Portfolio | Akashdeep Pawar

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Hello, my name is Akash Pawar, and I am a fifth-year master's Aerospace Engineering student at the University of Michigan having recently graduated with a bachelor's in Aerospace Engineering with minor in Computer Science.

Currently, I am working part-time as a mechanical engineering research intern at the university's Space Physics Research Lab working on a NASA-funded solar instrument known as SPICES. I have also spent all four years on the Structures and Assembly, Test, and Launch Operations (ATLO) sub-teams on Michigan's student-run high-powered rocketry team MASA. My work on MASA includes having served as the Structures Lead and working on projects involving aerostructures, fluid systems, and ground support equipment for the Clementine rocket, the team's architectural progression towards the spaceshot liquid launch vehicle Tangerine Space Machine (TSM). This past summer, I worked as a systems engineering intern at Northrop Grumman Space Systems, working on deliverables for the GBSD Sentinel system, the replacement to the aged Minuteman ICBM system. Overall, my project experiences include design, analysis, software development, machining on the mill and lathe, and some TIG welding.

I am grateful for the wonderful projects I have gotten a chance to work on and I aim to supplement my resume by providing a glimpse into my project work in this portfolio. Thank you for taking the time, and feel free to use the clickable menu at the bottom of each page as you browse.

NORTHROP GRUMMAN

MICHIGAN AERONAUTICAL SCIENCE ASSOCIATION

SPRL SPACE PHYSICS RESEARCH LABORATORY

MCubed – Senior CubeSat Design Project

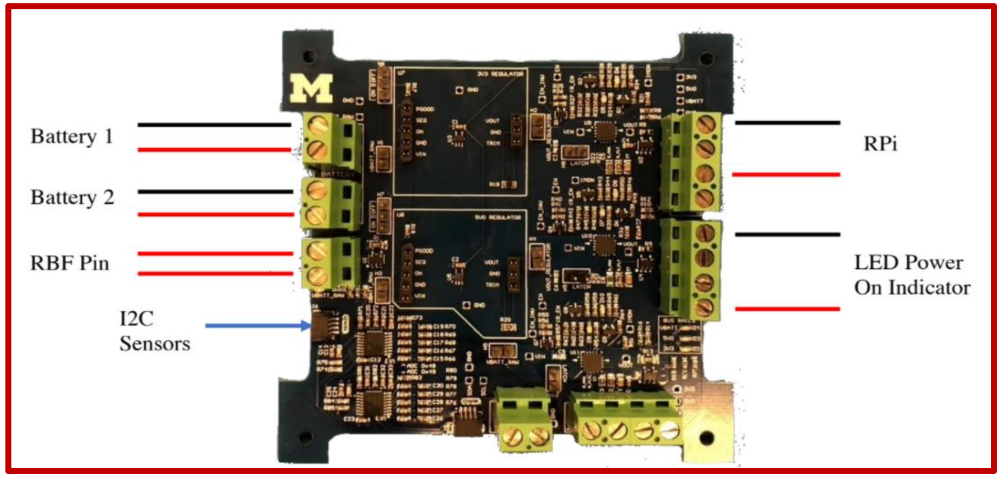
For my senior capstone design project in AEROSP 495, I developed power system hardware and flight software for my team's high-altitude CubeSat testbed. A total of five teams developed five CubeSat payloads for the stratosphere with a magnetometer as the scientific payload. Eventually, MCubed will work in a joint mission with JPL in launching CubeSats to orbit as a part of a university-led space systems engineering project.

Software: I developed Python software responsible for autonomously collecting and recording telemetry from various temperature, environmental, and inertial sensors via I2C. A watchdog program ensured nominal operation of the two data collection scripts by monitoring creation of telemetry log files on the Raspberry Pi4B flight computer. A system for commanding the flight computer was tested using a beaconing script which used a network on a Microhard pMDDL wireless data link allowing ground crews to access data during flight and command the flight computer from the ground.

Power System: As the power systems lead, I developed a procedure for and conducted battery tests while making a system power budget for the flight. Working with the course GSI, I contributed to the streamlining of the power system on every team's cubesat in the class with the Eddy EPS board, which provided a central interface for all regulated power supply rails and the I2C/UART communication buses. The board was inspected using a checkout procedure and Saleae Logic Analyzer software.

My efforts culminated in the first launch of the StratoSat V1, which saw all five teams launch prototypes to an altitude of 91,000 feet in their flights across the state of Michigan. Future plans this semester include a launch of StratoSat V2 with improvements to the watchdog architecture incorporating software functionality in flight computer restart events.

[Above] Me holding a Helium balloon with the payload train and parachute attached. **[Below]** The ground track for my team's CubeSat flight obtained using an APRS tracker on the balloon



[Above] Eddy EPS Board Rev A, which I helped develop alongside my CubeSat Team and the course GSI as the standard power system architecture. **[Right]** Team Echo shortly before pulling the RBF tag on the power supply and launching

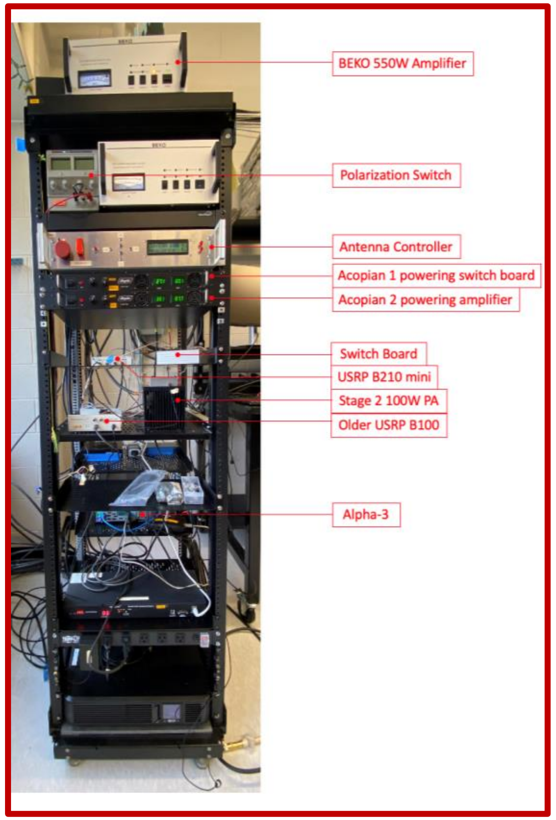
[Right] All 5 CubeSats after flight and recovery

MCubed – Satellite Operations, Structures Lead

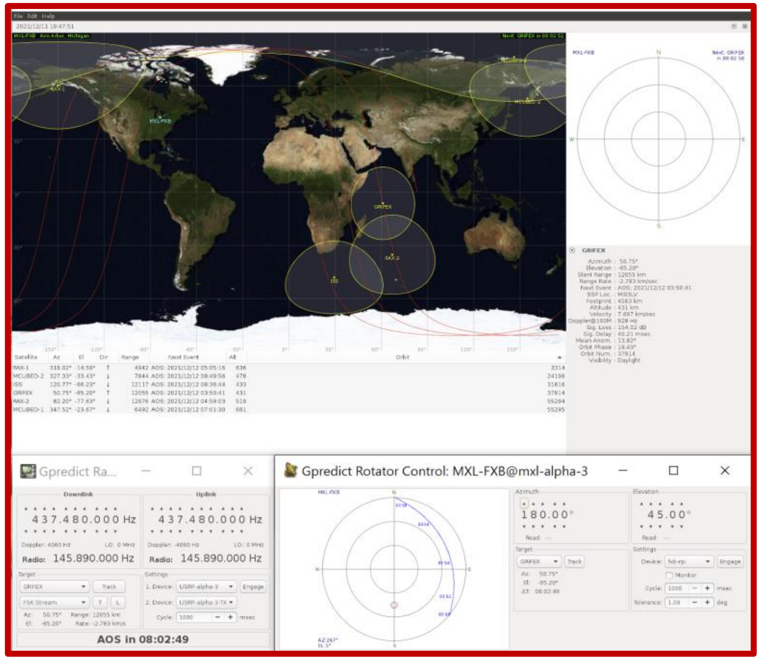
In the winter 2022 semester in AEROSP 495, I learned to operate and command satellites and receive telemetry using ground station radio equipment and tracking software

I wrote software in Python that deciphered radio application packets and extracted beacon data from MXL's GRIFEX CubeSat, its ground-based engineering unit, and M-Cubed 2, a fully operational operations training satellite and technology testbed.

For the second iteration of the CubeSat testbed, I served as the structures lead, managing a small team of students in improving the modularity of the 3U design, updating CAD assemblies, and managing 3D printing, machining, and other manufacturing activities in preparation for integration with avionics.



[Above] A pair of Yagi antennas used in satellite tracking and operations atop the Francois-Xavier Bagnoud Building at the University of Michigan North Campus. The antennas' azimuth and elevation are controlled using rotctl command-line software to control the antenna rotators. Additionally, they can be controlled using Gpredict. **[Right]** One of two fully-integrated M-Cubed 2 satellites. **[Below]** Image from the camera payload on M-Cubed 2 near apogee at 89,000 feet from its Spring 2022 flight



[Above] MXL ground station alpha-3 that I am operating this semester to track and acquire radio beacon data from GRIFEX as well as engineering units used in operations training. I use a client program to downlink file beacons from the satellites and units. Data from operational MXL CubeSats and engineering development units (EDUs) as well as our own and other open-source ground station networks is aggregated in the MXL Integrated Data Analysis System (MIDAS) to aid in rapidly assessing and maintaining the health of satellites. **[Left]** A Gpredict window being used to track a GRIFEX pass. Gpredict is an open-source satellite tracking software I use in satellite operations. This window shows an interface with rotctl, that moves the Yagi antennas with the satellite on each pass

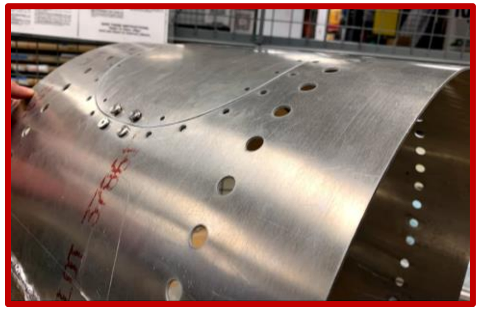
MASA - TSM/Clementine Airframe

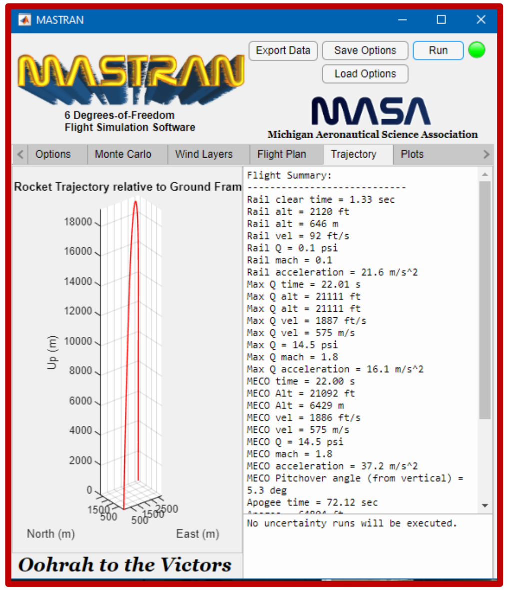
From May 2019 – August 2022, I was project lead for the development of the airframe for the TSM and Clementine rockets for the MASA managing a small team of 3-5 engineers. Over the course of the project, I have used SolidWorks and later Siemens NX with Teamcenter for CAD as well as MATLAB, hand calculations, and ANSYS for design analysis and validation. With design and manufacturing complete, the project has been transitioned to younger members on the team.

MASTRAN, Aerostructures Loads and Dynamics: Since winter 2020, I've worked extensively on MASA's custom 6-DOF flight simulator MASTRAN. I worked on integration of BENDIT7, a Visual Basic algorithm that assesses the structural loads including aerodynamically induced bending moments on the rocket fuselage using Barrowman equations. I also made a MATLAB-Excel interface that assesses data from the numerical time integration by the simulator and provides axial and bending loads on rocket bays during flight events like max Q and MECO for beam calculations and eigenvalue buckling simulations in ANSYS.

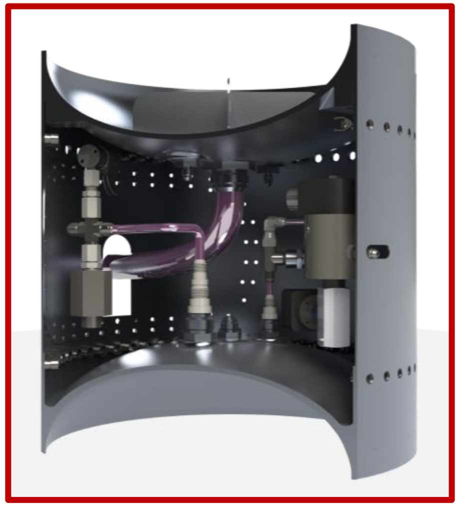
Airframe Fabrication The two primary airframe sections, the inter-tank bay (connecting the RP-1 and LOx propellant tanks) and the helium bay (housing upper rocket plumbing and the helium COPV) are monocoque aluminum structures. Working in house at the Wilson center and out of house manufacturers, I have managed the production of MASA airframes utilizing water jet cutting from DXF files, riveting, and sheet metal rolling.

[Top Left] Me installing rivet nuts on a propellant tank coupling ring **[Top Right]** TSM helium bay airframe after being rolled. **[Below]** Water jet and rolled access panel I assembled onto the inter-tank airframe

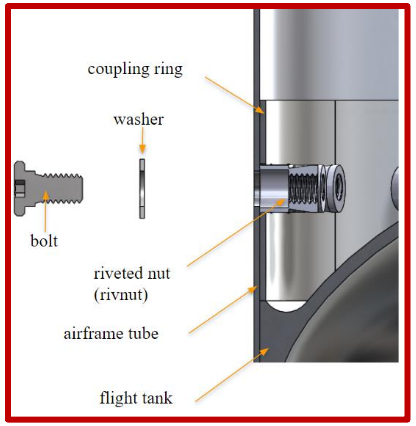


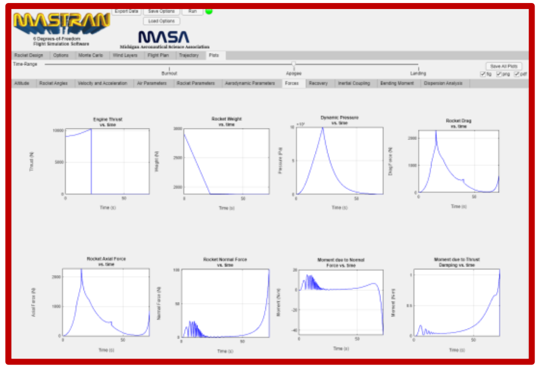


[Above] A MATLAB GUI for the MASTRAN flight simulation software, a project I have contributed to over 3 years. MASTRAN standardized the way we obtain loading conditions for individual component analysis **[Left]** First assembly of the Clementine aerostructure starting in August 2022 **[Below]** Sample MASTRAN output showing axial force, dynamics pressure, and other parameters over the course of the flight



[Left] CAD render of the Tangerine Space Machine (TSM) inter-tank bay with the LOx main propellant, fuel fill, and fuel pressurant lines plumbed. Due to administrative issues in obtaining a feasible coldflow/hotfire test sites and the collapse of the Base11 Space Challenge, the 400,000 ft TSM project has been put on hold in favor of a 50,000 ft liquid rocket Clementine **[Right]** Airframe-propellant tank coupling ring interface that connects both primary airframe sections to the rocket's propellant tanks I created my sophomore year.



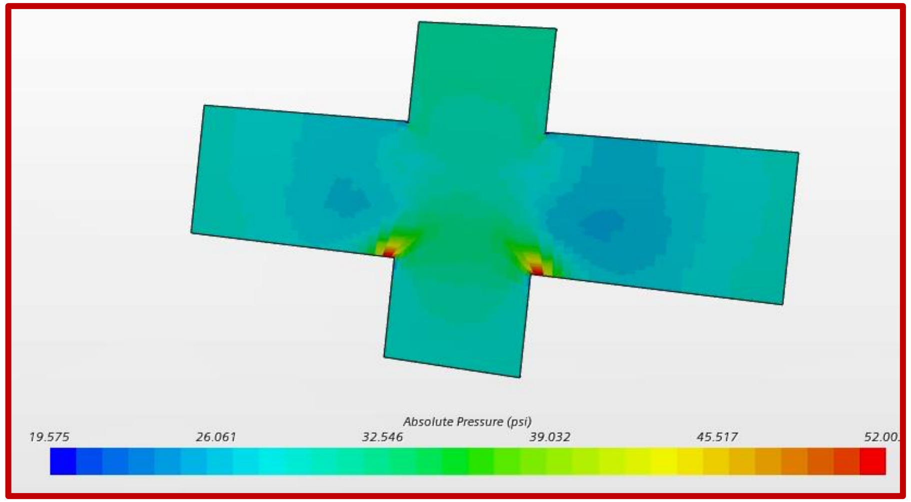


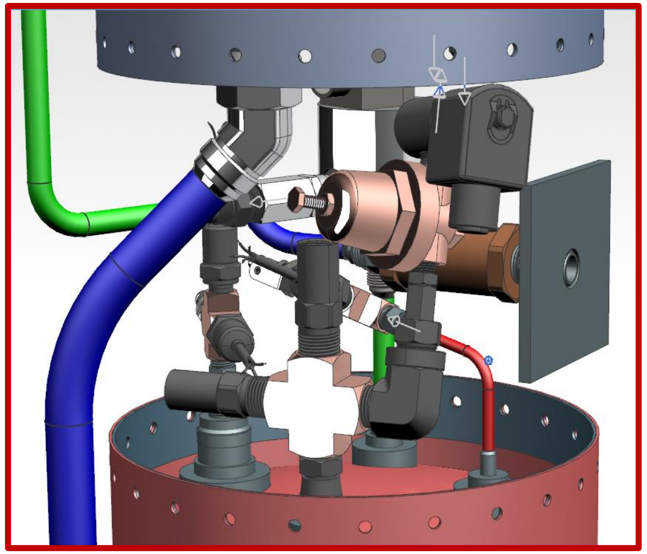
MASA – Rocket Plumbing & CFD, Clementine Integration

Inter-tank bay plumbing: My current role on MASA is leading design finalization of inter-tank bay plumbing and working on the construction of plumbing lines before integration with the propellant tanks.

Rocket Plumbing: I ran a CFD analysis on the a custom COPV manifold fitting using Star-CCM+ to determine the pressure drop of GN2 or Helium gas across the fitting and a static structural analysis in Ansys to verify structural integrity of the component under high-pressure loads of the pneumatic lines. The manifold allows the integration of redundant pressure transducers and multiple pneumatics lines to different parts of the rocket from a single COPV port

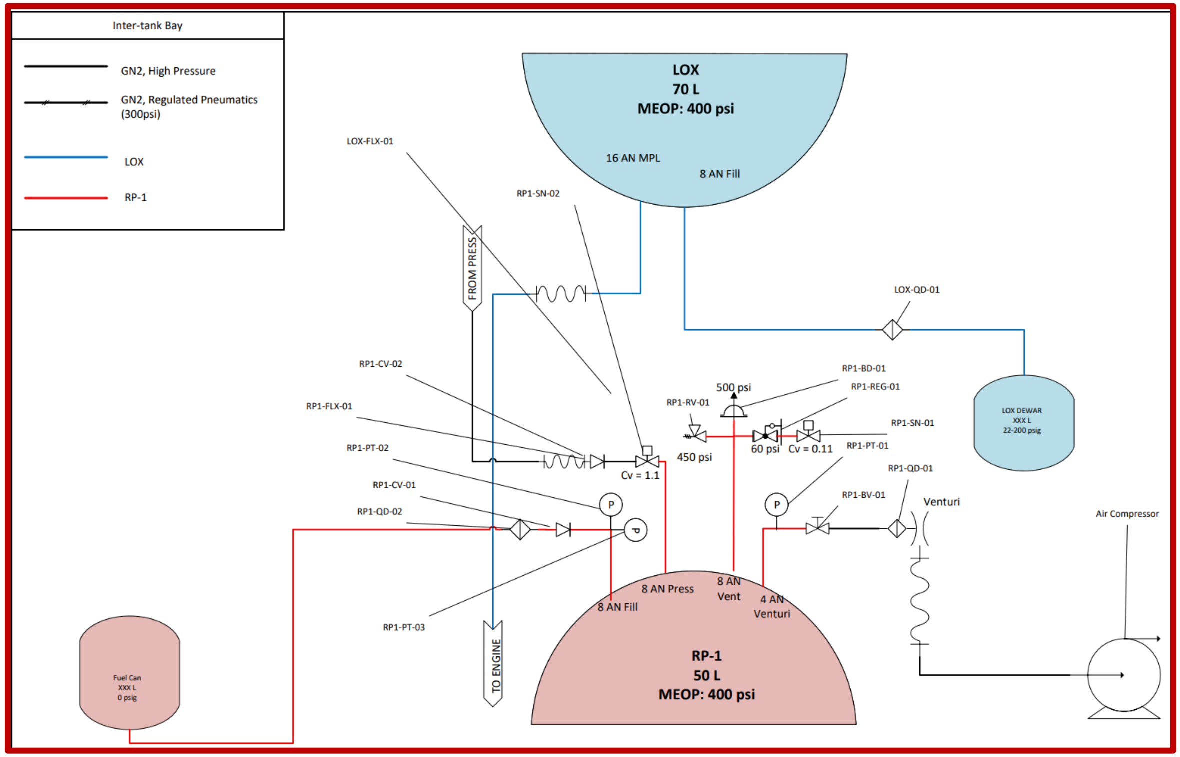
Plumbing and structural integration: Integration of the rocket bays goes hand-in-hand with integration of plumbing. Recently, I match drilled the interface holes on the composite avionics bay airframe section and am aiding the team in connecting rocket bays





[Above Left] Star-CCM+ CFD analysis of pressure drop across the COPV manifold. Recent changes to spatial constraints in the plumbing bay have led to the manifold being replaced by COTS fittings. **[Above Right]** CAD of the inter-tank plumbing in Siemens NX

[Left] Clementine plumbing integration and structural fit checks for Clementine begin on "rocket tables" (two of which I constructed) in a wind tunnel hangar at UofM. **[Right]** P&ID diagram of the inter-tank plumbing bay. P&ID and pressure budget spreadsheets are the methods I use to model the system, integrate changes, and construct lines.

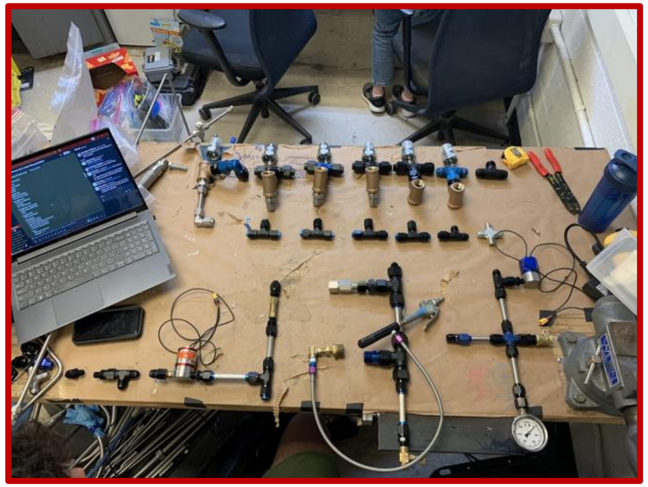


MASA – Engine Coldflow/Hotfire GSE

During the summer of 2021 I worked with a small team of ATLO engineers on the ground support equipment (GSE) for MASA's coldflow and hotfire testing of the RP-D2 engine. The GSE system is mounted on a single movable trailer, housing the propellant and pressurant tanks, the fill system, and the avionics/engine controller boards.

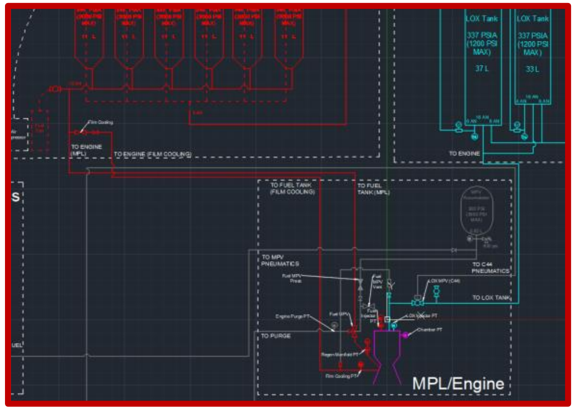
Fuel tank manifold: For the system, I designed the RP-1 fuel storage system which consisted of manifolded set of scuba tanks utilizing Swagelok bore-through fittings and inverted dip tubes to access ullage. The project required upwards of 40 hours a week at some points, with heavy usage of CAD and piping and instrumentation diagrams (P&ID). I maintained an extensive set of spreadsheets to track fittings, line assemblies, compatibilities, flow rates and coefficients to aid in the sourcing and purchase a large collection of AN, NPT, and Swagelok plumbing and various needle, pneumatic ball, solenoid, and check valves.

In August 2021, I traveled with the ATLO and Propulsion teams to the Mojave Test Area facility in California to perform coldflow testing. An upgraded version of this system returned to the Mojave this summer in 2022, where a de-rated version of RP-D2 was fired for the Clementine rocket



[Top Left] Fully plumbed fill system on the rail of the trailer and the stand containing the LOx manifolded tanks wrapped in thermal insulating fiberglass **[Top Right]** Fittings for the ethanol fuel tank manifold and its associated vent, relief, and fill lines before assembly. This project taught me to how manage several BOMs simultaneously and the many requirements associated with an extremely complex system. **[Bottom Left]** P&ID of the GSE system in AutoCAD. This section shows the main propellant lines (MPLs) to the engine from the propellant tank manifolds. Diagraming the system was crucial in tracking system requirements and making large purchases of fittings, valves, and tubing. **[Bottom Right]** MASA's RP-1/LOx engine RP-D2 after being plumbed and installed on the test stand at the RRS Mojave Test Area in California.

[Left] The chief engineer and I installing a motorized needle valve above the helium CG tank on the line to the fuel tank manifold. The tank pressures were controlled using this valve inside a custom housing and a servo-gear system.



[Right] The RP-1 fuel storage manifold I worked on. **[Left]** 1-second burn of RP-D2 at Mojave, CA

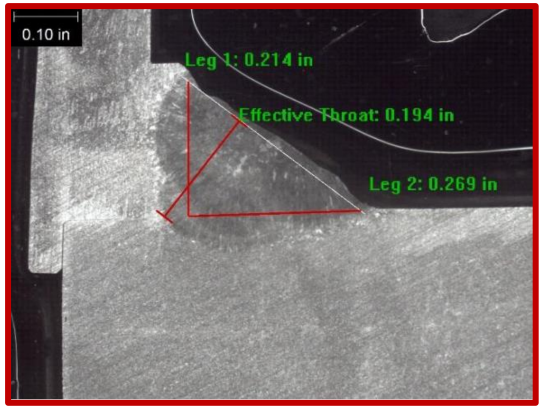
MASA- Clementine GSE Tanks, Burst Testing

In the fall of 2021, I was co-lead on the ground (GSE) tanks to be used for future MASA hotfires. The tanks are designed to a safety factor of 4 to critical with MAWP of 1000 psi and each one of the 6 tanks holds 40 liters of propellant, with 3 devoted to LOx and 3 for RP-1/ethanol.

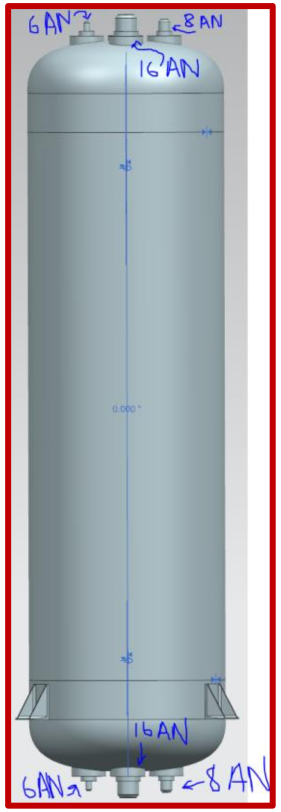
Using my prior knowledge and experience working with propellant tanks, the design utilizes stainless steel consumer off the shelf (COTS) schedule 40 endcaps and tubes, and features welded-on gussets that allow the tank to be fastened onto a tank stand on MASA's GSE trailer.

In the past spring, the inspection and weld process qualification via weld coupon testing to ensure that the AN bung and endcap-to-tube welds meet the Stainless-Steel Structural Weld Code (AWS D1.6). Lack of weld procedure qualification has been a major point of failure for past propellant tanks developed by MASA. This time around, we are working with a local weld inspection company to ensure the design safety factors and target burst pressures are realized during the manufacturing process.

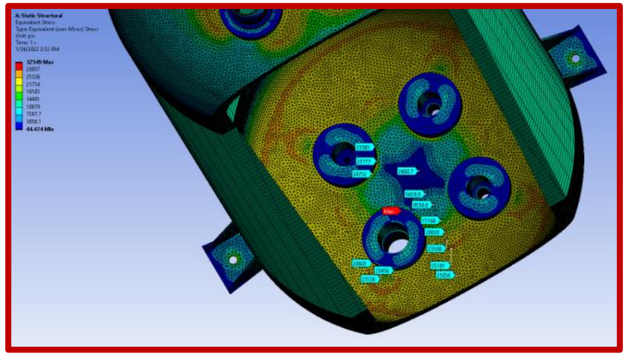
In Spring 2022, I worked with the team's production manager to design weld fixturing for the assembly welds and drawings for milling the COTS endcaps, each of which feature 4 adapter steel tubes onto which the bungs are welded.

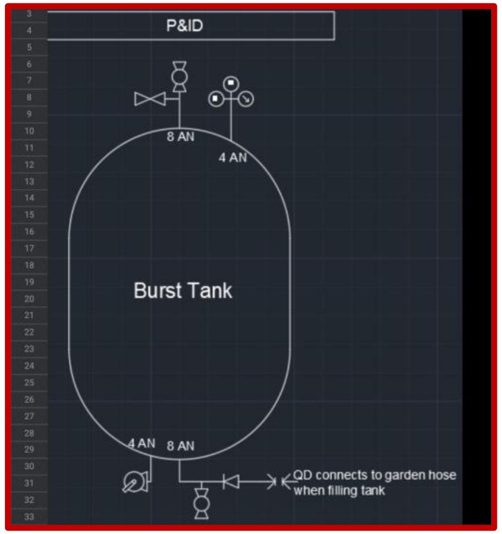


[Top Right] Macroetch inspection result from United Technologies of a coupon welded in AWS D1.6 position 2F, representing the fillet weld that will be used to join the 4 AN bungs to each endcap. These tanks are the first on MASA to feature weld process control **[Top Right]** Alongside the structures team after a successful burst test of the clementine LOx tank **[Bottom Left]** Burst test of a TSM propellant tank article **[Bottom Right]** ANSYS Static Structural FEA simulation of tank operation at the MAWP. I modeled the welds using an edge to face contact. Tensile and frictional stresses at the weld seam are obtained using contact results and the user defined "contforc" function.



[Left] Schematic of a GSE tank with 6, 8, and 16 AN bung fittings welded to each endcap and. The design is built to be somewhat futureproof, allowing for some tanks to be isolated for smaller scale testing or all of them to be used in long duration coldflows and hotfires. **[Bottom]** P&ID diagram I developed for burst testing campaigns including two pressure transducers, a pressure guage, and a hand pump





[Left] Recently arrived order of all 12 COTS endcaps. This project has taught me how to manage a mass production timeline, something uncommon in collegiate rocketry.

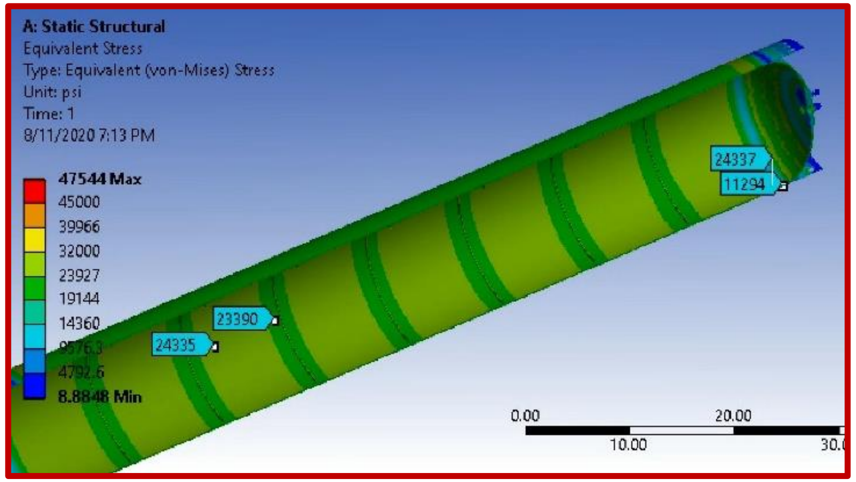
MASA – Structures Lead and TSM Propellant Tanks

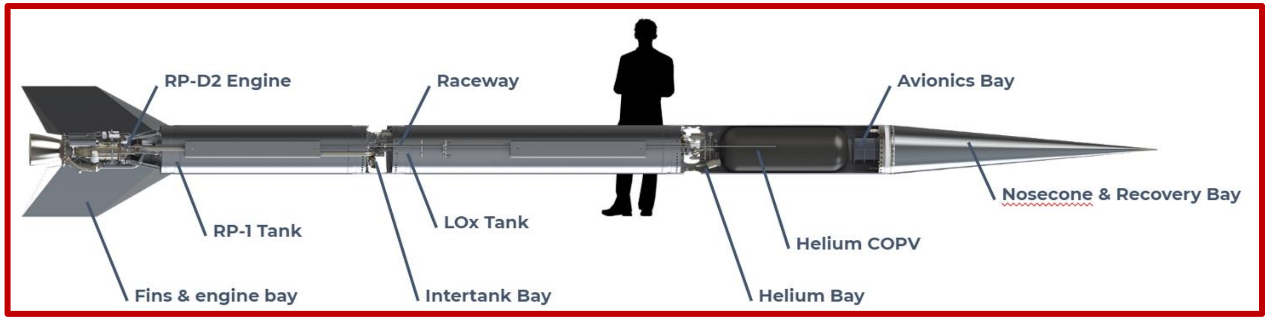
Structures Lead: During the 2019-20 academic year as a sophomore, I led the Structures subteam on MASA. I oversaw a team of 20 engineers in progressing the design of structures components, conducted weekly team meetings, and organized workessions and cross-subteam communications. My term featured a shift towards manufacturing and testing, in which I got my first real experience managing manufacturing lead times, movement of stock, making and approving production drawings and water jet DXF files, while making sure project timelines were met.

Spaceshot Vehicle Propellant Tanks: In my freshman year on MASA, I worked with peers on the Universal Endcap Assembly, which provides an endcap for the tanks, an interface for AN plumbing, and a connection point to the airframe. This UEA design is now standard on MASA's liquid designs due to ease of manufacture and design simplicity, requiring CNC operations and fillet welding.

Ultimately, both propellant burst test iterations fell short of the designed target burst pressure of 1.5 (attained 1.46) required by Base11 to qualify the tanks for flight operation due to the poor process control on welds. This led to a shift on MASA Structures, when the team started to place greater emphasis on conducting the testing and qualification of manufacturing procedures and methods ourselves.

[Left] Fully welded liquid oxygen tank test article at our welder's shop. **[Right]** The same burst test article after post-weld solution heat treat at the moment of burst. I was test conductor for this burst test in February 2021 and the Structures lead during the first burst test in March 2020. **[Below]** A static structural simulation in ANSYS I ran to model the effects of anti-slosh baffles on the interior of the tank tube which caused slight decrease in hoop stress in the direct vicinity





[Top left] The raceway team on Structures testing out their system on the first burst tank during my time as Structures lead. My management and coordination of manufacturing timelines made such assembly testing possible.
[Bottom Left] Diagram of the Tangerine Space Machine. At 27 feet in length and 15.5" in diameter, this bi-propellant spaceshot vehicle is one of the largest and most powerful student-built rockets in development. The bulk of the fuselage features the propellant tank architecture I worked on as a freshman with an external raceway feeding oxidizer around the RP-1 tank to the engine. A similar design is being used on Clementine

AEROSP 205 – Hovercraft Controls an CFD

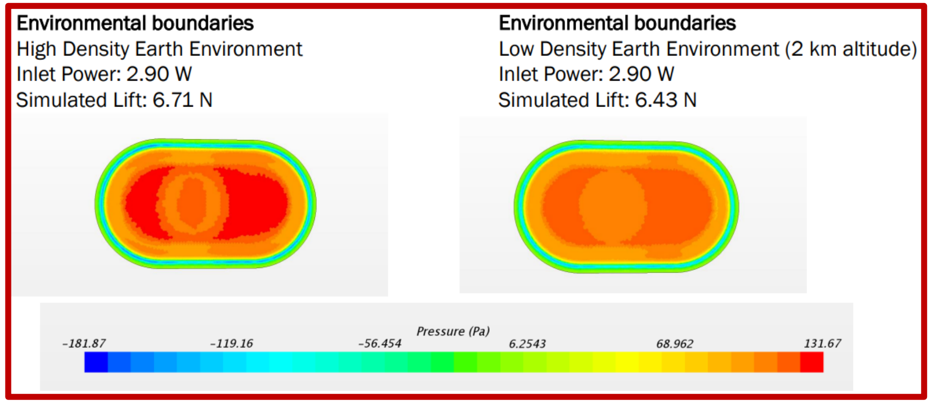
In my first aerospace systems course in fall semester sophomore year, I was responsible for running CFD analysis and aiding in the development of the controls scheme used to maneuver my team's RC hovercraft competing against 4 other teams in the course.

PID Controller for RC Hovercraft:

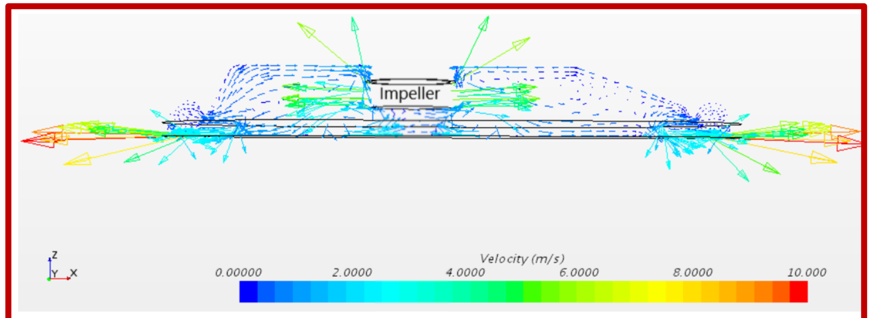
The craft's countersteering drift mechanism utilized a proportional and integral response to an inertial measurement unit sensor value and pilot/user RC inputs to recover from sharp turns faster into straights and remain straight until the pilot turned the vehicle. Controller gains were tuned via extensive testing and elementary tuning methods such as the Zeigler-Nichols Method, where the derivative response was deemed to be unstable, likely due to sensor noise and the slow control loop rate from the Arduino Nano receiving sensor measurements and controlling the propeller motor and gimbal servos.

CFD Analysis:

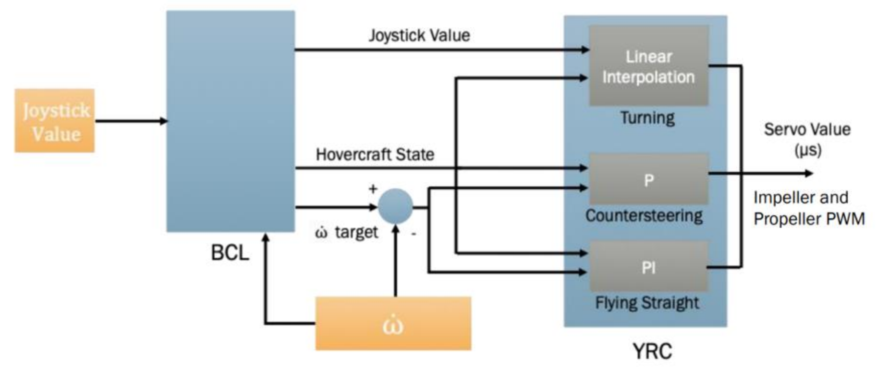
I helped my team converge onto a Milano-shaped hovercraft design as the primary member responsible for running CFD analysis on the vehicle. Simulation work was done using STAR CAT5, a version of Star-CCM+ embedded in Catia, which allowed me to run simulations and edit the design rapidly. The aim of the sims was to verify and maximize the design lift of the vehicle as well as the airflow performance of the impeller design before routering the layup mold and fabricating the fiberglass body.

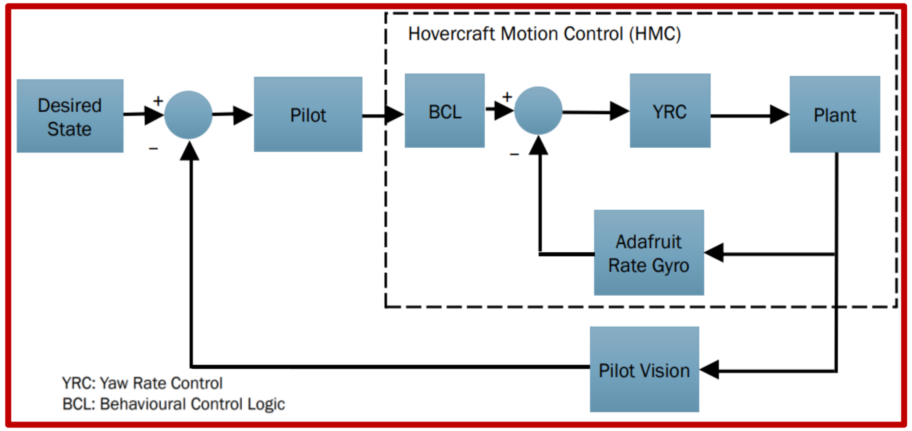


[Top] Completed hovercraft with impeller, Arduino board, batteries, and propeller. **[Top Right & Right]** CFD simulations I ran in STAR-CCM+ characterizing the lift of the hovercraft as well as the relationship between impeller input power and craft's plenum exit air velocity **[Bottom Right]** Block diagram schematic of the controls system. **[Below]** Controls diagram demonstrating the relationship between user input on the remote controller and the measurements received from the IMU during flight/racing operations. The counter-steering element of the controller allowed the hovercraft to drift around sharp turns drastically improving vehicle performance and winning my team the racing portion of the class-wide competition.



Shell Interior Airflow Simulation





SPRL– Electrostatic Analyzer and Venting Analysis

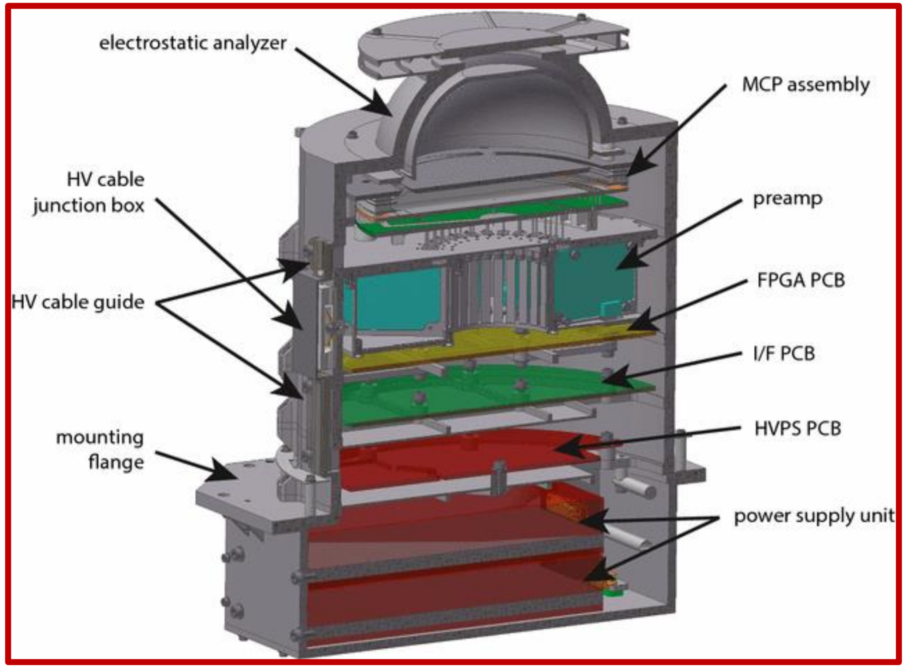
Starting in May of 2021, I have been working part-time at the University of Michigan Space Physics Research Laboratory as an Engineering Research Intern on SPICES, a NASA-contracted solar instrument that uses a high voltage electrostatic analyzer (ESA) and a microchannel plate (MCP) time-of-flight (TOF) chamber to measure and analyze solar particles.

Spacecraft Compartment Venting Analysis CFD:

My current project is to determine the venting characteristics and vent holes for the high voltage bubble (HVB) compartment housing the sensor assembly. To accomplish this, I am using transient CFD analysis in ANSYS Fluent to compare to an analytical mass-transport model in MATLAB in characterizing the pressure differential and sizing venting holes to meet NASA and JPL environmental requirements and ensure the integrity of the carbon foil applied on the ESA aperture.

Electrostatic Analyzer Photometric Testing:

In summer 2021, I designed a mount for an ESA prototype that attaches it to a rotational stage inside a vacuum chamber as well as mounting plates, bracketry, and fastening for AXUV and Quantar photodiode sensors. During its photometric testing, the ESA will be exposed to a UV light source to measure and ensure that the amount of UV light making it though the high voltage channels of the ESA assembly is below a specified threshold. I submitted production drawings, anti-reflective coating schematics, and assembly procedures to SPRL engineering staff for QT9 quality inspection.

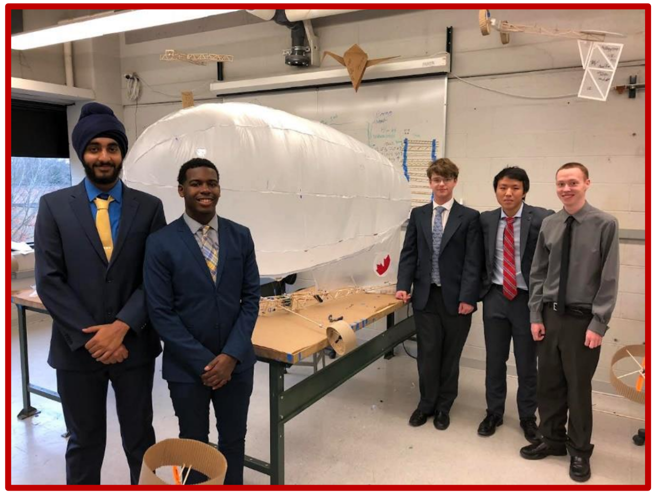


[Top] A schematic of a TOF-MCP instrument similar to the one being developed at SPRL

Papers & Publications

1. Final technical report on ENGR 100 Airship Design. Winner of the 2nd place Landes Prize in Technical Communication.
2. Phase 1 Report on MASA's Tangerine Space Machine Architecture. Winner of the $25,000 1st place prize from Base11 on preliminary design.
3. Phase 2 Report on MASA's Tangerine Space Machine Architecture. Winner of the 2nd place prize from Base11 on rocket design progression.

[Left] Reception ceremony for the Landes Prize in Technical Communication during my first semester freshman year. The report documented the design of our RC airship, which won the class wide competition. **[Right]** My blimp team alongside our airship on competition day



Activities

Honors and Awards:
- University of Michigan Merit Scholarship
- University of Michigan Regents Scholarship
- Sigma Gamma Tau Inductee (Michigan Aero Dept. Honor Society)
- University of Michigan College of Engineering Dean's List

Student Groups:
- AIAA University of Michigan Student Chapter – Outreach Committee Member
- University of Michigan Science Olympiad - Volunteer
- Sigma Gamma Tau – Member and Volunteer

[Left] Since my induction during sophomore year, I have been a member of Sigma Gamma Tau (ΣΓΤ), the Michigan aerospace department's student-run honor society where I volunteer and participate in social events. ΣΓΤ is a distinction held by students with a GPA of 3.5 and above.

[Right] I have served on the outreach committee of the Michigan AIAA branch, organizing and participating in outreach events with local K-12 schools. I have also taken part in the 2021 AIAA Congressional Visits Day and was a part of the branch's delegation at AIAA SciTech in 2020 and 2022

AIAA
SHAPING THE FUTURE OF AEROSPACE

[Above] Michigan AIAA delegation at 2022 SciTech in San Diego this past January, where I was a part of a collegiate rocketry forum announcing ARLA, an academic launch alliance between college rocketry teams nationwide.