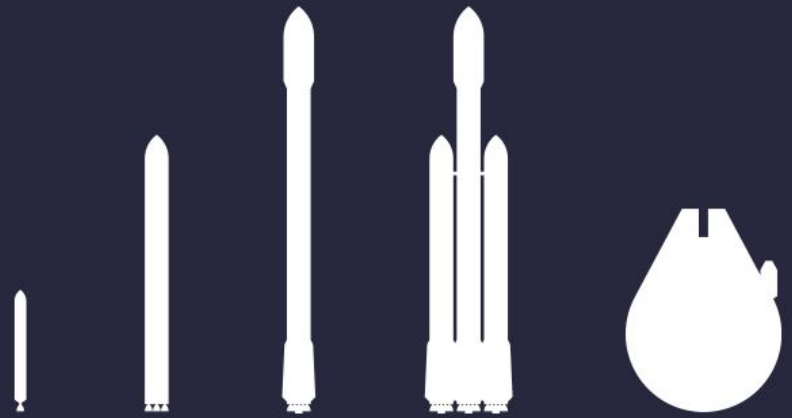


Malachi Williams

CAD | FEA | Structural Mechanics

Photo By: Michal Sobel

TABLE OF CONTENTS

I've learned that the greatest opportunities are a combination of hard work and grit.

I've used this perspective through difficult times, and problems to find new solutions. I am seeking the opportunity to demonstrate my love of design, engineering, and problem solving to solve the toughest challenges at SpaceX.

M

About Me

Major: Civil Engineering
Minor: Aerospace Engineering

Relevant Coursework:

- Advanced Rocket Propulsion
- Aerospace Heat Transfer
- Steel Design
- Structural Analysis
- Fluid Mechanics
- Orbital and Space Flight Mechanics
- Atmospheric Flight Mechanics
- Mechanics of Materials
- Construction Engineering
- Construction Materials
- Transportation Engineering

Skills

Mastery: Solidworks, CATIA V5, ENOVIA, PDM, GD&T, Lean Manufacturing/5S, LaTeX, 3D printing, Public Speaking, Sketch (UI/UX), HTML/CSS Web Design

Proficient: ANSYS (structural), Fusion 360, Manufacturing/machine shop fabrication, MS Project, MatLab, Spanish

Learning: ANSYS Fluent (CFD), ANSYS Maxwell, Python, Javascript, ReactJS, AutoCAD (Civil 3D)

Current:

- Director
- Focal for Aerostructures, Composites, Suspension

Previous:

- Director
- Manufacturing & Composites Engineer
- Mechanical / Propulsion Lead
- Manufacturing Lead

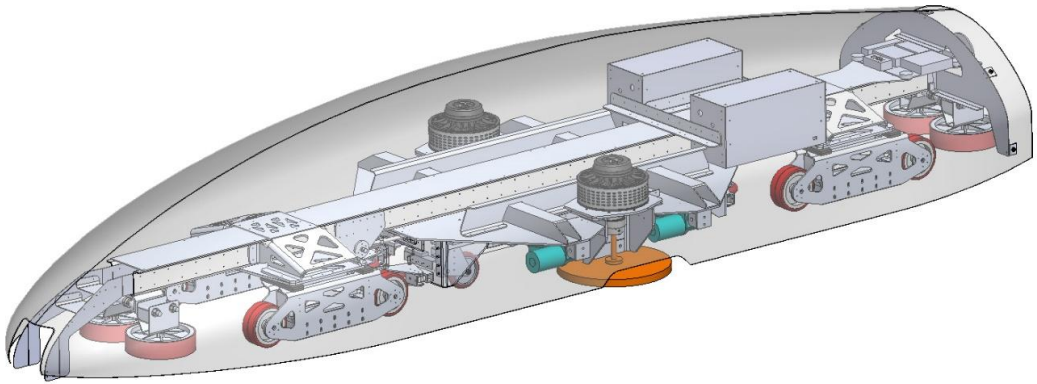
UWASHINGTON HYPERLOOP

The next era of transportation.

H

Overview

- Placed #6 in the world, and #4 in the nation in SpaceX's first Hyperloop Pod Race Competition 1/27/17
- Placed top 15, and won technical excellence award for best safety sub system in Design Weekend 1/27/16
- Participated as both governing Co-Director, and Focal in Competition II for Aerostructures, Composites, and Suspension

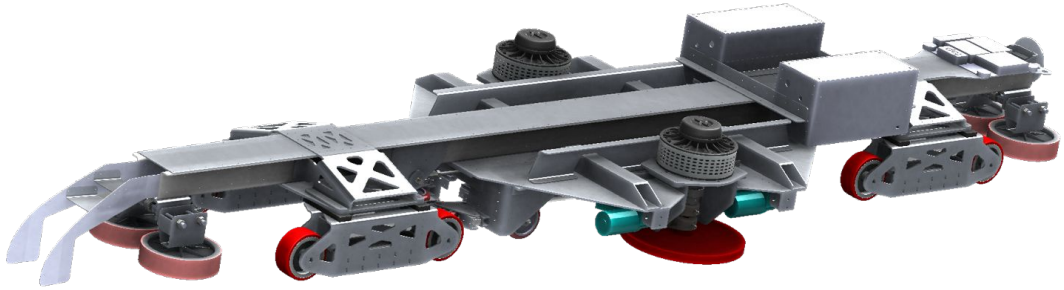


Projects

- Composite Design & Manufacturing
- Propulsion Design & Manufacturing
- GSE Design & Manufacturing
- Technical Leadership

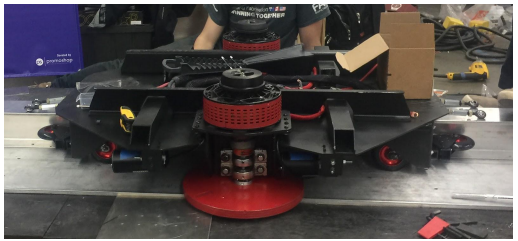
H

Structural Design



Supported design, mechanical analysis, manufacturing, and assembly of main support structures.

- Led approaches to ensure failure happened at predetermined mechanisms
- Supported top level design review to ensure proper load paths, shear planes, connections, and bolts
- Participated in all stages of manufacturing and assembly. *Especially the paint job!*



H

Composite Fairing

Led sub team in the process planning, manufacturing.

Supported preliminary analysis and led physical build up.

- Performed two complete layups within one week
- First layup resulted in failure due to improper setting of resin throughout fiber
    - Resulted in delamination between layers, high porosity and dry spots
- Utilized working experience to prepare foam tool, secure new materials, and produce a new 30hr cure, room temp wet layup

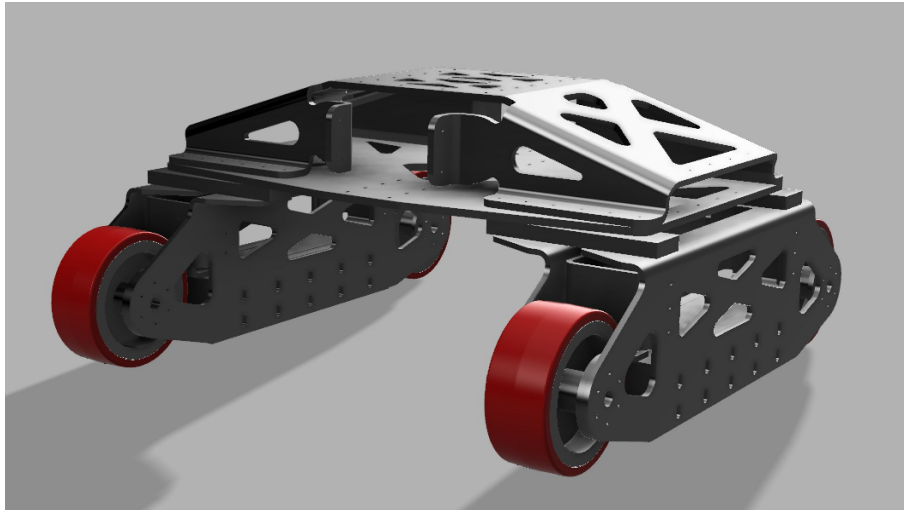
Attempt #1

Attempt #2

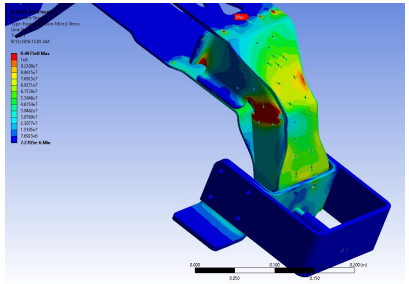
H

Levitation

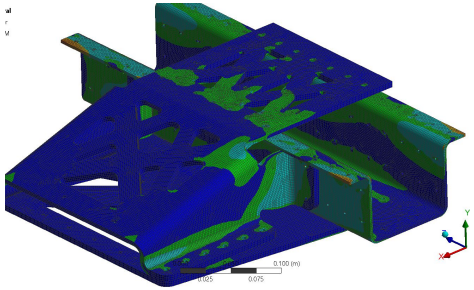
- Supported structural components from an analytical perspective. Worked with design team to ensure 2.0 minimum safety factor.
- Performed initial FEA to determine stress concentrations, and how we could lightweight the structure. Initial concept could not support large bending moments.
- Worked cross functionally to maintain high level system integrity, and model simplified system dynamics.



Final Structure



Initial Concept



Revised Version

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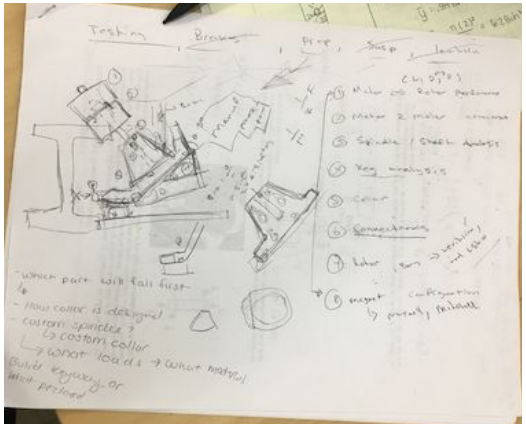
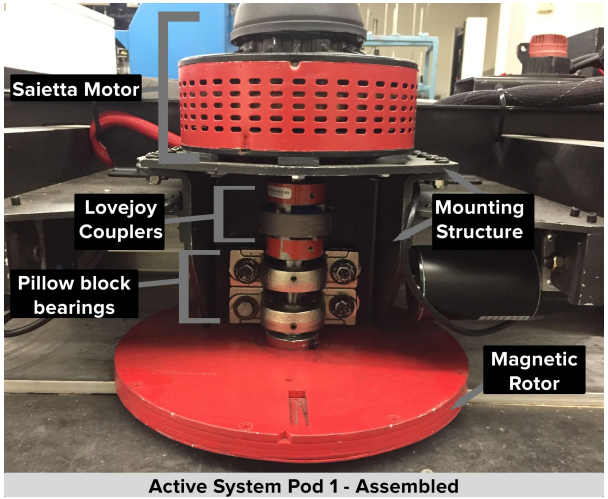
Propulsion

Performed trade study to determine performance vs. cost vs. manufacturability of electrodynamic rotors.

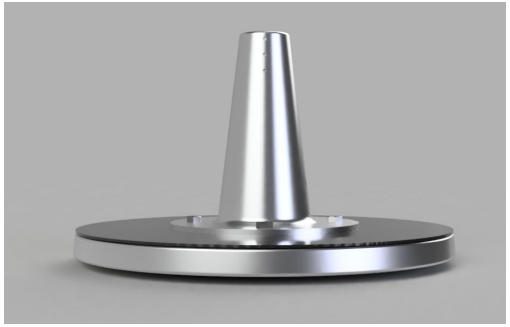
Performed hand calculations to determine

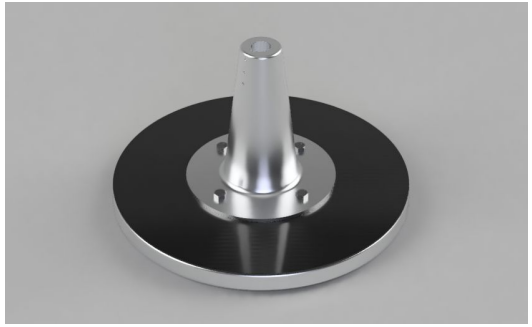
- Learned electrodynamic characterization to gain understanding of propulsive force
- Utilized top down study to iterate initial concept to a tapered base
- Drove thorough design analysis of connections, intentioned design failures, and safety factor
- Led assembly for finalized run





Active System Pod 1 - Assembled





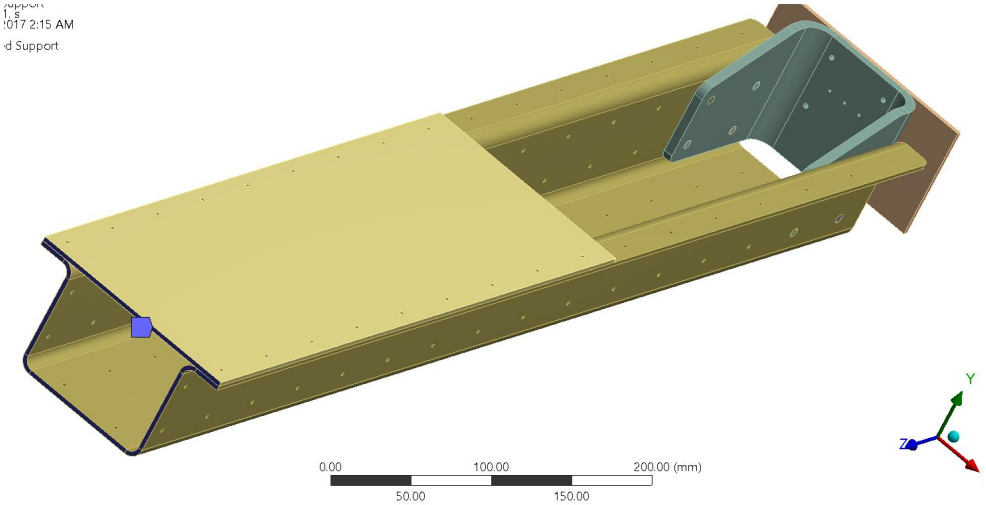
Tapered Rotor Concepts

H

FEA

Meshing and Mechanical Connection

- Two models were built, one with the circular plate as shown in the official design and one with the square plate to be identical with the physical crush test.
- A cylindrical extrusion was used as a “dummy rivet” to simulate shear stress on the rivets. Bolt contact was bonded.
- Hex mesh was used with 3-4 elements over the thickness to accurately give bending stress result, 6-10 elements were used at the holes to reduce singularity stress and for increased stress resolution.



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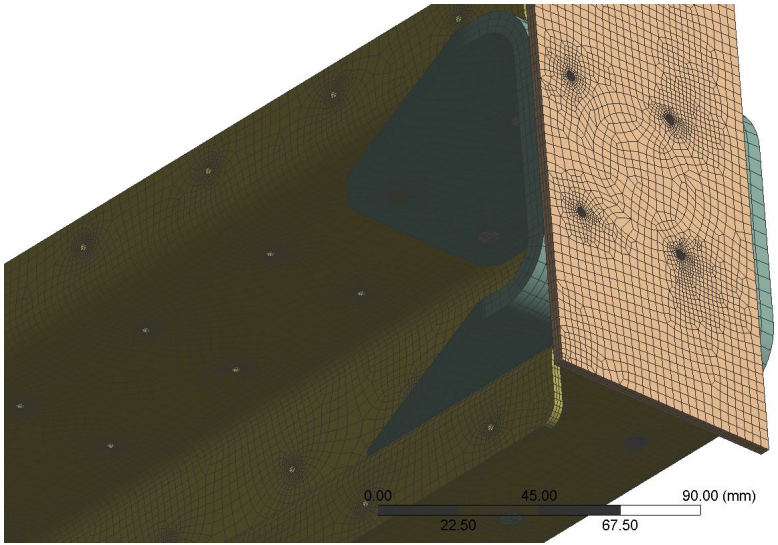
Boundary Conditions

FEA Model Assumptions

- Middle region of the chassis represents the center of gravity of all pod subsystems.
- The center of gravity has inertia reaction as the pod accelerates 2.5G, thus the fixed support was used at that center of gravity region.
- The 1925lb load applied at the circular mesh region at the back plate in the forward direction to simulate acceleration load.



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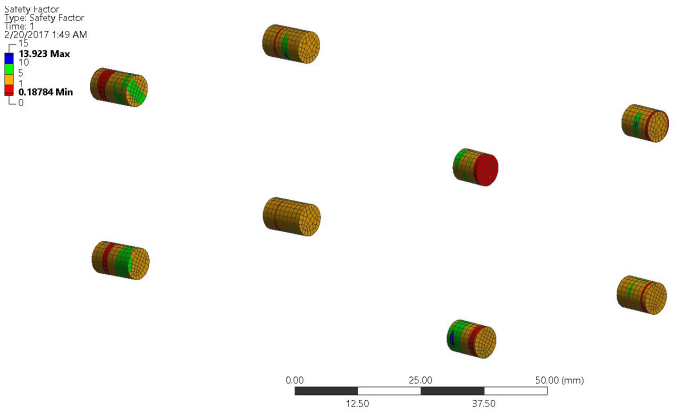
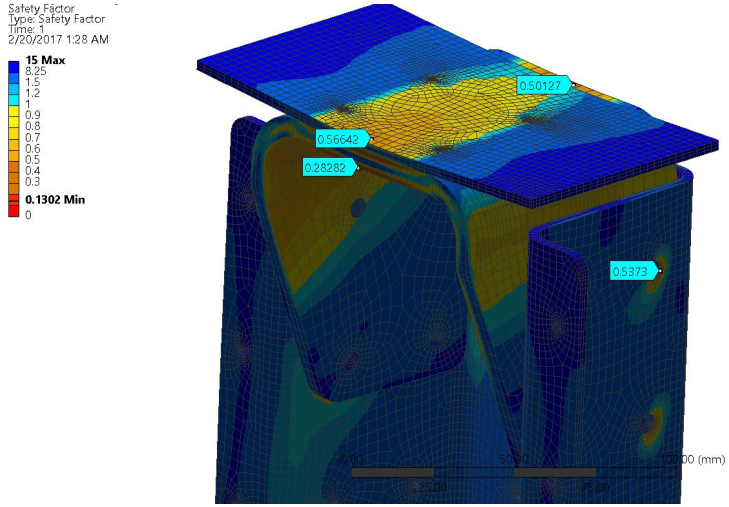
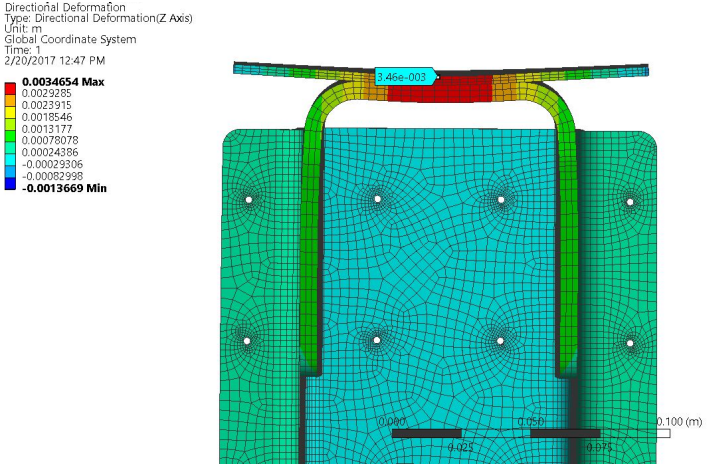
Results

- Based on the safety factor, the bolt would be very close to failure at this load.
- Deformation is comparable to real life.



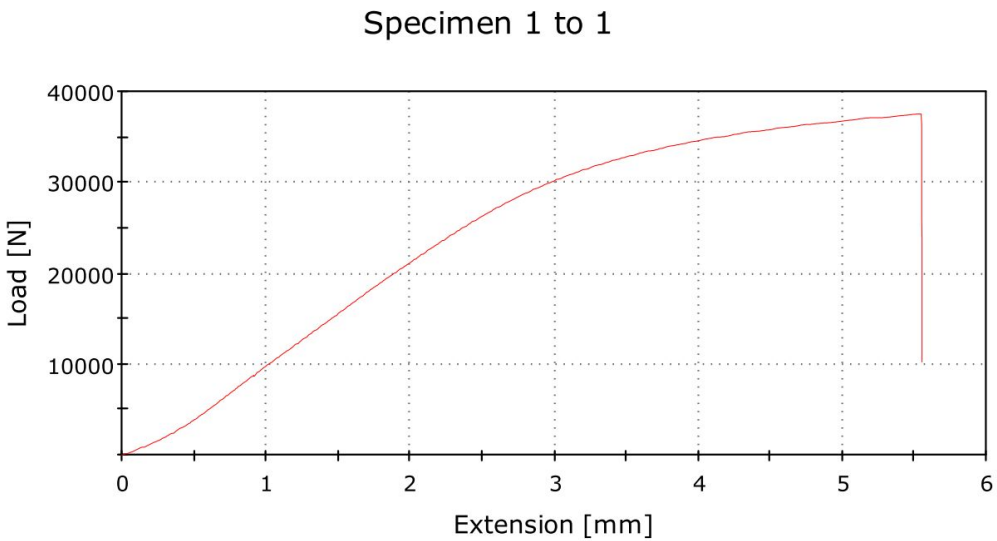




H

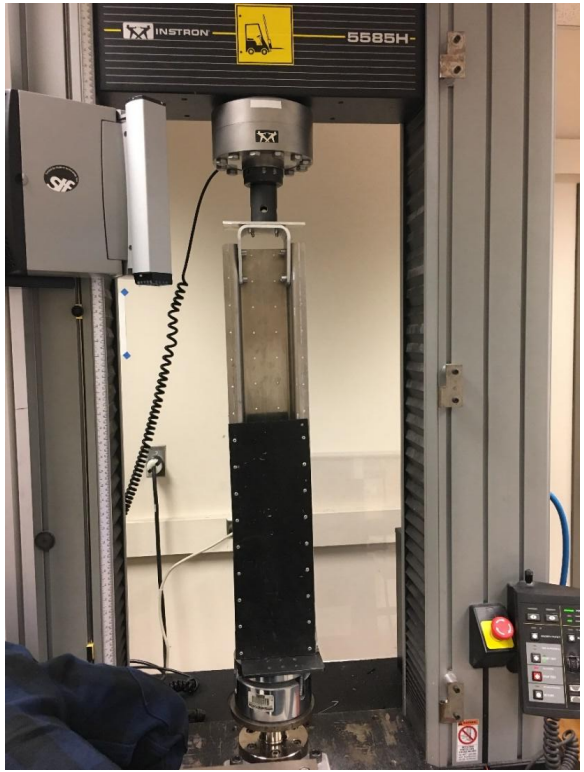
Physical Testing

- An INSTRON quasi-static crushing test was done to validate the FEA model.
- A steel tube pushed the plate down slowly until failure. At the time of test, I did not have a chance to install a strain gage to the chassis to compare strain result with the FEA model.

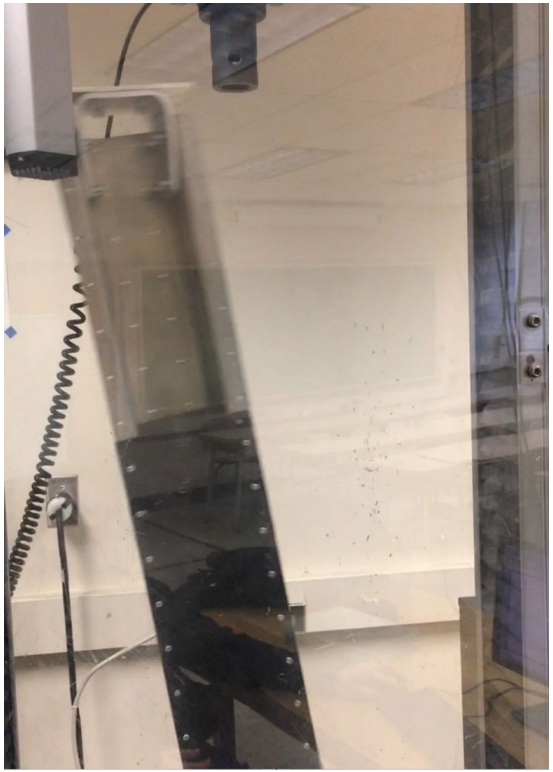


The load history of the test, the chassis failed at the rivet joints at 37,500N (8431lbs)

Physical Testing Continued



During test



Moment of Failure

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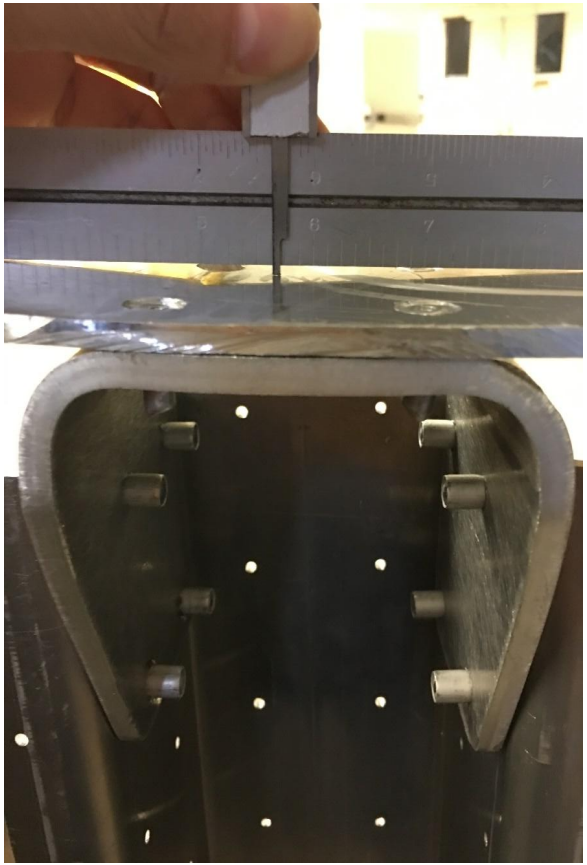
Failure Analysis

- Two rivets on the rear right side failed before the structure as expected. Maximum shear force rated on those rivets was 780N.



H

Business Management

Led the direction of sponsorship procurement and finance allocation.

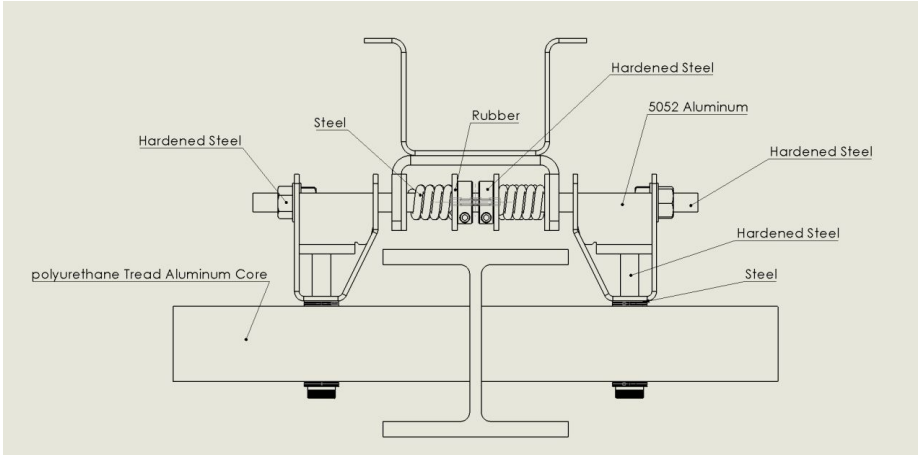
- Achieved lowest cost pod for approved race, of ~$27,000
- Selected as one of 36, out of 2,000+ in the Hyperloop One Global grand challenge
- Led direction of branding, marketing, initial designs, and web development
- Driving competition sponsorship goal of $100,000

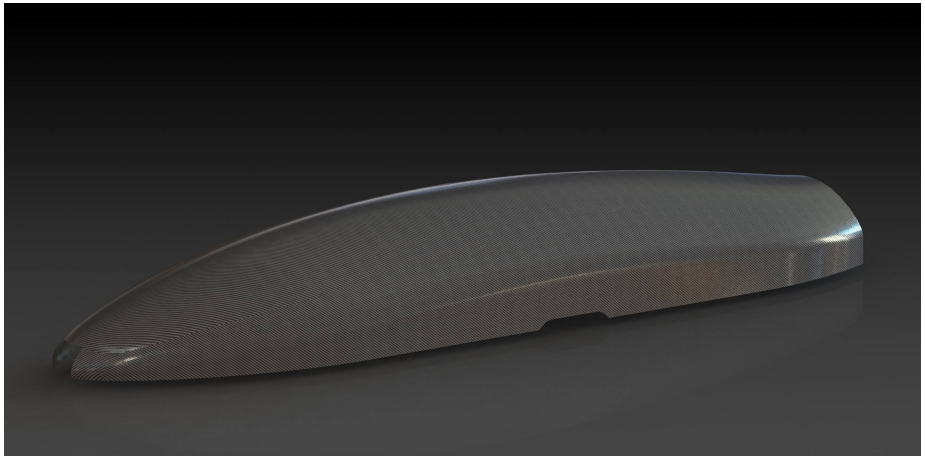
H

Technical Leadership

Investigating kinematic and load analysis, material selection, fault tolerance, and verifying that they meet all SpaceX requirements.

Additionally maintained high fidelity production packages for vendor manufacturing and support.





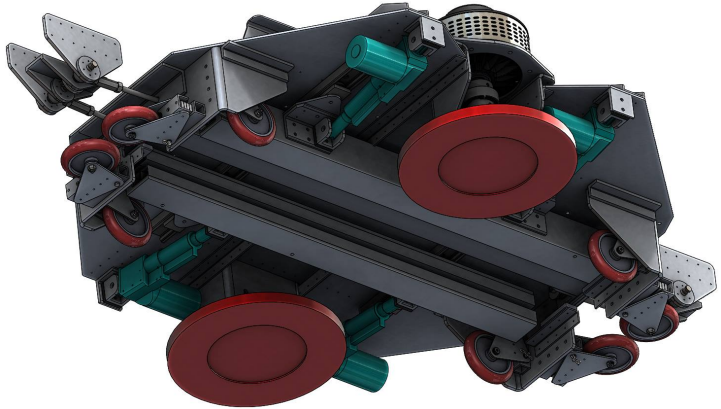
H

Technical Leadership 2

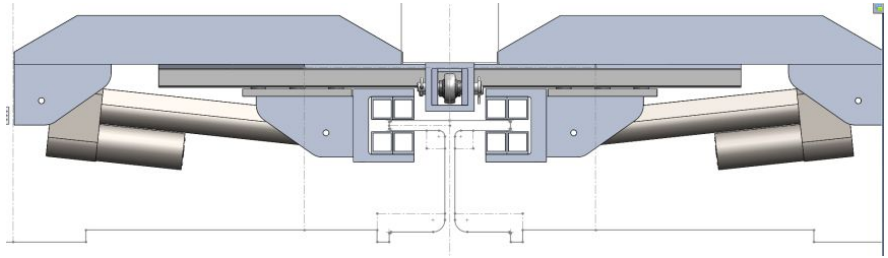
Serving as focal for multiple groups equates to vetting designs for their mechanical proficiency.

Under my supervision

- Chassis
- Composites
- Suspension / Stability
- GSE & Testing Rigs
- Braking
- Propulsion
- Levitation
- Analysis: Structural, CFD, Magnetic



Integrated braking, stability, propulsion bogie



Braking Front View

Design Engineering, Exteriors

Design Engineering

For my internship at Tesla, I focused on CAD and working with other engineering groups to improve exterior vehicle systems!

Advanced CATIA V5 learning

- Delved deeper into CATIA V5 Generative Shape Design workbench
- Focused on Boolean Operation centered design

Cross Functional Support

- Worked with body engineering, manufacturing, electrical and tooling to ensure designs were optimized for manufacturing and met product design requirements

Due to the proprietary nature I cannot share pictures of actual work.

Front Trunk Seal

- Designed and developed front trunk seal and testing concept to validate performance for Model 3
- The front trunk seal serves the purpose as its name entails, to seal the mechanical and electrical closure components for the front trunk
- Designing the part using boolean operations was key here due to the complex mating surface geometry

Due to the proprietary nature I cannot share pictures of actual work.

NVH Foam Absorber

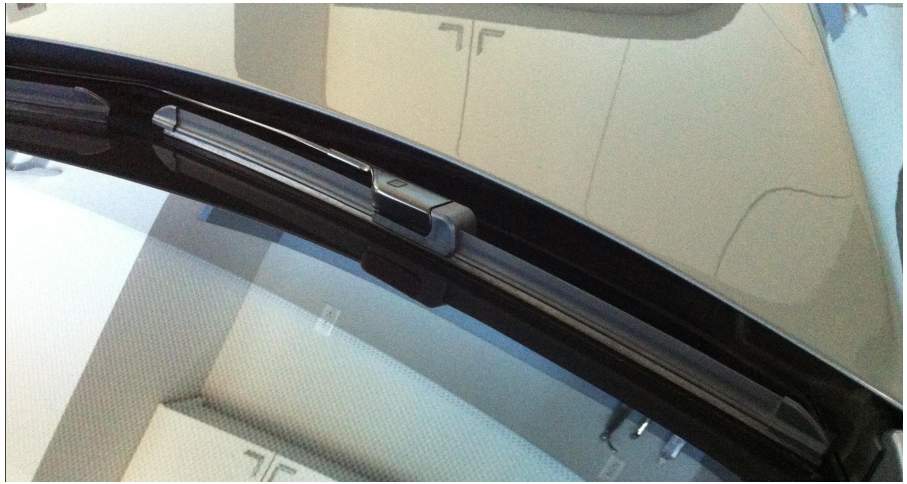
Here I was able to work with and learn how all of the vehicle systems interact with one another and alter my part accordingly.

- Designed and developed high frequency NVH foam absorber for Model 3
- The foam absorber is fabricated by compression molding a rigid polyurethane foam and is designed to nest in the vehicle's sheet metal structure
- Design requirements were to maintain a set material thickness to meet NVH requirements and energy transfer characteristics

Due to the proprietary nature I cannot share pictures of actual work.

Wiper Arm Rework

- Optimized electro-mechanical wiper systems to eliminate arm rework on assembly line
- Created surfaces of re-worked wiper arms using point cloud data and compared to production designs
- Coordinated with vendors to verify proposed design changes



Due to the proprietary nature I cannot share pictures of actual work.

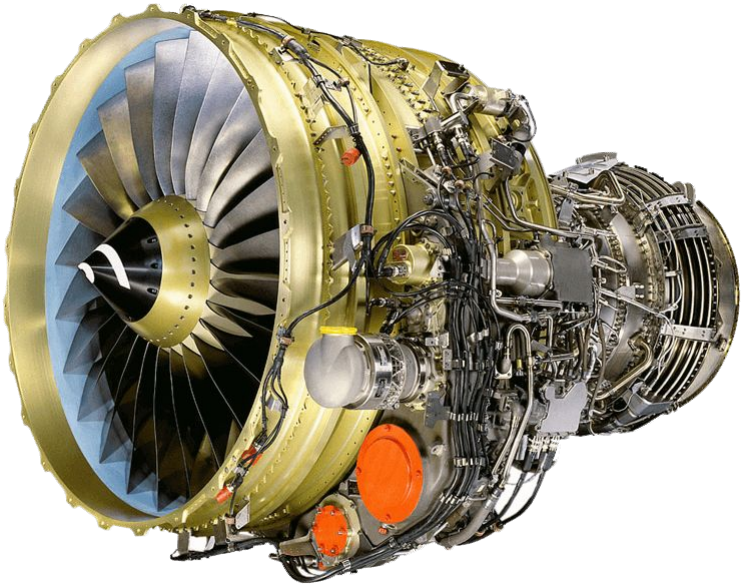
Engine Build up Design | Materials Review Board | Fuel Systems Design

B

Engine Build Up Design

- First intern in the Propulsion Systems Division to lead a product revision improvement project
  - Directed Cowl Thermal Anti-Ice Valve through design release workflow
  - Coordinated with vendor to ensure design changes did not impact part quality

- Developed, maintained and modified structural engine component designs using CATIA V5

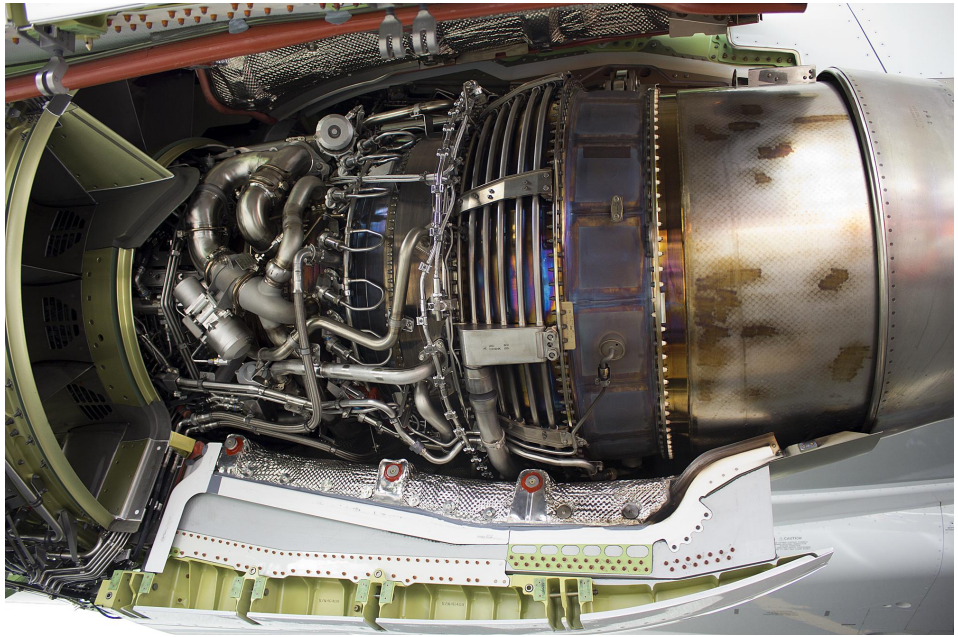


Due to the proprietary nature I cannot share pictures of actual work.

B

Materials Review Board

- Developed repair instructions to resolve damage/deviations on the CFM56-7B turbofan engine structure and components
- Utilized knowledge of material specifications and manufacturing methods to ensure that specifications, design, criteria and performance schedules were maintained
- First intern to be sole engineer on site to facilitate engine build up line at 42 airplanes per month build rate

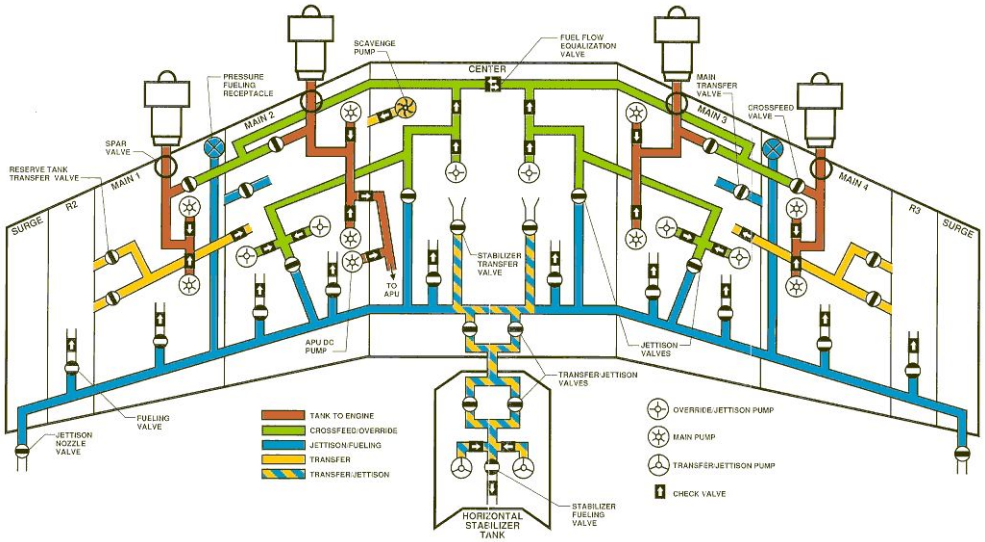


Due to the proprietary nature I cannot share pictures of actual work.

B

Fuel Systems Design

- Traveled to permanent mold casting foundry to create visual inspection criteria and guidelines for suppliers to mitigate surface discontinuities found on aluminum cast parts
- Built support brackets using CATIA V5 sheetmetal workbench and created detailed installation drawings for fuel quantity indication system wash line tubing
- Investigated and resolved pre-flight volumetric tap off issues and completed drawing change release in time to not impact production



Due to the proprietary nature I cannot share pictures of actual work.

misc

Developing engineering excellence through side projects.

M

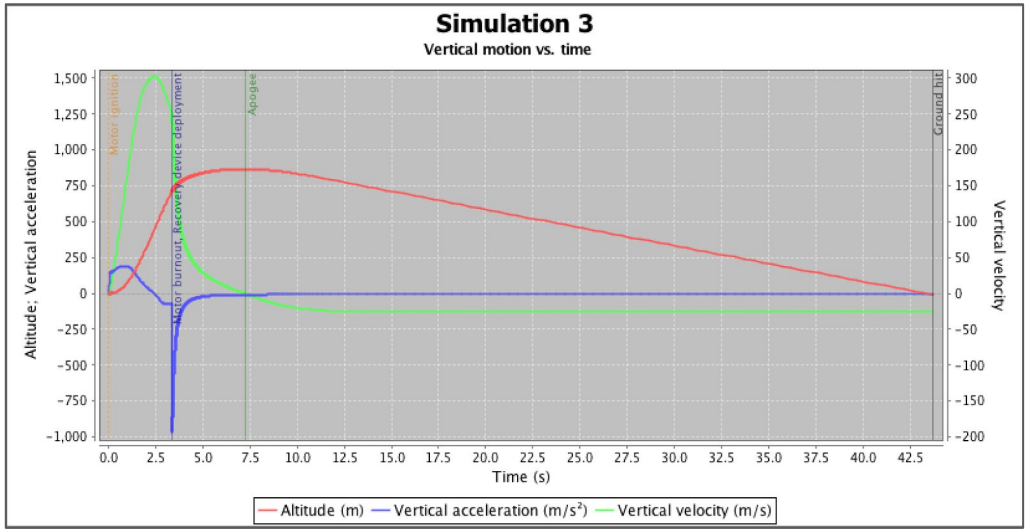
L-2 Rocket

Worked in a group of engineering students to build and launch an L-2 rocket.

- Designed, manufactured and launched a fiberglass single stage, K695R-L motor rocket
- Utilized main and drogue dual parachute system for redundancy

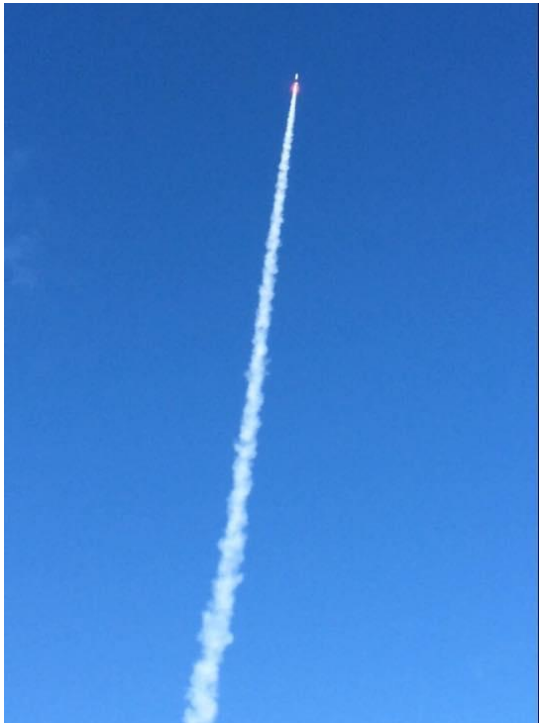
L-2 Rocket Analysis

- Used OpenRocket to create flight simulation using given stage design and motor configuration
- Designed, manufactured and soldered wires for the electronics payload, that consisted of a flight altimeter, batteries and safety switches
- Designed to reach apogee at 890 meters with a speed of Mach 0.91



L-2 Rocket Flight

Take Off

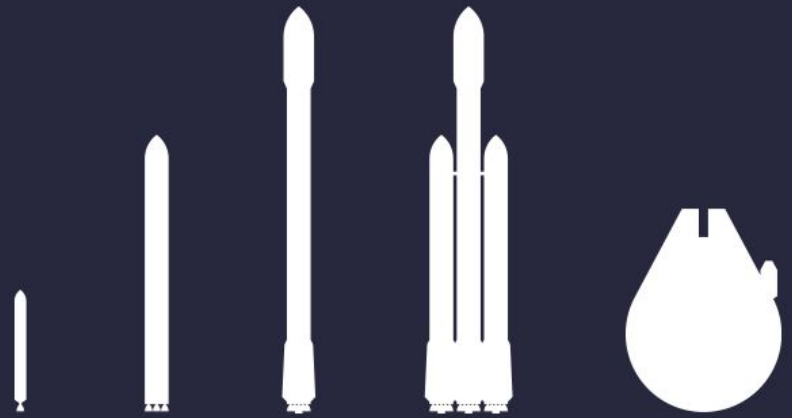


There it goes!

M

UAV Drone

- Gained in depth experience in Solidworks parametric design, GD&T, and complex assemblies
- Utilized complex surfacing
- Designed utilizing pictures from google searches



Thank you!

253-722-4073 | malachiw707@gmail.com

Photo By: Michal Sobel