Oregon NASA Space Grant Consortium

2020 Virtual Student Symposium Proceedings

November 13, 2020
9am – 3pm

featuring presentations from
NASA student interns, fellows, research scholars, and student teams

2020 NASA Student Symposium

Hosted by
Oregon NASA Space Grant Consortium (OSGC)
November 13, 2020

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Presentation Schedule

Friday, November 13, 2020, 9-3 PM | OSGC Virtual Student Symposium		
9-10am	**WELCOME – Jack Higginbotham, Ph.D.** | Director, Oregon NASA Space Grant **KEYNOTE ADDRESS – Fredrick Colwell, Ph.D.** | Oregon State University | ***Microbiology of the Planet, One Gig at a Time***	
	SESSION A **Moderator: Nancy Staus, Ph.D.**	**SESSION B** **Moderator: Kathryn Sinor**
10:30am	**[A-1]** **Rowan Parker** Oregon Institute of Technology NASA Goddard Space Flight Center Internship ***Next Steps: Laying the Groundwork for Bundle Protocol v7***	**[B-1]** **Jason Burns** Oregon State University NASA Glenn Research Center Internship ***Life Support Filtration Systems Developments***
10:40am	**[A-2]** **Olivia Clark* | Colton Harms | Justin Morgan | Adam Ragle** Oregon State University OSGC Undergraduate Team Experience Award ***High Altitude Liquid Engine (HALE) Team: Oregon State University***	**[B-2]** **Patrick Cornwall | Davia Fleming* | Carter Knutson** **Justin Ringle | Laura Sanchez** Oregon Institute of Technology OSGC Undergraduate Team Experience Award ***RockSat-C: Experiments and Expected Results***
10:50am	**[A-3]** **Oleg Krishcko** Portland State University OSGC Virtual Summer Internship ***The Topology and Stability of Drops at Open Tube Ends***	**[B-3]** **Huy Nguyen** Pacific University OSGC Affiliate Faculty Research Incubator Award Program ***Designing an Educational Exhibit on Orbital Dynamics within the Earth-Moon System***
11:00am	**[A-4]** **Jessica Jorgens** Oregon State University NASA Marshall Space Flight Center Internship ***Creating a Canfield Joint for Gimbaled Thrusters***	**[B-4]** **Catie Spivey** Portland State University NASA Langley Research Center Internship ***NASA Langley Academy***
11:10am	**[A-5]** **Haley Davis | Chloe Gan* | Kevin Hoser** **Sam Kreifels | Alex Schendel** University of Portland OSGC Undergraduate Team Experience Award ***NASA 2019 Robotics Mining Competition***	**[B-5]** **Amy Caldwell* | Nathan Kentner | Nicole LeRoux | Jessica Peterson** Oregon State University OSGC Undergraduate Team Experience Award ***2019-2020 NASA University Student Launch Initiative (OSU USLI) Competition Team***
11:20am	**[A-6]** **Chase Keller | Jack Richardson** Oregon State University OSGC Virtual Summer Internship ***Summary of Biomechanics of Hind-end Loading Techniques for Rodent Microgravity and Lunar Gravity Simulations***	**[B-6]** **Steen Rasmussen** Oregon Institute of Technology OSGC Virtual Summer Internship ***Oregon Tech Rocketry and Aerospace (OTRA) Space Debris Prototype Board***
11:30am	**[A-7]** **Ian Ellis* | Sarah Malpass | Onar Smith** University of Oregon OSGC Undergraduate Team Experience Award and Virtual Summer Internship ***TorqueDucks on Magnetorquers***	**[B-7]** **Cory Gillette | Kathleen Joslyn* | Marc Wasserman** Portland State University OSGC Undergraduate Team Experience Award ***Redesigning the PSAS Liquid Fuel Engine for the Base 11 Space Challenge***

11:40am	**[A-8]** **Peter Strohmaier** Oregon State University NASA Langley Research Center Internship ***Enabling Sustained Presence Using Recyclables (ESPUR)***	**[B-8]** **Logan Francisco** Oregon Institute of Technology OSGC Virtual Summer Internship ***Detection Software for the Oregon Tech Space Debris Detection Payload***
11:50am	**Q & A**	**Q & A**
12-1pm	**LUNCH BREAK**	
AFTERNOON SESSIONS		
	SESSION C **Moderator: Randall Milstein, Ph.D.**	**SESSION D** **Moderator: Kathryn Sinor**
1:00pm	**[C-1]** **Sean Lai** Portland State University NASA Langley Research Center Internship ***Fatigue Crack Diagnosis using Embedded Fiber Optic Strain Sensors***	**[D-1]** **Gabriela Griffin** Oregon State University NASA Langley Research Center Internship ***Streamlining the ACS3 Solar Sail Manufacturing Process***
1:10pm	**[C-2]** **Codey Winslow** Oregon Institute of Technology OSGC Virtual Summer Internship ***Optimized Learning with Virtual Reality***	**[D-2]** **Kaseylin Yoke** Oregon State University NASA Goddard Space Flight Center Internship ***Optical Analysis of Ion-beam Figuring Polished Silicon Wafers***
1:20pm	**[C-3]** **Leah Hanen** Oregon State University NASA Marshall Space Flight Center Internship ***Feasibility Study of a Lunar Sample Return***	**[D-3]** **Clement Forbes | Izikaula Huntley | Adrian A. Jimenez*** **Taylor L. Lohrie | Faye Nieman** Portland Community College Southeast Campus Undergraduate Team Experience Award ***Aquaponics as a Food Source for Long-Term Interplanetary and Lunar Expeditions***
1:30pm	**[C-4]** **Umair Khan | Catie Spivey*** Portland State University OSGC Undergraduate Team Experience Award ***Design and Test of the OreSat Cirrus Flux Camera***	**[D-4]** **Nathan Wiley** Oregon Institute of Technology OSGC Virtual Summer Internship ***Artemis Student Challenge***
1:40pm	**[C-5]** **Brandon Foose | Logan Francisco | Rowan Parker*** **Steen Rasmussen | Joseph Saxon** Oregon Institute of Technology OSGC Undergraduate Team Experience Award ***Oregon Tech Space Debris Detection Payload for CubeSats***	**[D-5]** **Mandy Kiger** Oregon State University NASA Marshall Space Flight Center Internship ***Analysis of a Ring Assembly for Adapting a Mars Transfer Vehicle and Transit Stage for Artificial Gravity***
1:50-2pm	**BREAK**	
2:00pm	**[C-6]** **Jacob Beder** University of Oregon NASA Johnson Space Flight Center Internship ***Backup Flight Software for Project Orion***	**[D-6]** **Theodor Giles* | Kai Hattan | Jay Sucharitakul** Oregon Institute of Technology OSGC Affiliate Faculty Research Incubator Award Program ***Oregon Tech Underwater Robotics***
2:10pm	**[C-7]** **Eren Bikmaz** Oregon Institute of Technology OSGC Virtual Summer Internship ***Solar Sailing Simulator***	**[D-7]** **Oleg Krishcko** Portland State University OSGC Undergraduate Team Experience Award ***Thermal Analysis and Testing of Oregon's First Satellite***
2:20pm	**[C-8]** **Craig Weeks** Oregon State University NASA Glenn Research Center Internship ***Hardware Design for an Efficient Inverter used in Electric Aircraft Power Systems***	**[D-8]** **Noah Cayson | Brandon Foose*** Oregon Institute of Technology OSGC Undergraduate Team Experience Award ***Thrust Vectoring Toroidal Aerospike***

2:30pm	**[C-9]** **Kaitlyn Dickinson** Oregon Institute of Technology NASA Ames Research Center Internship ***Celestial Mapping System***	**[D-9]** **Grace Semerjian** Portland State University OSGC Virtual Summer Internship ***Quasi-Infinite and Zero Stiffness Magnetic Spring for Space Applications***
2:40pm	**[C-10]** **Joshua Bamberger | Edgar Jimenez*** Oregon State University OSGC Undergraduate Team Experience Award ***2019-2020 Design Build Fly Competition Team***	**[D-10]** **David H. Beal | Isaac Gilmer | Mario Segura*** Oregon Institute of Technology OSGC Affiliate Faculty Research Incubator Award Program ***Lava Tube Diver Vehicle***
2:50pm	**[C-11]** **Jerika Christman** Oregon State University NASA Goddard Space Flight Center Internship ***SMA Cataloguing System Creation for Standard Component Commodity Usage Guidelines (CUGs) Specifically for Charge-Coupled Devices (CCDs)***	
3:00pm	**SSESSIONS ADJOURN**	
3-4pm	**Q&A | Zoom Informal Mixer –** Breakout rooms organized by Session A, B, C, D	

Keynote Address

Frederick (Rick) S. Colwell, Ph.D.
Professor, College of Earth, Ocean, and Atmospheric Sciences and Department of Microbiology
Oregon State University, Corvallis, OR

Dr. Colwell received his B.S. in Biology from Whitman College (1977), his M.S. in Microbiology from Northern Arizona University (1982), and his Ph.D. in Microbiology from Virginia Tech (1986). Dr. Colwell was a scientist at the Department of Energy's Idaho National Laboratory (INL) for 20 years. His research there involved geomicrobiology, determining microbial rates and processes in subsurface settings, sensing and monitoring of environmental microbes, methods for sampling Earth's subsurface for microorganisms, and bioremediation.

At OSU, Dr. Colwell teaches undergraduate courses in Astrobiology and Oceanography, and a graduate field course called Cascadia. He was a Scientist-in-Residence at the Exploratorium in San Francisco, CA, an instructor and organizer of microbial ecology courses taught in China, and organizer of the Deep Carbon Observatory Summer School in Yellowstone National Park for 40 international postdoctoral fellows from multiple Earth science disciplines.

The primary focus of Dr. Colwell's research has been exploring the extent, diversity, and activity of the subsurface biosphere in continental and seafloor settings. He has investigated microbes in subseafloor sediments including determining the rate of methanogenesis near methane hydrates and methane seeps) microbial enhanced calcite precipitation to remove contaminants in aquifers and as a geoengineering technique, and the sequestration and biogeochemical cycling of carbon in Earth's critical zone and in aquifers. He led the Census of Deep Life, a decade-long, global survey of microbial diversity in the deep subsurface of the continents and the seafloor. Dr. Colwell has led or participated in 18 scientific drilling or sampling expeditions at numerous locations in the continental US, Alaska, and Canada, and also in several of the world's oceans. He has authored or co-authored over 90 peer review publications.

Abstracts

Session A

[A-1] Rowan Parker

Oregon Institute of Technology | NASA Goddard Space Flight Center Internship

Next Steps: Laying the Groundwork for Bundle Protocol v7

Delay/Disruption Tolerant Networking (DTN) is a networking model and protocol suite that extends the terrestrial internet to the challenging communication environments of space. These environments are typically subject to frequent disruptions, which can cause delays or errors. DTN protects data transmission by wrapping data into bundles (similar to Internet Protocol packets), storing them until a connection can be established between two nodes (similar to terrestrial routers or computers), and forwarding them to their destinations. Bundle Protocol (BP) is responsible for generating those bundles and creates the transport layer of DTN, much like how Transmission Control Protocol (TCP) and User Datagram Protocol (UDP) create the transport layer of the Internet Protocol.

BPv6 is the current, accepted version of the Bundle Protocol standard. However, recent missions and test implementations have revealed missing components and areas for improvement in the standard. Using lessons learned from NASA missions and gathering inspiration from the Internet Protocol, BPv7 is intended to be a more robust Bundle Protocol that improves upon its predecessor and increases the technology readiness level of the DTN architecture.

The DTN Standard Interface Design team, a sub-team of the DTN Infusion Project at the Goddard Space Flight Center, worked to create a dictionary of terms for bundle components and functional decomposition of the protocol. These efforts aided in the standardization of BP interfaces, something missing from BPv6, and supported parallel network management and configuration work. This standardization will ultimately contribute to LunaNet (a lunar communications and navigation architecture that will bring networking, positioning, navigation, timing and science services to the Moon), the Solar System Internet (SSI), and expand crewed and uncrewed space exploration opportunities.

[A-2] Olivia Clark, Colton Harms, Justin Morgan, Adam Ragle,

Oregon State University | OSGC Undergraduate Team Experience Award

High Altitude Liquid Engine (HALE) Team: Oregon State University

Liquid engine development at Oregon State University has progressed significantly in the two years since the HALE team was established. Progress includes the development of the test stand and related testing infrastructure. The project is nearing its first static test fire of the MIRA engine. A successful static test fire will mark the start of a fully operating liquid engine test stand that will provide future undergraduate and graduate students the opportunity to perform liquid engine research. Current methods used in the development of liquid rocket propulsion systems involve many infrastructural challenges stemming from the equipment needed to test engines safely. Ongoing improvements to the existing propulsion laboratory facilities at Oregon State University will simplify and decrease the engine development timeline.

During the past year, the team has been performing system testing including cold flow analysis and controls validation. In tandem with these improvements, the engine team has been working to finalize the prototype engine and perform related integration tasks. The benefits of improving automation, sensor data collection and visual feedback provided by a dedicated liquid propulsion test stand result in a safer and more efficient liquid propulsion development workflow. When integrated into existing infrastructure, these improvements streamline the process of analyzing test results and allows the development team to more quickly determine if the performance characteristics meet design requirements or if further design iterations are needed. This workflow will be crucial to engine characterization and progression towards development of flight hardware.

[A-3] Oleg Krishcko

Portland State University | OSGC Virtual Summer Internship

The Topology and Stability of Drops at Open Tube Ends

Droplet behavior at the end of open tubes has important implications for the design of fluid systems in low gravity. On earth, gravity dominates the stability of such droplets which results in small stable droplet size with larger drops simply falling off. Subtle differences in stable configurations are also generally not noticed on earth since such droplets are so small. The stability is governed by a dimensionless group called the Bond number which leads to larger stable droplet sizes as gravity is decreased. This means that in low gravity environments droplets on the tips of open tubes can become very large with a variety of different stable configurations. Mapping these stable configurations for different Bond numbers as a function of contact angle can be useful and even critical to fluid system designs aboard low-g spacecraft. A simulation software tool called the Surface Evolver-Fluid Interface Tool (SE-FIT®) was used to run different initial configurations on which Bond number and contact angle were varied. The simulations revealed three primary regimes in which the droplet assumes a certain stable configuration. Further refinement of these regimes is in progress and plans are being made to experimentally confirm these results. This 'regime map' can be a useful tool for determining what stable configurations are expected at various Bond number and contact angles and can be applied to fluid system designs, particularly in low gravity.

[A-4] Jessica Jorgens

Oregon State University | NASA Marshall Space Flight Center Internship

Creating a Canfield Joint for Gimbaled Thrusters

I am Jessica Jorgens, and I was an intern at Marshall Space Flight Center, NASA, for spring term 2020. My main project was creating a Canfield joint for gimbaled thrusters. Currently, spacecraft use 16 or more fixed-position air thrusters for direction changes in orbit; my project's purpose was to decrease the number of thrusters and increase efficiency by creating a mounted thruster that can point in many directions. A Canfield joint consists of a top plate attached to three hinged servo arms that allow the mounted thruster to point in a full hemisphere of directions.

A gaming controller was programmed to move the servos in the canfield joints to point to any combination of twelve preset radial directions and three pitch angles. Our initial plan included building a final joint out of 3-D printed parts to decrease weight and allow for vertical mounting of the joint instead of just horizontal, but without access to a machine shop or proper tools due to the Covid-19 shutdown of NASA campuses, our work ended here. Just before being quarantined, we were able to gather supplies to work on the programming from home: one fully assembled prototype, the parts for a second, circuitry supplies, and a few hand tools.

While they still need adjustments, these Canfield mounted thruster prototypes can already decrease the number of mounted thrusters by three to one, increase directional accuracy, and increase overall efficiency of direction changes in orbit.

[A-5] Haley Davis, Chloe Gan, Kevin Hoser, Sam Kreifels, Alex Schendel

University of Portland | OSGC Undergraduate Team Experience Award

NASA 2019 Robotics Mining Competition

The University of Portland (UP) Robotics Club and Capstone Team has designed a robotic mining system capable of operating on the Moon, for participation in NASA's Robotic Mining Competition (RMC): Lunabotics. Held at the Kennedy Space Center, the RMC is designed to develop innovative robotic mining systems, following NASA's efforts of returning to the Moon through the Artemis program. The program aims to bring humans closer to achieving a sustainable presence in space. In addition to the robotic system, teams are judged on K-12 STEM Outreach, Systems Engineering papers, and oral presentations. With new rules added to the competition, a complete restructure and redesign of a rover took place over the course of the 2019-20 academic. As a result of the COVID-19 pandemic and the closure of the UP campus, manufacturing of the new rover and STEM Outreach efforts was not met. However, with the continued support granted from the Oregon Space Grant Consortium and the Dean of the Donald P. Shiley School of Engineering, the team developed new rover designs which established a solid foundation for next year's team.

[A-6] Chase Keller, Jack Richardson

Oregon State University | OSGC Virtual Summer Internship

Summary of Biomechanics of Hind-end Loading Techniques for Rodent Microgravity and Lunar Gravity Simulations

The biological effects of an organism being exposed to Galactic Cosmic Rays (GCR) is an ongoing exploration, as well as the effects on those who are in microgravity. In a search to study the effects of GCR with an organism suspended in microgravity, a Hindlimb Unloaded apparatus was made. GCR simulations will be held in the NASA Space Radiation Laboratory in Brookhaven, NY. This research allows those who are involved in space travel a higher understanding of the radiation exposure, and how to avoid biological problems while in microgravity.

Summer research into Hindlimb Unloading was the main study, as well as the techniques that past researchers have used to optimize and improve upon past apparatuses. With background knowledge into Hindlimb Unloading a full, working model of a Hindlimb Unloaded apparatus was made to then be sent to the NASA Space Radiation Laboratory.

To study the effects of GCR upon exposure, three treatments of study will be conducted: 0.75, 1.5 and 2.25 Gy of GCR beam exposure, directed into the left eye. The first treatment will involve all mice being treated with .75 Gy. Two days later, after recovery, two thirds will be treated with 1.5 Gy. Again, after two days, half of the 1.5 Gy mice will be treated with 2.25 Gy. After radiation treatment, half will be placed in cages, while the other half will be placed in Hindlimb Unloaded apparatuses.

[A-7] Ian Ellis, Sarah Malpass, Onar Smith

University of Oregon | OSGC Undergraduate Team Experience Award/Virtual Summer Internship

TorqueDucks on Magnetorquers

OreSat1 is a two-unit cubic satellite set to deploy into Low-Earth Orbit (LOE) sometime in early 2022. Its position and orientation will be controlled using “magnetorquers”, or solenoids with core materials, assigned to the three cartesian axes x, y, and z. These magnetic coils will be supplemented by mechanical reaction wheels to harmonize satellite stabilization. In addition to detumbling the satellite after launch, finer positional adjustments will engage the star-tracker cameras, the Cirrus flux cloud monitoring cameras, and the external solar panels. Joined by two faculty leads Ben Mcmorran and Greg Bothun, the University of Oregon undergraduate TorqueDucks Team sought to answer one primary research question: How do we maximize the magnetic dipole moment of a magnetorquer to generate the greatest possible torque pursuant to optimal attitude control? This question was further narrowed by project constraints including power budgets, payload limitations, material restrictions, cost, and geometric implementation.

The presentation details the research, design, construction, and integration of an optimized magnetorquer system complete with two cylindrical magnetorquers and one coreless octagonal coil.

Included is a synopsis of material choice and mathematical derivations used to determine the most heavily weighted factors for maximizing the magnetic dipole moments.

The production of magnetorquer rods including coil winding, machining, and 3D printing will be addressed, as well as the testing apparatus used and the results found.

[A-8] Peter Strohmaier

Oregon State University | NASA Langley Research Center Internship

Enabling Sustained Presence Using Recyclables (ESPUR)

ESPUR researches a novel procedure for the synthesis of polycarbonate and copoly (carbonate urethane) (CPCU) materials. These polymers are being investigated for in-space additive manufacturing applications. Two epoxy microparticle types using a furan and a maleimide functionalized CPCU coating would be used to generate a recyclable feedstock for 3D printing. A two-stage polycondensation reaction between 2,2 Dimethyl-1,3-propanediol and Dimethyl carbonate with 1,5,6-Triazabicyclo[4.4.0]dec-5-ene as a catalyst was used to synthesize the polycarbonate. The resulting polycarbonate oligomer was then analyzed via nuclear magnetic resonance (NMR) spectroscopy to determine the material’s degree of polymerization and molecular weight. The polycarbonate oligomer was used in a synthesis with m-Xylylenediamine to obtain the resulting CPCU material. The CPCU materials were characterized through infrared spectroscopy, thermogravimetric analysis, differential scanning calorimetry, and rheology. Type V dogbone mechanical test articles were cast from the CPCU materials, however no mechanical testing was completed on these materials because they did not display desirable properties. Two syntheses for generating a maleimide-functionalized CPCU and furan-functionalized CPCU were conducted, which will be used in a "Diels-Alder click chemistry" reaction in future research. Throughout the spring internship session, 19 polycarbonate and CPCU syntheses were conducted as well as several side experiments. Through the research of these materials, a broad spectrum of material coating properties was achieved from the same base chemical reactions. Further experimentation revealed improvements to the polymer synthesis process and ^{1}H NMR spectra analysis procedure. These discoveries will allow the future research team to better arrive at a finalized coating.

SESSION B

[B-1] Jason Burns
Oregon State University | NASA Glenn Research Center Internship

Life Support Filtration Systems Developments

Project purpose: To create a filtration system that removes bulk particulate matter out of air stream prior to HEPA filtration with a solution that is lightweight, regenerable and efficient.

The intrusion of planetary dust inside space vehicles on future lunar missions may lead to performance compromises of the cabin air-filtration system. The evasive character of the fine lunar dust could enable the dust to make its way through the seals and barriers of the EVA hatches and become airborne in the cabin. This can result in performance and capacity overload of the filter system. Adequate pre-filtration can substantially reduce the load on the higher efficiency components of the filter system, thereby protecting and extending the life of these components. A particle separation concept, based on centrifugal separation, is being investigated for its application as a pre-filter. The concept has previously been proposed for application in the aircraft engine industry, as means of capturing corrosive dust and salt deposits that may harm the engine. The technique has the advantages of being passive, integrable to HVAC and space vehicle architecture, and has the potential for high degree of particle separation with proper fluid dynamic design. Computational Fluid Dynamics (CFD) and particle tracing modeling were used to arrive at an initial design for rapid prototyping and testing. If feasible, the concept can be integrated to the Scroll Filter System which is being developed by NASA to address the filtration demands on long duration spaceflight and surface missions. Computational modelling shows positive separation of larger airborne particles for to potential centrifugal filter designs, for which prototypes were created and further testing is required.

[B-2] Patrick Cornwall, Davia Fleming, Carter Knutson, Justin Ringle, Laura Sanchez
Oregon Institute of Technology | OSGC Undergraduate Team Experience Award

RockSat-C: Experiments and Expected Results

The progress and remaining challenges facing the RockSat-C team from the Oregon Tech, Portland-Metro Campus, on their mission to develop and launch a small payload into space in conjunction with Wallops Island Flight Facility. RockSat-C is a program offering students the opportunity to design payloads to be launched past the atmosphere in a NASA sounding rocket. In 2019, the team began development of the payload to fulfill RockSat design requirements to conduct 4 experiments during the flight to space and back. While originally scheduled to launch in June of 2020, COVID-19 has placed unique pressures on both the design process, and launch schedules. Currently the team is still in the testing phases for each experiment, while trying to overcome limited access to laboratory equipment. The new, tentative schedule for launch is summer 2021. Talks and preparation with the ROCKSAT organization are ongoing. This presentation addresses the goals of each experiment, the current state of the process, previous progress, and the steps needed to move forward for the team.

[B-3] Huy Nguyen

Pacific University | OSGC Affiliate Faculty Research Incubator Award Program | **Todd Duncan**

Designing an Educational Exhibit on Orbital Dynamics within the Earth-Moon System

NASA's recent focus on returning to the Moon offers a valuable opportunity to generate enthusiasm and increase public understanding of space science. This presentation will describe a plan we've developed for a museum exhibit that builds on this opportunity. It includes a hands-on scale model that makes the key concepts of orbital dynamics accessible to the general public. The core of our exhibit is a 3D-printed contour map of the gravitational potential produced by the Earth-Moon system, on which visitors can place marbles and roll them with varying speeds and directions. This experience will provide an intuitive understanding of what happens to a satellite that is launched from Earth, and an entry point for exploring a rich variety of questions. For example: Under what conditions does a satellite go into Earth orbit, into lunar orbit, or fall into one of the two inherently stable orbital locations (Lagrangian points), where it will simply sit static relative to Earth and Moon? What happens to a satellite that passes near one of the other Lagrangian points, where the forces are balanced but the equilibrium is unstable? What is required to launch a real satellite to these locations? What existing and planned NASA spacecraft are in orbit at these various orbital locations and why? What deep understanding can we gain about motion and gravity by studying these situations? The primary aim of the exhibit is to spark curiosity and further exploration by making the concepts concrete and accessible.

[B-4] Catie Spivey

Portland State University | NASA Langley Research Center Internship

NASA Langley Academy

The 2020 NASA Academy was a ten-week summer internship tasked with designing and simulating an autonomous vehicle. This internship was conducted virtually with an interdisciplinary team of 15 students from various STEM majors. Through this internship, I learned about using Bekker's terramechanics models to determine required input power to wheels, designing for various environments, and balancing the design requirements of a mechanical team versus an aerospace team. Due to the virtual nature of the internship, obstacles with team communication and collaboration were overcome with daily meetings and extensive use of Microsoft Teams.

[B-5] Amy Caldwell, Nathan Kentner, Nicole LeRoux, Jessica Peterson

Oregon State University | OSGC Undergraduate Team Experience Award

2019-2020 NASA University Student Launch Initiative (OSU USLI) Competition Team

Every year, NASA challenges university students with a different, multifaceted rocketry competition with the purpose of teaching them about real-world engineering project lifecycles and how NASA's programs operate. This year, the challenge was to accurately predict the altitude to which their rockets would fly during launch week and to design and build a payload that could navigate to a collection site, collect 10 mL of simulated lunar ice, store it, and navigate 6 ft out of the site.

To meet these challenges, the OSU USLI team predicted an altitude of 4,000 ft, and worked to ensure that the rocket would fly to 4,000 ft through designing and manufacturing a reliable rocket, selecting a commercial motor, and implementing a custom airbrake system. The team designed and built the payload to be a remote-controlled rover with a scoop that could collect the ice and then be retracted to store the ice as the rover was driven away. The team also designed and manufactured a recovery system that allowed the rocket to land safely and an avionics system that collected data and helped locate the rocket after landing.

Ultimately, OSU USLI successfully met all of NASA's challenges, however, the team was unable to finish the competition due to COVID-19 and all USLI activities after April 1st being cancelled. Despite this, the competition was still scored with 60% of the regular points. OSU USLI placed 8th overall out of 46 teams, and 1st in STEM Engagement, with over 2,000 K-12 students reached.

[B-6] **Steen Rasmussen**

Oregon Institute of Technology | OSGC Virtual Summer Internship

Oregon Tech Rocketry and Aerospace (OTRA) Space Debris Prototype Board

Purpose: Developing a well-rounded platform for future club projects.

2019-2020 was OTRAs first year participating in a CubeSat project. With little experience working on CubeSats and under a year to develop designing new hardware was determined not possible. Instead, the objective was to launch any functioning hardware on a CubeSat utilizing predeveloped materials capable, but not optimized for the task into space.

The prototype board project is a subset of OTRAs CubeSat Space Debris project without the constraints. The goal is to bring OTRA a full prototype board students will be able to customize, curate, and deploy in future CubeSat projects. It will be developed to optimize power and performance using modern computer hardware.

The prototype board utilizes a Field Programmable Gate Array (FPGA) as the image processor and a microprocessor for general purpose processing. Combined, a high-speed camera can operate at its full potential. The board can operate with various battery voltages, turn on/off individual camera cards, and save images to long term storage with redundancy to reduce errors. The design is constructed with two 10x10cm boards stacked vertically with some modularity to facilitate expansion.

[B-7] **Cory Gillette, Jennifer Jordan, Kathleen Joslyn, Teresa Nguyen, Jean-Pierre Pillay, Marc Wasserman**

Portland State University | OSGC Undergraduate Team Experience Award

Redesigning the PSAS Liquid Fuel Engine for the Base 11 Space Challenge

The Portland State Aerospace Society (PSAS) has been working for the past four years on developing a liquid-fueled engine to propel our next-generation 100 km capable rocket, Launch vehicle No. 4 (LV4). We built on prior work to develop a parametric model of a simpler, more robust heat-sink engine design. We evaluated materials with CFD, compared manufacturing approaches, and analyzed fuel injector performance in a water test. The final design features an oxidizer-centered pintle injector with a 3d-printed stainless-steel chamber, which is expected to survive a short duration hot-fire test. This test will allow us to verify our theoretical calculations and simulations and validate the design.

[B-8] **Logan Francisco**

Oregon Institute of Technology | OSGC Virtual Summer Internship

Detection Software for the Oregon Tech Space Debris Detection Payload

With the advent of the Space Age, the ability to safely launch capital into space has been of paramount importance. Increasingly, space debris from dead satellites, rocket shards, and other unnaturally occurring materials has multiplied in quantity and importance to endanger the future of space flight. Traditionally, space debris is measured in larger sizes from ground-based systems that are unable to detect smaller debris, which are of greater risk to the safety of space flight than larger debris. This project seeks to offer an in-flight software solution for the detection of space debris in low earth orbit from a cube satellite and serves as a starting effort in small debris detection by utilizing high-resolution, high-speed imagery and filtering methods implemented programmatically. This software utilizes double exposure capture methods, cooperation with an onboard star-tracker, and extensive image processing with the goal of detecting space debris.

SESSION C

[C-1] **Sean Lai**

Portland State University | NASA Langley Research Center Internship

Fatigue Crack Diagnosis using Embedded Fiber Optic Strain Sensors

Quantitative characterization of crack formation and growth allows for efficient and timely management of structural health. By using real-time strain data and a probabilistic diagnosis process to inform a persistent digital twin of a structure, failure modes can be monitored and addressed with greater confidence by decision makers. It has been shown that a probabilistic approach can be used to diagnose cracks with full-field strain data using digital image correlation [1]; this project aims to perform a comparable diagnosis process by using embedded fiber-optic strain sensors that are more practical in real-world applications. A geometrically complex part was manufactured with embedded fiber-optics and subjected to fatigue loading to initiate and grow a crack. A finite element (FE) model of the part was created and crack growth was simulated under identical loading conditions. Strain data recorded from the FE model were used to train a Gaussian process surrogate model to reduce the computational cost of the diagnosis process. Surrogate model output and measured strain data were compared using uncertainty quantification techniques to estimate cracks lengths at different times throughout the test. Diagnoses resulted in good predictions for crack length up until the crack grew through all the fibers in the test specimen, at which point modeled and measured strain fields showed significant differences. While it was shown that accurate crack length predictions can be made using this process, it would be necessary to create more complex algorithms to monitor and select only strain data relevant to a diagnosis for use beyond the laboratory environment.

[C-2] Codey Winslow
Oregon Institute of Technology | OSGC Virtual Summer Internship

Optimized Learning with Virtual Reality

Learning skills takes many forms, but arguably the most successful way is to learn by doing. When performing these skills requires expensive equipment or mock environments, we should look to virtual reality technology to aid in simulation instead. My goal with Optimized Learning with Virtual Reality was to gather evidence that using virtual reality helps people learn skills more effectively than alternatives, such as learning by watching video. The experiment that was designed to gather this data involved three procedures of varying difficulty which subjects would learn either by using virtual reality or by watching an instructional video, then their competency would be tested. Though IRB approval was not obtained in the time frame allocated for this project, and thus the experiment has yet to be performed, valuable revelations arose as I developed and tested virtual learning environments.

[C-3] Leah Hanen
Oregon State University | NASA Marshall Space Flight Center Internship

Feasibility Study of a Lunar Sample Return

The goal of this project was to study the feasibility of a lunar sample return campaign. Based on the Mars Sample Return and the Mars Ascent Vehicle, this proposed mission would collect a sample of lunar water ice from a shadowed crater at the moon's south pole and return it either to orbit or to a specified location for collection by a crewed mission at a later date. To do this, a bottom up analysis was conducted to plan the mission and determine its potential. As part of this analysis, models and examination of all parts of the mission were conducted including, propulsion systems, trajectory, providers, mission profile, and thermal analysis. The results of this investigation proposed a mission to a crater to the west of the Shackleton crater rim with a robotic rover to collect the sample and a Lunar Ascent Vehicle (LAV) to return the sample to orbit and potentially back to earth. Each of the propulsion systems considered (solid, liquid, and hybrid) for the LAV were sized based off propellant masses compared to the Mars Ascent Vehicle and modeled to create a better picture of the requirements of the mission. While more work is still necessary and some technology readiness increased, the group's analysis is that this is a feasible mission and could one day allow scientists to study some of the moon's water ice.

[C-4] Umair Khan, Catie Spivey
Portland State University | OSGC Undergraduate Team Experience Award

Design and Test of the OreSat Cirrus Flux Camera

The Cirrus Flux Camera (CFC), a subsystem of the OreSat CubeSat, is designed to characterize and monitor the physical properties and distribution of cirrus clouds from space, with the eventual aim of contributing data to global climate models. Initially envisioned as a visible-spectrum camera with an optical filter wheel, the CFC is now being developed as a shortwave infrared (SWIR) imager with bespoke filters applied directly to the sensor, in a joint project with the Laboratory for Aerosols, Clouds, and Optics at the University of Maryland, Baltimore County. We present the initial mechanical design of the subsystem and related electronic and thermal considerations, as well as a discussion of the concept of operations and a brief roadmap towards future engineering and scientific goals.

[C-5] Brandon Foose, Logan Francisco, Rowan Parker, Steen Rasmussen, Joseph Saxon

Oregon Institute of Technology | OSGC Undergraduate Team Experience Award

Oregon Tech Space Debris Detection Payload for CubeSats

Currently, millions of chunks of dead satellites, lost tools, broken parts, and rocket shards are encircling Earth. Collisions with this junk not only make launching new things into space dangerous, but also threaten the lives of astronauts on the International Space Station and the functionality of satellites scattered across low earth orbit. Currently, most orbital debris detection methods are limited to ground-based systems and are only able to detect medium and large pieces. To capture information about smaller debris, Oregon Tech Rocketry and Aerospace developed a prototype for a CubeSat space debris sensor to explore debris detection while in flight. Using high-speed image sensors, double exposure capture methods, and subtractive information from an onboard star-tracker, the detection sensor is intended to photograph small debris in low earth orbit.

[C-6] Jacob Beder

University of Oregon | NASA Johnson Space Flight Center Internship

Backup Flight Software for Project Orion

On the Backup Flight Software team (BFS), I was assigned to work on support software that would enable engineers to do their work faster. This work involved creating a script to transfer table data from one file format to another, a graphical user interface (GUI) to increase usability of the script I made, and fixing bugs in another GUI to further speed up the development cycle.

The script I created was used to take table data from a C++ file format and put the information into a JSON (JavaScript Object Notation) file that would be easier to configuration control. Before this script was created, engineers would have to do this by hand. The script automates the process and allows this work to be done in under a couple seconds.

The GUI that I created for the script was done to make it easier for engineers to run the script. This GUI shows the user what files they selected and what parameters they chose as well. Once they click the “run” button, it tells them the status of the script and when it is done running.

The last project I worked on was another GUI that was an update to a previous GUI that would provide more features to allow engineers to process items quicker. This project was a big undertaking and a lot of it was already completed, so my main job was to work on fixing bugs and adding new functionalities.

[C-7] Eren Bikmaz

Oregon Institute of Technology | OSGC Virtual Summer Internship

Solar Sailing Simulator

Purpose: This was a summer project supported by the Oregon Space Grant Consortium. My personal goal was to gain experience in making games, especially simulations. The institutional goal of the project was to develop a simple simulation of a solar sailing craft to serve as an educational tool on the principles of orbital mechanics and solar sailing. This was based on my own experiences with games whose mechanics are based on real-world physics; it offers a powerful intuitive understanding of the subject with relatively low barriers to entry.

Methodology: This simulation was built in Godot, an open-source game engine under the MIT license. The project leveraged Godot’s built-in physics engine, which streamlined development significantly. During my initial planning stage, I set several points where I would force myself to start over and attempt different approaches, which allowed me to restructure the project as I learned more about how to best structure the project within the Godot engine.

Results: The simulation was a success, but the scope is limited; this is mostly due to my lack of experience with the Godot engine. However, if you told me to publish it, I could push it out in a week or two.

Conclusion: I may not continue work on this project, but I hope to keep developing simulations like this in the near future. If my professors allow it, I will do something very much like this for my senior project.

[C-8] Craig Weeks
Oregon State University | NASA Glenn Research Center Internship

Hardware Design for an Efficient Inverter used in Electric Aircraft Power Systems

This presentation concerns the development of a mechanical packaging for a 250-kW scaled up version of the High-Efficiency Electrified Aircraft Thermal Research (HEATheR) 72-kW inverter. Design considerations were made for the hardware to be used at the NASA Electric Aircraft Testbed (NEAT) at Plum brook Station. The packaging was designed to be actively cooled by existing equipment, withstand all coolant pressures, and be sealed against 40,000 ft of elevation. All of this had to be accomplished while staying under a mass budget. Although the design has not yet been built or tested, finite element analysis models have appeared promising and show that the packaging is resistant to failure under operating conditions.

[C-9] Kaitlyn Dickinson
Oregon Institute of Technology | NASA Ames Research Center Internship

Celestial Mapping System

Celestial Mapping System (CMS) is a desktop application that provides a toolkit of features for visualization and analysis of celestial bodies, beginning with a 3D lunar globe. Although there are lunar mapping products publicly available, they use old data from lunar missions, have no native desktop version, and they are mostly 2D. CMS addresses this by providing high-resolution datasets from recent lunar missions, accurate elevation data to display and read 3D terrain, and is built on top of WorldWind Java library which provides a rich set of functionality and the ability to easily expand to other celestial bodies. CMS is also looking at implementing features to support situational awareness, path optimization and resource assessment, which will be of use in upcoming missions to the lunar surface. CMS utilizes geospatial tools such as QGIS and GDAL to test and modify planetary data. Other features include the ability to enable specific place names, a measurement toolbox, terrain profiler, anaglyph view of the Moon, navigation capabilities, and an interactive visit to the Apollo landing sites which showcase 3D objects of the astronauts and lunar landers. In the world of planetary mapping, CMS aims to significantly improve upon existing functionalities, and bring new tools, that will be useful to the planetary science community and mission planners.

[C-10] Joshua Bamberger, Edgar Jimenez
Oregon State University | OSGC Undergraduate Team Experience Award

2019-2020 Design Build Fly Competition Team

Student members of the OSU Design Build Fly (DBF) team successfully constructed a competitive “banner towing bush plane” remote control aircraft for the 2020 AIAA DBF competition. Although the competition was cancelled, the aircraft successfully completed all mission requirements and fulfilled the customer requirements of the capstone class. Concurrent mission requirements of speed, payload capacity, takeoff length, and towing ability required a thorough numerical scoring analysis to inform the design direction. Under the experienced guidance of Dr. Roberto Albertani and Dr. Nancy Squires, capstone team members found real world applications for the aerospace concepts many team members were learning in class. Through the iteration of six full scale prototypes, the team employed composite design and manufacturing, analytical and experimental drag characterization, and propulsion testing to converge on the final aircraft. As the only OSU student group focusing on aviation, DBF provided valuable hands on experience to over 20 seniors and underclassmen alike with an interest in aviation. DBF welcomes students of all experience levels to broaden our impact and inspire interest in aerospace careers. Student members have also applied DBF experience to conduct research on relevant aerospace topics including novel non-invasive composite inspection techniques, and active flutter suppression systems for high aspect ratio wings.

[C-11] Jerika Christman
Oregon State University | NASA Goddard Space Flight Center Internship

SMA Cataloguing System Creation for Standard Component Commodity Usage Guidelines (CUGs) Specifically for Charge-Coupled Devices (CCDs)

GSFC Safety and Mission Assurance (SMA) Reliability and Risk Assessment Branch works to develop analytical and risk assessment processes for spacecraft and payload standard components (PSC) to identify conformance risks and mitigations while increasing safety of Earth and Space systems exploration. Needing a database that would contain the heritage (i.e., the performance, reliability & anomaly history) of payload standard components for risk-based mission assurance, the goal of this project was to create a compressed catalogue/referencing system for mission personnel known as Commodity Usage Guidelines (CUGs). CUGs are populated using vendor data, lessons learned, associated component risks, and other data found within Engineering Peer-Reviewed (EPR) presentations, Flight Review (FR) documents, and the Meta Database. They allow the user to quickly locate aggregated instrument heritage and reliability data in order to make risk-based decisions for future component use and integration. Charge-coupled devices (CCDs) served as the first component CUG entry and were heavily research on the basis of anomaly history, testing results, manufacturer reliability, and overall performance results. The creation of CUGs for PSCs reduces time spent searching through existing risk-related data and saves both time and money in preventing reoccurring performance testing. The fabrication of the CUG catalogue/referencing system aims to serve foundationally for a future SMA Database, and will be updated and refined continually.

SESSION D

[D-1] Gabriela Griffin
Oregon State University | NASA Langley Research Center Internship

Streamlining the ACS3 Solar Sail Manufacturing Process

The Advanced Composites-based Solar Sail System (ACS3) is a technology demonstration project of a solar sail in low earth orbit. ACS3 uses a 12U CubeSat platform with an approximate volume of 24 x 24 x 34 cm. The sail is deployed using composite booms which unroll over the course of 45 minutes. The membrane is made of polyethylene naphthalate (PEN) with one side covered in an aluminum coating to increase reflectivity; the other coated in chromium to increase thermal emissivity. Throughout the course of the internship, the sail membrane manufacturing process document was updated. In addition, a storage container for the sail membrane raw material roll was designed and assembled. Finally, sail and boom structures were modeled using Abaqus in order to understand whether the additional material due to membrane support should be included in analysis.

[D-2] Kaseylin Yoke
Oregon State University | NASA Goddard Space Flight Center Internship

Optical Analysis of Ion-beam Figuring Polished Silicon Wafers

NASA's direct imaging of exoplanets missions and projects such as WFIRST and LUVOIR require fabricated coronagraph masks to control scattering and diffraction of light. In this study, we intend to enhance the pathfinder masks for High-contrast Imager for Complex Aperture Telescope (HiCAT) at Space Telescope Institute (STScI) while assessing their optical performance independently. The fabrication of pupil mask involves silicon wafers to be sliced and polished at $\lambda/20$ using recently procured ion beam figuring (IBF) system where the absorbent region will be black-silicon etched using Oxford Instrument Etching system currently under commission at the GSFC Detector Characterization Lab. A comparison between pre- and post-IBF polished silicon wafers done in Summer 2019 showed that IBF polishing greatly decreases the surface figure error on the silicon wafers. In this study, the results from Summer 2019 will be verified and corrected. Additionally, a Zernike polynomial decomposition will be performed on each wafer to determine the exact surface aberrations present.

[D-3] Brooke Brown, Carrie Chan, Clement Forbes, Noah Ford, Izikaula Huntley, Adrian A. Jimenez, Taylor L. Lohrie, Faye Nieman, Ethan Stouder, Wolfgang
Portland Community College | OSGC Undergraduate Team Experience Award

Aquaponics as a Food Source for Long-Term Interplanetary and Lunar Expeditions

The goal of this project was the development of a fully automated and self-regulating aquaponic system that could withstand the environmental constraints associated with space travel. Under investigation for this first project iteration was the viability of a system to produce algae in a closed environment through optimization of a current aquaponic system at the PCC-Southeast campus. During the initial phases of the project (November 12, 2019-March 2020), we drafted and finalized a design for a terrestrial aquaponic system. We intended on optimizing the system and using it as a baseline for the design of a space-ready system. The system included two tanks in which we would cultivate algae and tilapia. From these tanks, nutrient-rich water would flow out

into containers growing strawberries, bok choy, lettuce, and other plants (depending largely on the time of year we initiated growth) before re-entering the tanks. Unfortunately, as we were to begin construction, the COVID-19 pandemic forced us to put the project on hold. Now, the Portland Community College campus is still closed, and construction will not be viable for the foreseeable future. We are now focusing on the future of the project, with the hope that our design can be utilized by future research groups at PCC.

[D-4] Nathan Wiley
Oregon Institute of Technology | OSGC Virtual Summer Internship

Artemis Student Challenge

Purpose: The University of Washington's *Artemis Project* is a challenge that Oregon Tech is participating in with five other schools. Members from all the schools were put into teams to work on different aspects of the project including geology, mechanical functions, rover design, and computer programming. The Oregon team chose the rover collaborative with the goal of creating a vehicle that can enter and navigate a simulated lava tube course.

Methodology: The specifications of the course are to descend into the cave, climb at least a 30-degree incline and navigate over sand and rocky surfaces, all while in complete darkness of the cave. To accomplish this, we were sent Vex kits to get us started. In order to traverse over the various terrain, we needed to design something versatile. We created three different designs. The first design uses crescent shaped legs, the second has four tank-treaded legs that can move independently, and the most promising so far being a spoked wheel-leg hybrid.

Results: We have just received our lava tube obstacle course and have not had the chance to test our designs on it yet. However, we have tested our designs over various terrain and found that each design has its own pros and cons which I will showcase in the presentation.

Conclusion: This project is far from over and we still have a lot of work to do, our next steps are to improve object recognition and try our hand at stereoscopic 3D mapping.

[D-5] Mandy Kiger
Oregon State University | NASA Marshall Space Flight Center Internship

Analysis of a Ring Assembly for Adapting a Mars Transfer Vehicle and Transit Stage for Artificial Gravity

While artificial gravity designs are not uncommon in spaceflight design proposals, few ever go beyond conceptual drawing stage from a mechanical and structural standpoint. This paper outlines the mass trades and analyses done to better refine a minimal-mass, single-launch capable system designed to integrate into as-built Mars mission architecture and which could be used to supplement the crewed periods with artificial gravity in an effort to minimize risks and increase crew comfort over the long mission durations required. While many previous designs focus on the benefits of a completed system and gloss over assembly and manufacturability questions, the authors of this paper have made a concerted effort to focus on real-world requirements and demands when running analyses – keeping cost, schedule, manufacturability, integration, launch vehicle lift mass, fairing dimensions, and safety all at the fore. This completed design has been created to be as modular as possible – capable of mating to a variety of stage and habitat designs and still providing this additional potential. Our results show that a system capable of spinning a crewed Mars Transit Habitat in the 45mt class, and a comparable transit stage, can be manufactured with a minimum factor of safety of 5, launched on a variety of commercial-launch vehicles, and integrated into the system with a minimal influence or impedance on the designs of either other component.

[D-6] Theodor Giles, Kai Hattan, Jay Sucharitakul
Oregon Institute of Technology | OSGC Affiliate Faculty Research Incubator Program Award | **Don Lee**

Oregon Tech Underwater Robotics

For the 2019-20 season, the Oregon Tech Unmanned Systems (O.T.U.S.) team was able to compete in the RoboSub competition and apply a variety of improvements to every aspect of our project, such as the development process, mechanical and software systems of the robot, and our future engineering prospects. This would not have been possible without the support from Oregon Space Grant and their funding to give us access to equipment, labs, and time to work on the Robosub during such difficult times. We had planned to work on our Robosub in person, but due to the current COVID-19 pandemic, we had to figure out strategies to work virtually and in person for limited amounts of time. Our three-man team along with our mentor, Don Lee, worked during this time to ensure we had a system that would allow us to compete in the RoboSub competition, that was greatly improved from last year, with foundation for improvement and further advancements on a new robosub frame. On the mechanical side, these improvements include a more compact electronics housing integrated with natural water cooling, an integrated main power distribution board, and more versatile mounting options for peripheral electronics and sensors. On the software side, the improvements consisted of a completely rewritten system, modularizable sensors and hardpoints, virtual environments for task simulation and AI development, as well as extensive documentation. There is also a framework being developed for our next advancements, including the amphibious designs of our future 'Rover Sub'.

[D-7] Michael Corcoran, Zachary Dilday, Oleg Krishcko, Danny Nelson, Tara Prevo, Ian Robinson, Catie Spivey
Portland State University | OSGC Undergraduate Team Experience Award

Thermal Analysis and Testing of Oregon's First Satellite

OreSat is a 2U CubeSat under development at Portland State Aerospace Society (PSAS). Our mission was to provide PSAS with a full thermal analysis of the current OreSat design and make actionable suggestions to ensure all flight- and mission-critical components remain within their operable range through the duration of the mission. Thermal analysis is broken into two stages: orbital heat transfer computer simulation and physical testing in a thermal vacuum chamber. Thermal simulations revealed that the batteries would likely experience concerningly low temperatures, while heat-generating components such as CPU's would stay within an operable range. The battery assembly was redesigned, and heaters were added. For testing, a liquid nitrogen radiative cooling system was designed to be placed into a vacuum chamber to simulate low-Earth orbit conditions. Due to covid-19 restriction, only limited access to the vacuum chamber has been granted and testing was postponed. As a result, our team pivoted to focus more on design and simulations. Thermal simulations and FEA were performed on the test equipment to ensure smooth operation once the system could be built. The completed cryogenic cooling system will be delivered to PSAS, and limited testing will take place by the end of 2020.

[D-8] Noah Cayson, Brandon Foose
Oregon Institute of Technology | OSGC Undergraduate Team Experience Award

Thrust Vectoring Toroidal Aerospike

The Oregon Tech Rocketry and Aerospace club, supported in part through NASA/Oregon Space Grant Consortium grant NNX15AJ14H, investigated the feasibility of controllable thrust-vectoring on an aerospike. The inherent altitude compensating abilities of an aerospike nozzle makes it a promising alternative to the traditional bell nozzle, although toroidal aerospikes lack a method of thrust vectoring. A traditional, toroidal aerospike was designed, in addition to a thrust vectoring aerospike with controllable compound nozzles integrated at the throat to produce thrust vectors. The designs of both aerospikes were preliminarily validated through a computational fluid dynamics study. For testing, a low-pressure chamber was designed to test the aerospikes at two different pressures to verify the altitude compensating characteristics of the nozzle. The nozzles were to be cold fired with compressed air, so a schlieren system was developed and tested to record and then analyze the results. Unfortunately, the project was brought to an abrupt halt before testing could be completed due to COVID-19. All design and analysis were completed, the only remaining portions of the project were hands-on fabrication and testing. Since access to the labs has resumed, the project team has begun working toward performing a test of the aerospike before the end of the year. Additionally, a new senior project team has taken up the project, looking to improve upon the systems in place and move the project through a successful test of a controllable thrust vectoring aerospike.

[D-9] Grace Semerjian
Portland State University | OSGC Virtual Summer Internship

Quasi-Infinite and Zero Stiffness Magnetic Spring for Space Applications

This project looked into developing a quasi-infinite magnetic spring, as well as a constant force/quasi-zero stiffness magnetic spring arrangement. Ideally, when we think of suspension, we don't want our mass that's being suspended to be displaced whenever a disturbance occurs. An infinite stiffness spring is part of the solution; it'll always place the mass back to its original position when it sees a force. A zero stiffness spring is the other part of the solution; it'll keep a mass at a certain constant force and thus position. Both springs seem like they do the same thing, but that's not entirely true. The zero stiffness spring helps support the infinite stiffness spring and mass, while the infinite stiffness spring actually repositions the mass back to its original position. This kind of resilient suspension can be applied to many different types of systems, including space applications. Inexpensive vibration isolation is sought after by many and utilizing permanent magnets can help with this. The quasi-infinite stiffness magnetic spring setup was designed with spring equations and later simulated in JMAG, which performs finite element analysis. Both magnetic spring arrangements output the desired force responses. An experimental prototype that uses the two magnetic springs in conjunction is being designed at the moment.

[D-10] Isaac Gilmer, Riley Lundry, Mario Segura
Oregon Institute of Technology | OSGC Affiliate Faculty Research Incubator Program Award | **Sean Sloan**

Lava Tube Diver Vehicle

Purpose: Oregon Tech will be developing two prototypes to compete in a lava tube competition. The purpose of this project is to develop a vehicle that can maneuver throughout various lava-tube terrains. The vehicle must be capable of propelling itself down a hole, driving up a 30-degree incline, plugging a hole, and retrieving material (elements). There are two aspects of the competition, an autonomous section, as well as remote controlled section. In preparation for the challenge, Oregon Tech has decided to create a testing platform that will contain various terrains and inclines. Once an initial platform is made, the design will be produced for all participating schools.

Methodology: Due to the nature of the project, Oregon Tech plans to make two designs from the ground up. Two teams were constructed, and subgroups were created within each team. Team One will be developing a three-section vehicle with 6 wheels. The plan is to have two of the three-sections rotate 360 degrees. Team Two will be developing a "Land Master" design that will consist of two segments with rotating arms that have wheels implemented on to them.

Results: Both teams are still currently in the design phase, with the hope to order materials by the end of October and have two functioning prototypes by the end of Fall term.

Conclusion: As it is still early in the competition, there is still a lot to be accomplished.