out of the payload bay. The drone is designed in such a way that it is extremely stable at its operating speeds, which will allow remote control to be established by the ground team to ensure a successful recovery.

To date, the motor casing has had a successful hydrostatic test, which is a requirement of the governing body of the Spaceport Cup for all SRAD motors. In addition to this, a small batch of fuel was mixed, but problems with the mixing setup led to the fuel being unusable in a motor. Owing to the response by Purdue University as a result of the COVID-19 outbreak, work has unfortunately stopped on the motor for the remainder of the semester. Additionally, the 2020 Spaceport America Cup has been cancelled out of caution and for the safety of all involved with the competition.

PSP Solids has currently mixed and fired the largest solid rocket motor ever created by an undergraduate team at Purdue University, which occurred in January of 2019. The team has also completed extensive work on the autonomously deployed drone payload, which is analogous to NASA's future Dragonfly mission.

Looking forward, the team intends to continue work on the motor over the summer with the goal of doing a full-scale test of it during the fall semester. Payload tests are also ongoing, with a test flight set to happen near the beginning of the fall semester. ■



Solids launch crew at the Spaceport America Cup during the 2019 season.



Launch of Better Late than Never (2019)



Solids members working the dawn before launching Better Late than Never.



PSP SSPI is involved in the annual SEDS-SSPI competition. Usually, the competition involves teams designing a solution to tackle a problem/opportunity in the space industry. This year, the competition revolves around the issue of space debris. SEDS and SSPI want college teams to research and write a report for the best methods to handle the orbital debris problem.

The design report will cover four aspects of the problem. First, we will be discussing the extent of the problem such as the density of orbital debris and the risk they pose in various orbital regions. Second, we will discuss the political and legal factors surrounding the issue. The team will devise a hypothetical political solution that can help address the orbital debris problem. The third aspect of the problem is economics. The team will come up with hypothetical economic incentives that should be in place to encourage better behavior with regards to the orbital commons. Additionally, the team will come up with a business case for cleaning the orbital commons. Finally, the team will look at the various technological solutions being developed. PSP SSPI will come up with a recommendation for a single technology that will be able to efficiently ease the orbital debris burden at a low cost.

Since the beginning of the Spring 2020 semester, the team has conducted research in all four aspects of the problem, and has recently completed an outline of the report. The team is now writing the report which is due at the end of May 2020. ■



PSP SSPI was one of the top three teams in the 2018 challenge to present their "Sisyphus Tug-Station System" concept at Spacevision.



PSP Student Launch participates in a yearly NASA-hosted competition to craft a solid-propellant rocket with a mission-driven payload. The team designs its payload (and by extension, the entire rocket) around mission specifications given to the team by employees at NASA Marshall in Huntsville, Alabama, and presents its work to these employees in scored design reviews throughout the course of the year. At the end of the competition, the team travels to Alabama and demonstrates the ability of its design to launch and accomplish the payload mission. The team is joined by many other high school and collegiate teams from around the country, who all compete to earn awards from NASA in categories such as safety, altitude, and overall performance. This year the competition is comprised of 46 collegiate teams and 18 high school teams.

It is no easy task to participate in this competition: flight competency must be displayed to NASA through successful sub-scale and full-scale launches, and if the team is unable to successfully fly both launches on its home turf or to acquire funding to get to Huntsville, then the team has to drop out of the competition for the year. At Huntsville, the team must fly one final full-scale flight which shows NASA in person what the team's vehicle, avionics, and payload is capable of. Through all of these vehicle and payload launches, the team's safety procedures are tested to a high degree of accuracy. If there is one small step that is overlooked, the safety of the team, the vehicle, and the payload is put at risk.





In the 2018-2019 competition, the team managed to successfully finish the competition for the first time since 2013, placing 12th out of 45 teams. This year, the team expects to finish in the top 5, which is an aggressive goal but the team feels it would be selling themselves short if it pushed for anything less. The team also feels that, after having successfully completed its sub-scale and full-scale flights and scoring significantly above average on all scored design reviews to date, it is in a good position to meet its goals. The team is happy to be in this position, but it was not easy to attain; the team's first full-scale launch ended in a flight failure which caused a near-complete loss of the vehicle and payload. Undeterred by this setback, however, the team was able to pull itself back together with the help with a number of generous sponsors by constructing a new launch vehicle and payload within two weeks. The new vehicle and payload were built more professionally and flew successfully during the second full-scale flight. With such a strong capability to overcome adversity, the team is very confident it will perform well throughout the rest of the competition.

Throughout this competition, the team has not had an easy journey. One of the amazing things about the team is its ability to keep its eyes on the goal, keep moving forward, and to work together. Team members are close, as they bond both while working on the project and in classes or at team social activities like movie nights. General meetings often have a lighthearted tone to them, and it is due to this bond; despite this tone, however, the team is very serious about its work. PSP-SL is devoted to an outstanding performance in this year's competition, and the tight friendships its team members form are a part of its plan to reach that goal. ■



DEMOGRAPHICS

OVERVIEW

224

Active Members
Cumulative 2019-2020

203

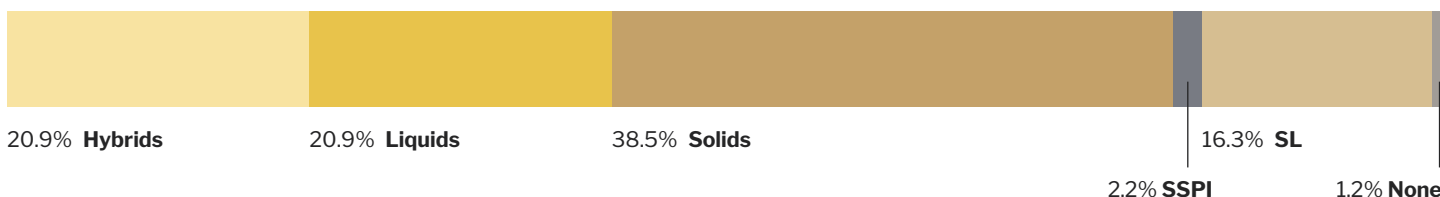
Active in Fall 2019

161

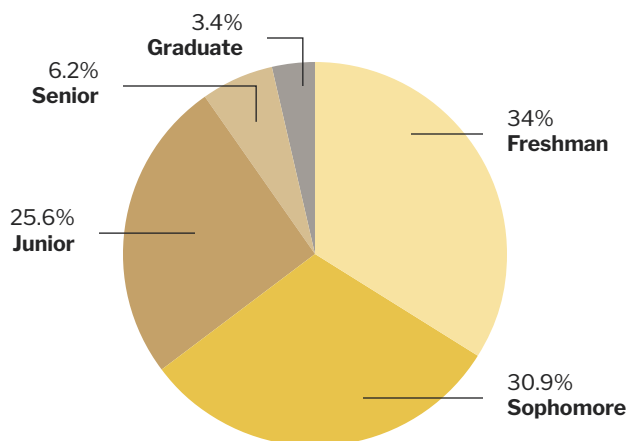
Active in Spring 2020

"Active" is defined as students who paid annual or semester dues for the organization.

TEAM PARTICIPATION



CLASSIFICATION



MAJORS

Aeronautical and Astronautical Engineering	52.0%
First-Year Engineering	32.3%
Mechanical Engineering	7.6%
Computer Engineering	2.1%
Aerospace Engineering Technology	0.9%
Electrical Engineering	0.9%
Industrial Engineering	0.9%
Civil Engineering	0.6%
Multidisciplinary Engineering	0.6%
Physics	0.6%
Other	1.5%

Breakdown includes students pursuing multiple majors.
"Other" includes students pursuing Computer Science, Finance, Interdisciplinary Engineering, Mathematics, and Mechanical Engineering Technology.

CAREERS

40+

Received Internship
or Co-Op Offers

34

Employers
Represented

AGI	Eaton	Raytheon Technologies
Agile Space Industries	ExxonMobil	RocketLab
Aptiv	GE Aviation	Rolls Royce
Arconic	General Atomics	RZ Automation
Blue Origin	Geostructural Engineering	Sierra Nevada Corporation
Boeing	John Deere	SpaceX
CADENAS	Lockheed Martin	Trane Technologies
Cirrus	Marotta Controls	UPS
Collins Aerospace	Microsoft	U.S. Dept. of Defense
Cummins	The Museum of Flight	Virgin Orbit
Daimler	NASA	
Dana Incorporated	Northrop Grumman	

SUPPORTERS



PSP Solids,
PSP Student Launch



PSP



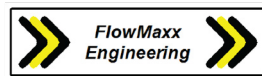
PSP Hybrids, PSP Liquids,
PSP Solids

BurnSim

PSP Solids



PSP



PSP Liquids



PSP Liquids



PSP Liquids



PSP Liquids



PSP Liquids



PSP Student Launch



School of Aeronautics and Astronautics

PSP Liquids, PSP Solids,
PSP Student Launch



School of Electrical and
Computer Engineering

PSP Student Launch



School of Mechanical Engineering

PSP Student Launch



PSP Liquids, PSP Solids,
PSP Student Launch

Rail-Buttons.com

PSP Student Launch



PSP Hybrids



PSP Hybrids, PSP Liquids



PSP Student Launch

PURDUE SPACE PROGRAM

A SEDS Chapter

purdueseds.space

