Hirsh Kabaria

ENGINEERING PORTFOLIO

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INTRODUCTION

I am a sophomore studying Aerospace Engineering at the University of Michigan with a minor in Computer Science. Most of my out-of-class work has been with MASA, UMich's rocket team. Over the past two years, I have developed a deep understanding of the design, simulation, and testing of aerostructures, as well as significant experience with project management. I am also MASA's Business Lead, helping steer our team and raise >$100,000 per year to support our work.

Please see my attached resume for more details!

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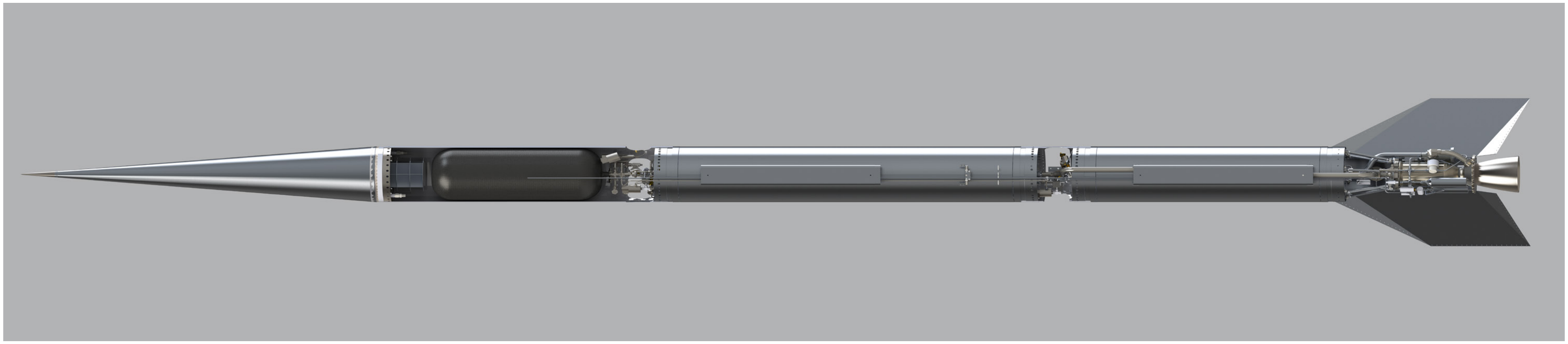
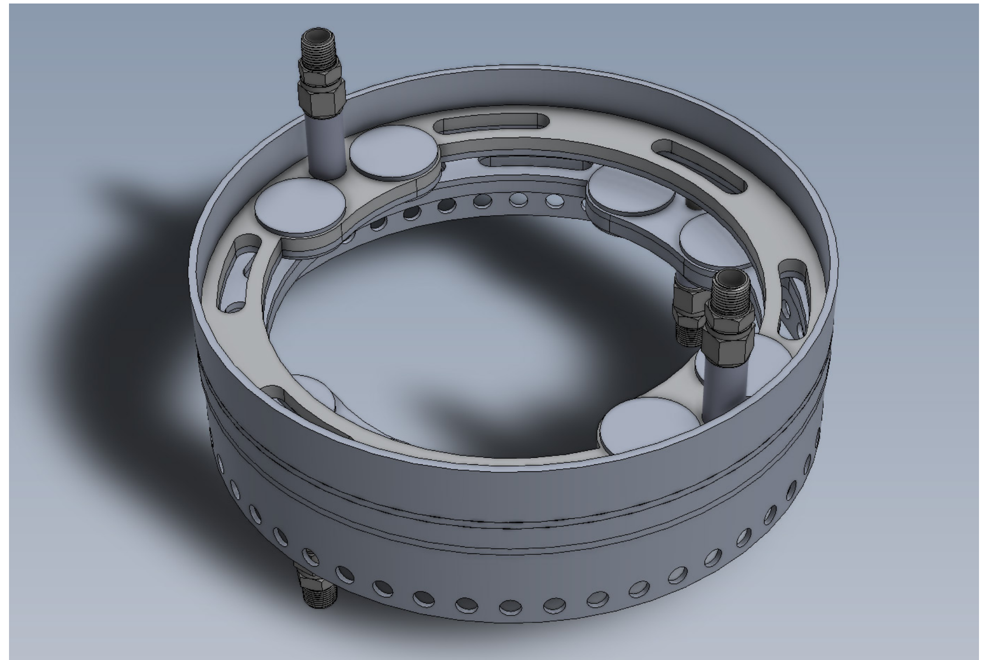
A render of Tangerine Space Machine (TSM), our spaceshot liquid rocket



Tangerine Space Machine

Separation Mechanism (2020-2021)

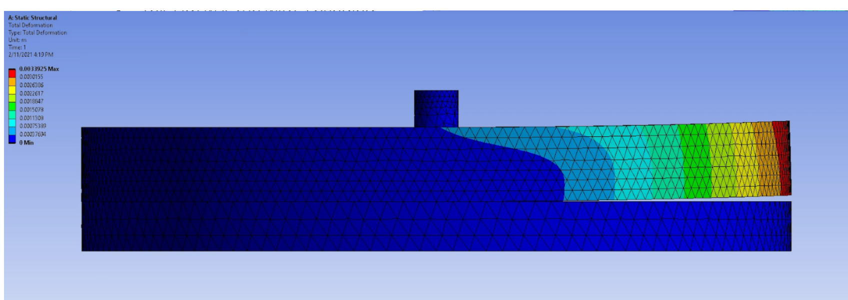
TSM's Separation Mechanism served to ensure the recovery of the rocket by separating the nosecone from the airframe, allowing the deployment of parachutes.



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

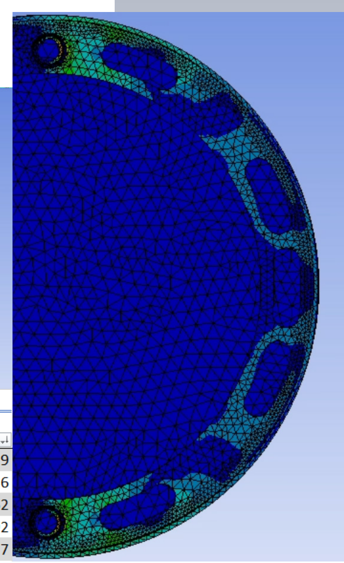
In regards to the environment, we had a redundant system of two pins, with two rings pushed apart by a set of 8 springs. It was important that we maximized spring energy to ensure recovery and range safety in an abort case, and as such, I conducted a trade study our of 543 springs to find which held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

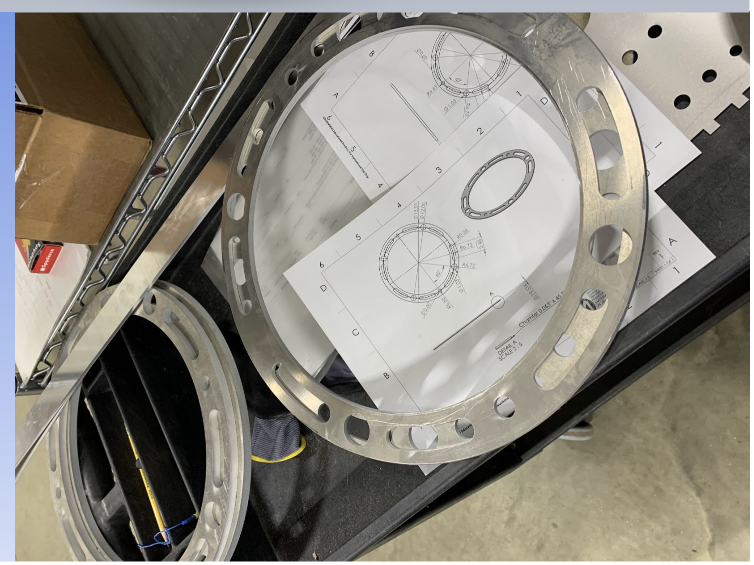
However, our greatest challenge was the bending moment induced by the nosecone. I proposed and simulated multiple designs in ANSYS Mechanical, resolving issues with yielding and failed simulations. Eventually, we settled on a thicker base and walls, with holes to save mass.



A Nice Comparer for McMaster Springs (Imperial)

Index	Uncompressed Lg.	OD	ID	Compressed Lg. @ Max. Load	Max. Load, lb	Qty.	Link	Pkg. Price	Refined U(J)
321	2	1.937	1.614	0.7	90	1	9657K585	9.05	6.7785519
244	1.5	1.687	1.333	0.75	133	1	9657K571	8.52	5.6563256
317	2	1.46	1.19	0.78	71	6	9657K409	12.88	4.8011762
322	2	1.938	1.642	0.72	67	1	96485K12	9.21	4.7759692
160	1.063	0.688	0.392	0.81	213.35	1	9657K251	16.11	4.538127





Tangerine Space Machine

Fin Can Test Stand (Summer 2021)

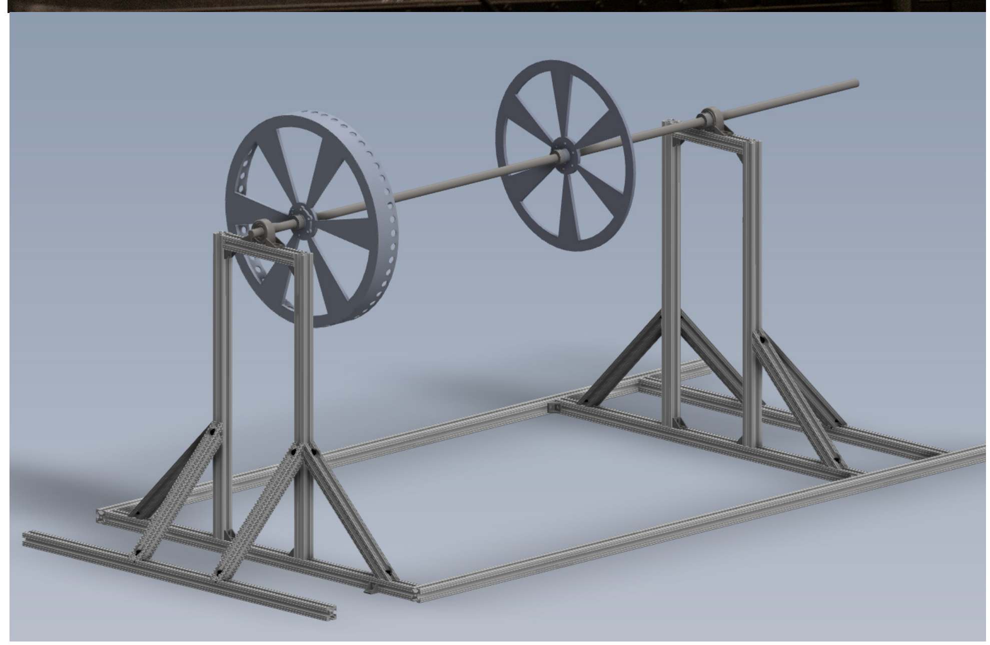
A common issue with fins in rocketry is that any inaccuracies in construction might cause them to induce significant roll. Given that partner teams have lost rockets due to inertial roll coupling, this was of great concern to the team.

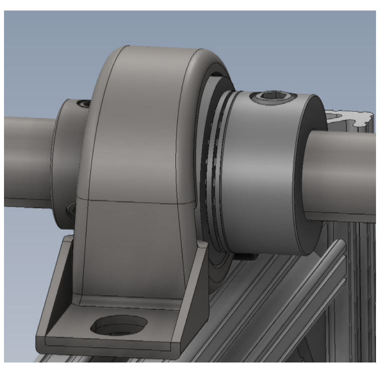
Over the summer of 2021, I designed a rotating stand that allowed us to quantify this effect, in the university's 5'x7' wind tunnel. It had to:

- 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 created designs in SolidWorks and performed an internal design review before moving into discussions with the wind tunnel manager. I then significantly reinforced the design and moved into the production phase.

I wrote the grant that funded the project and sources 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.

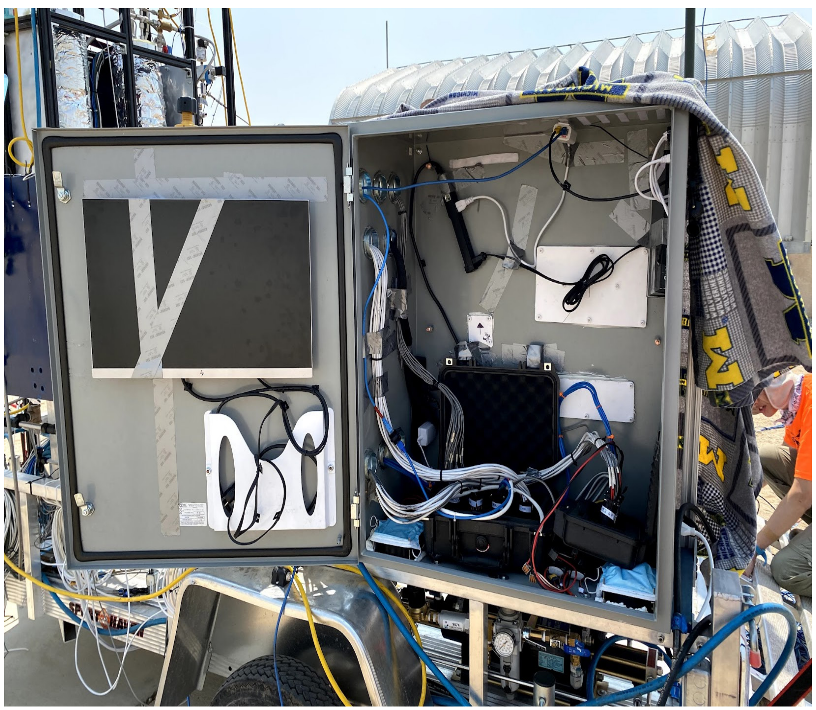
Ground Support Equipment

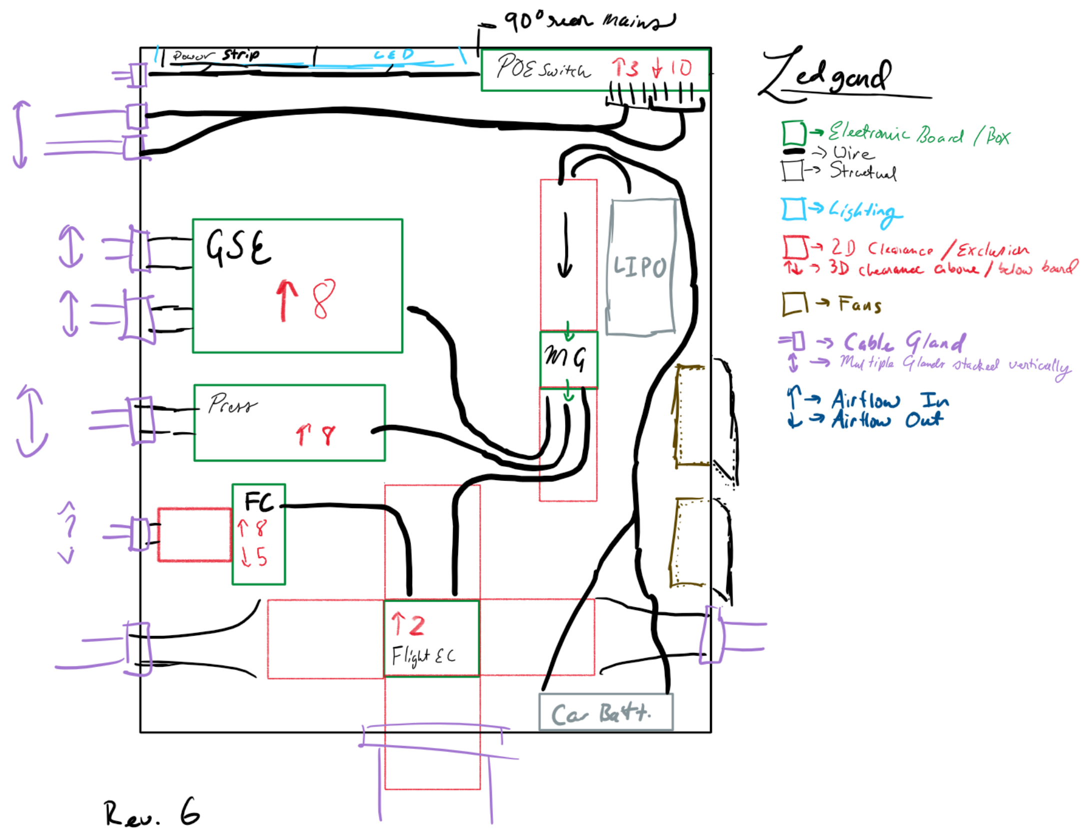
Electronics Box (Summer 2021)

In mid-summer, it was determined that MASA would need a portable testing system in order for us to be able to conduct hotfire testing in California before the start of the semester. Once the trailer was ordered and planned, I remotely oversaw the procurement, layout, and assembly of an electronics box within a three week time-frame before the team was to leave for California. In those weeks, I met with multiple teams, from the board designers to the operators and trailer team. We formulated a layout plan, and had it approved by all parties. Before the team left, the holes were cut and the mounts were attached. We even included extras, like a monitor!

The enclosure had to:

- Survive the vibrations of the adjacent engine hotfire
- Be weather resistant for testing in Michigan's winter
- Have significant cooling for the California summer heat
- Be large enough to hold 5 boards and their harnessing
- Be easily accessible for test operators





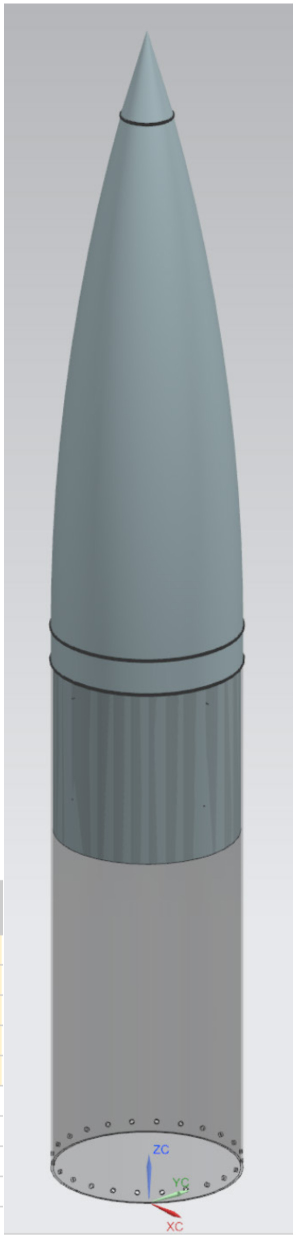
Clementine

Nosecone Coupler (2021-2022)

After the Base 11 Space Challenge was terminated, MASA chose to re-evaluate our position and start a new project with a shorter timeline. Thus, Clementine, a single stage, kerolox rocket with an apogee goal of 50,000 ft, was born. Clementine will double the current altitude when it launches later this year, and will be one of the most advanced rockets ever built at the collegiate level.

This year, I also am designing the nosecone coupler, ensuring the nosecone stays attached up until drogue parachute deployment. As of yet, our largest challenge is the composite nature of these components. High accuracy simulation of these components is impossible, and production is a challenge. In the coming weeks and months, we will work to overcome these challenges, culminating in full system testing in late spring.

This project has also introduced me to the roles of project manager/systems engineer. I act as a liaison between the nosecone, recovery, and airframe teams, coordinating timelines, writing grants, and ensure interoperability and ease of assembly. I have already raised significant funds for the nosecone through a grant, and we are continuously updating our assembly plan and timelines.



6.00	Nosecone-Body Coupler		Preliminary Design	Critical Design			8/31/21	4/7/22	219
6.01	Preliminary Design	Integrated with Nosecone and Recovery			Complete	Complete	9/27/21	10/29/21	32
6.02	Critical Design				Critical	Complete	1/1/22	1/14/22	13
6.03	Production	Combination of Ordering Materals, Building, and Unit Testing			Critical	Not Yet Started	3/1/22	3/31/22	30
6.04	Testing	Integration with Nosecone, System Testing			Medium	Not Yet Started	3/31/22	4/30/22	30
6.05	Flight Manufacturing								
6.06	Coupler Design/BOM				Critical	In Progress	8/31/21	2/22/22	175
6.07	Coupler Order Stock				High	Not Yet Started	3/1/22	3/3/22	2
6.08	Coupler Prod				High	Not Yet Started	3/3/22	3/23/22	20
6.09	Coupler Unit Testing				Medium	Not Yet Started	3/24/22	3/31/22	7
6.10	Integration to Nosecone				Critical	Not Yet Started	3/31/22	4/7/22	7