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ENGINEERING PORTFOLIO

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INTRODUCTION

I am a junior studying Aerospace Engineering at the University of Michigan with a minor in Computer Science. During my time here, I have designed, built, and tested record breaking rockets with MASA, as well as innovating new aircraft mechanisms with MACH. I have significant experience in team leadership, project management, and the design of deployment systems and structural components for flight vehicles.

Please see my attached resume for more details!

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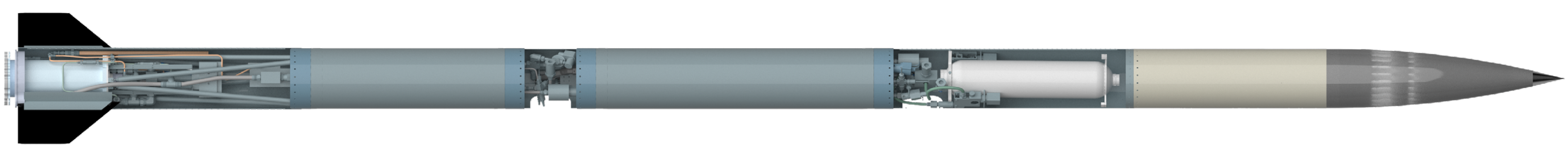
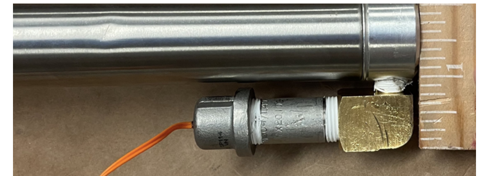
A render of Clementine, MASA's current rocket, planned to launch to record-breaking heights in November 2022.



Clementine

Nosecone-Airframe Coupler (2021-2022)

Since August 2021, MASA has been working Clementine, a 1.5 year project to bring us back to the launchpad while innovating on the best of previous designs. Clementine will double the current altitude record when it launches later this year, and will be one of the most advanced rockets ever built at the collegiate level.



I am leading the design, testing, and construction of the nosecone-airframe coupler, ensuring the nosecone stays attached up until parachute deployment. During the design phase, I acted as a liaison between the nosecone, recovery, and airframe teams, coordinating timelines, writing grants, and ensuring interoperability and ease of assembly.

During the summer of 2022, we took the coupler into the prototyping and testing phases. I led multiple layups, of both the coupler and the airframe. These prototypes were tested exhaustively, ensuring the shear pins would break on deployment, and that the nosecone would clear the airframe in flight. When our testing showed that the pyrotechnic bolt design was unreliable, I designed and sourced a new system, improving reliability and ease of assembly.

In the coming months, we plan to make a smoother coupler for flight, as well as start nosecone integration and full system testing!

Tangerine Space Machine

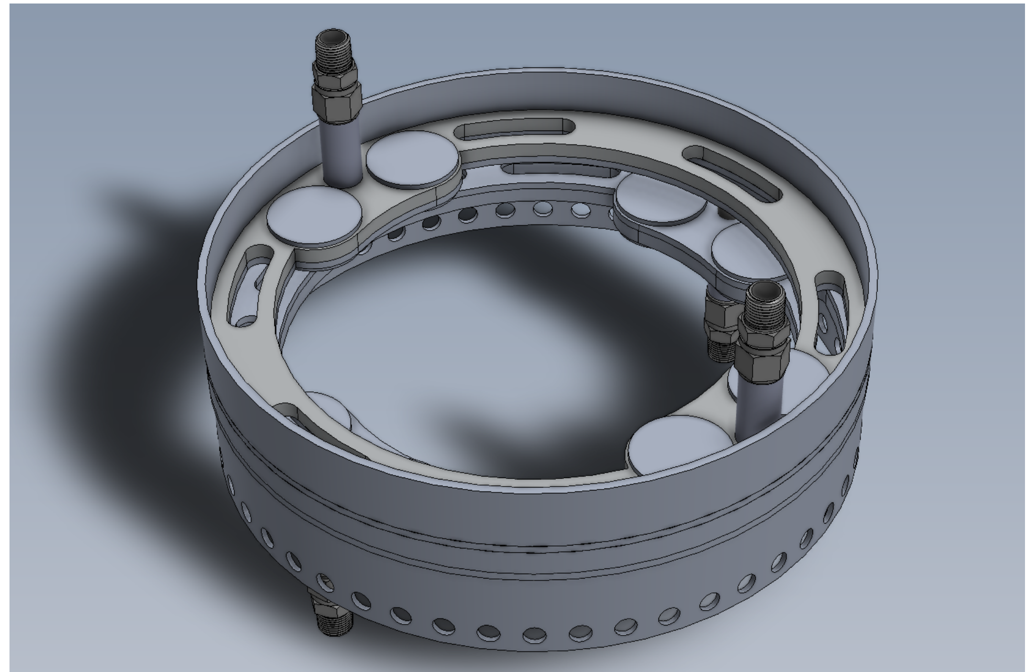
Separation Mechanism (2020-2021)

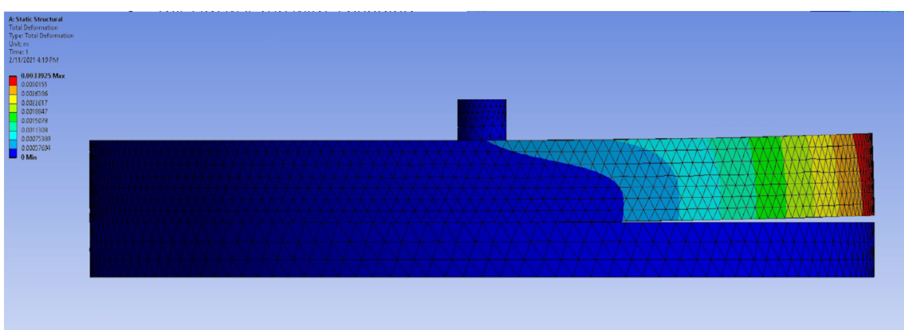
As part of the Base 11 Space Challenge, Tangerine Space Machine was set to be the first student built liquid rocket to cross the Kármán line and enter space. As such, the separation mechanism faced a completely different set of design requirements.

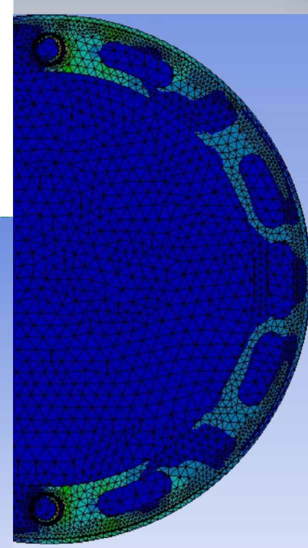
Our two largest considerations were the oxygen-free environment and the bending moment induced by aerodynamic loads.

In regards to the environment, we had a redundant system of two pins, with two rings pushed apart by a set of 8 springs. It was important that we maximized spring energy to ensure recovery and range safety in an abort case, and as such, I conducted a trade study out of 543 springs to find which held the most energy within our size and clamp force.

However, our greatest challenge was the bending moment induced by the nosecone. I proposed and simulated multiple designs in ANSYS Mechanical, resolving issues with yielding and failed simulations. Eventually, we settled on a thicker base and walls, with holes to save mass.







Tangerine Space Machine

Fin Can Test Stand (Summer 2021)

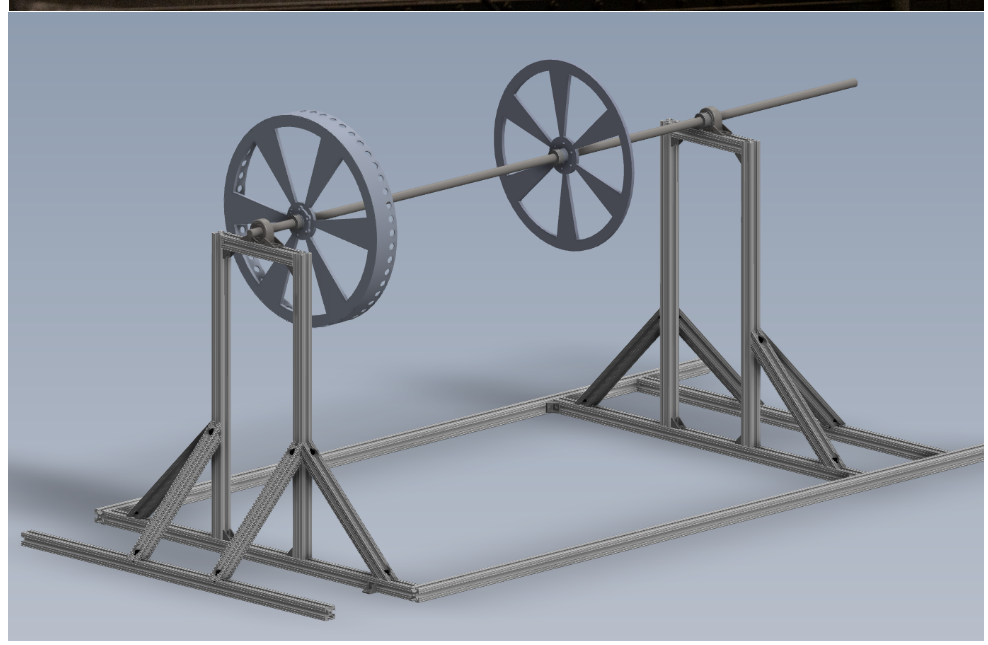
A common issue with fins in rocketry is that any inaccuracies in construction might cause them to induce significant roll. Given that partner teams have lost rockets due to inertial roll coupling, this was of great concern to the team.

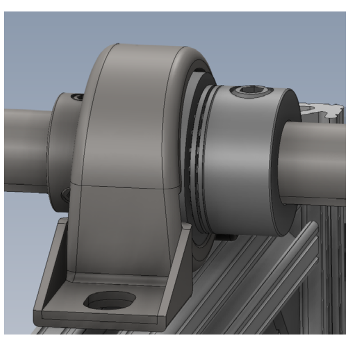
Over the summer of 2021, I designed a rotating stand that allowed us to quantify this effect, in the university's 5'x7' wind tunnel. It had to:

- Be adaptable to the pre-existing floor hole layout
- Adjust to up to 2° AOA
- Survive 400 lbs of downforce and ~100 lbs of thrust
- Not significantly disrupt the airflow around the fins

As such, I chose 80/20 extrusion due to its adaptability. I then drafted designs in SolidWorks and performed an internal design review before moving into discussions with the wind tunnel manager. From there, I significantly reinforced the design and moved into the production phase.

I also wrote the grant that funded the project and sourced the materials from metal suppliers and McMaster-Carr. As the summer ended, the project was handed off to a capstone project team.





I used a needle-roller thrust bearing to ensure drag forces were transferred around the bearing.

MACH 6

FEA and Rear Faring Hatch

I discovered MACH in the December 2021, and joined soon after, wanting to explore my interest in aircraft. At the time, MACH did not have anyone with FEA experience, and as such, my role was to simulate loads on the wing spar attachment and motor mount.

The wing spar attachment was a custom 3-D printed geometry, and the simulations found that it had a sufficient safety factor, backed up by physical testing. For the motor mount, the preliminary design called for a wooden plate. However, the simulation showed that it would fail. We instead switched over to two plates, one plastic and one metal, bolted together.

The challenge called for us to insert two packages into the plane as quickly as possible. I led the development of a single pin design for our detachable rear fairing, decreasing complexity, while still constraining all six degrees of freedom. This allowed us to retain the aerodynamics of a smooth rear fairing, while maintaining easy access for the ground crew.

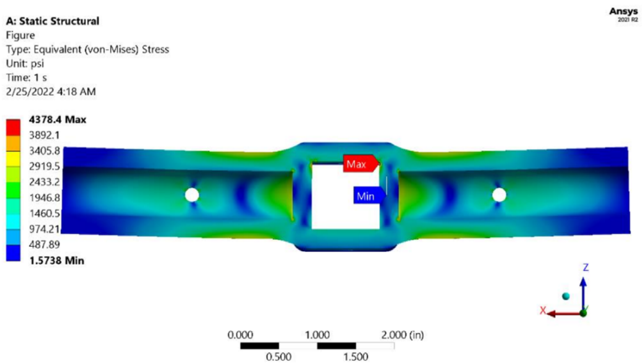


Figure 31: Stress in Wing Mount for 3-G Upward Load Case

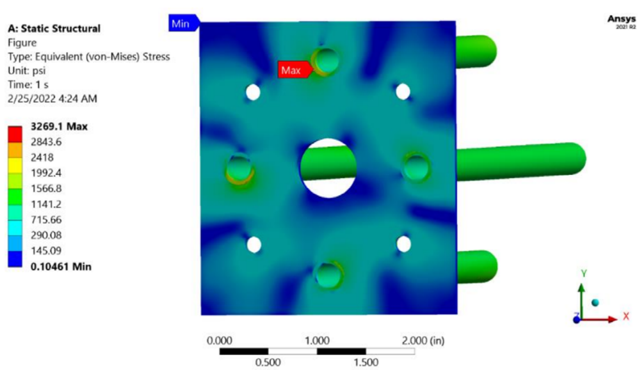


Figure 32: Stress Results from FEA Analysis of Motor Mount