Emory Hill

Aerospace Engineering Portfolio

Georgia Institute of Technology
B.S. Aerospace Engineering, Dec ‘27
M.S. Aerospace Engineering, Dec ‘28

About Me

Professional Interests:
- Aerodynamics
- Propulsion
- CFD

Skills:
- **Simulation:** Ansys (Fluent, Workbench, SpaceClaim), Matlab, Solidworks FEA
- **CAD/Design:** Solidworks (CSWP), Fusion360, GD&T, Instron Testing
- **Programming/Data:** Matlab, Python, Java, Excel
- **Machining:** Mill/Lathe/CNC, Waterjet, Wire EDM, CMM Inspection

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- **Website:** https://emory-hill.com/

Contents

Engineering Intern

Fabritek Aerospace Manufacturing

Winchester, VA, May 2026 - August 2026

SolidWorks | AutoCAD | CMM | Mill/Lathe/CNC

Internship Overview

Background:

Fabritek is a precision aerospace manufacturer specializing in high-tolerance machining and reverse-engineering of critical flight hardware. They support major defense contractors, including Northrop Grumman and L3Harris, by producing and inspecting complex components with strict dimensional and performance requirements.

Objective:

I supported both project management and quality inspection, helping with day-to-day engineering tasks across machining, metrology, and customer-driven work. My role blended hands-on inspection, documentation, and coordination to keep high-tolerance aerospace parts moving through production. Overall, my work can be represented best through 3 projects.

Project 1 - Laser Engraving Throughput Optimization

Background:

- **Engraving workflow analysis** - studied operator movement and cycle timing to identify bottlenecks in the engraving process
- **Fixture redesign** - developed a new fixture pin layout that allowed multiple components to be engraved simultaneously
- **Process validation** - confirmed improvements through measured time studies and production logs

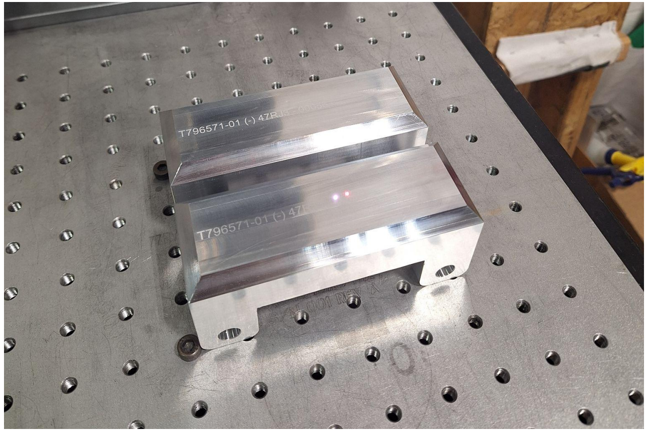
Results:

- **Impact:** Enabled 6× more components per cycle, reduced operator time 67%, and increased throughput 32% across $800k+ worth of serialized parts.

Skills:

- Laser engraving
- Manufacturing optimization
- Time-study validation

Project 1



Various parts that were lasered, some using new fixture redesign. Fixture can’t be shown due to facility guidelines.

Project 2 - Customer-Facing Reverse Engineering

Background:

- **CAD + drawing development** - created models, STEP/DXF files, and drawings for a tight-tolerance rotating component
- **GD&T application** - interpreted and applied as low as ±0.001 in tolerances to ensure manufacturability and inspection alignment
- **Project coordination** - worked directly with project managers to meet customer requirements and maintain documentation accuracy

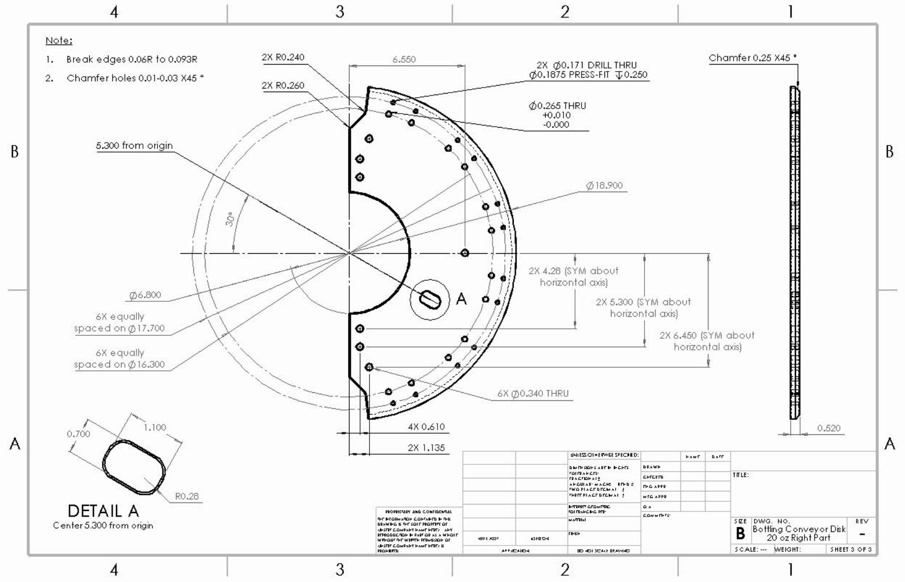
Results:

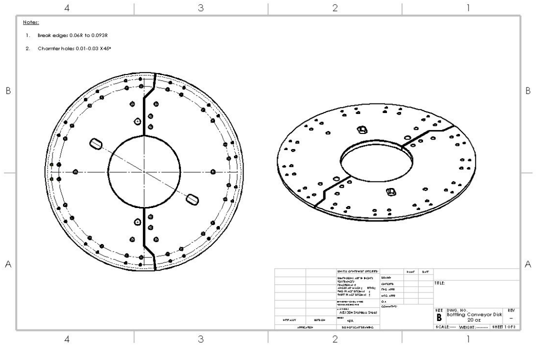
- **Impact:** Delivered the full machining job with complete travelers and inspection readiness.

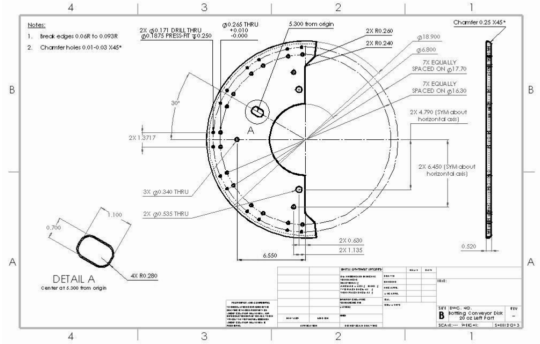
Skills:

- CAD modeling (Solidworks)
- Engineering drawings
- Customer communication
- Precise tolerancing
- Machining workflow

Project 2







Engineering drawings for the reverse engineered disk (2 pieces). Modeled and created in Solidworks following CMM inspection to find accurate dimensions.

Project 3 - Defect Inspection

Background:

- **Aerospace component inspection** - performed dimensional checks on $1M+ worth of flight-critical parts using Mitutoyo metrology tools and CMM workflows
- **Tolerance verification** - reviewed machining programs and inspection routines to ensure parts met strict GD&T requirements
- **Defect escalation** - coordinated findings with project managers to adjust machining paths and inspection sequences

Results:

- **Defect prevention:** Caught a defect early in a 2,400-piece, $50k order, preventing $45,760 in scrap/rework across 2,200 remaining parts.

Skills:

- CMM Inspection
- Metrology Tools
- GD&T Analysis
- Quality Documentation
- Manufacturing Workflow

Project 3

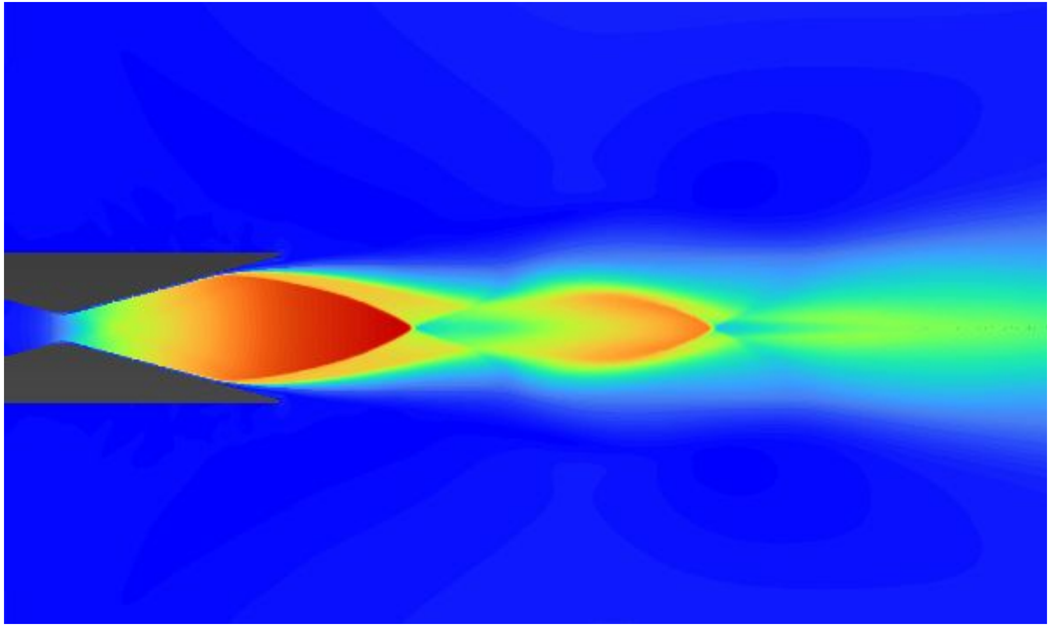
CMM (left) and Mitutoyo metrology calipers (middle) were among the tools used for inspections. The defect order parts can't be shown due to customer privacy. Teflon parts on the right were inspected at precise temperatures to ensure no thermal expansion affected precision.

CFD - Nozzle Flow Optimization

Personal Project

May 2026 - Present

ANSYS Fluent | MATLAB



Project Outline

Background:

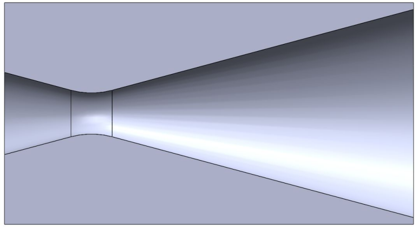
- This project examines compressible flow through conical and bell (Rao) nozzles to understand how geometry and expansion ratio affect performance.
- Six nozzle variants were designed for ideal expansion at three ambient pressures to create a controlled basis for comparison.
- ANSYS Fluent simulations were used to study shock formation, exit conditions, and overall flow quality across all geometries.

Objective:

- Evaluate performance differences between conical and bell contours under identical operating conditions.
- Quantify key flow metrics such as shock structure, mass flow rate, and thrust across varying ambient pressures.
- Generate optimized nozzle geometries and compare them directly to the original isentropically modeled designs to assess improvements in efficiency and flow quality.

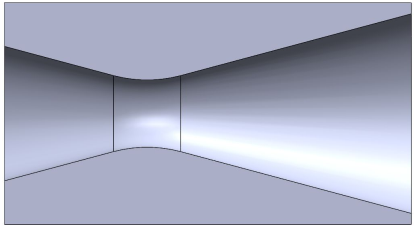
Geometry Set

G1



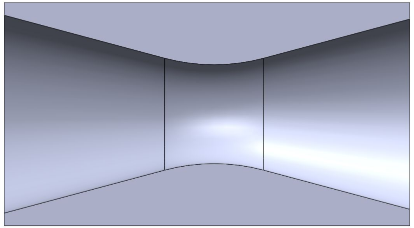
Conical nozzle for ideal expansion at 20 km

G2



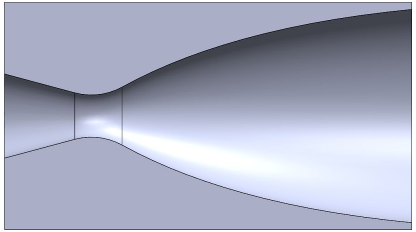
Conical nozzle for ideal expansion at 10 km

G3



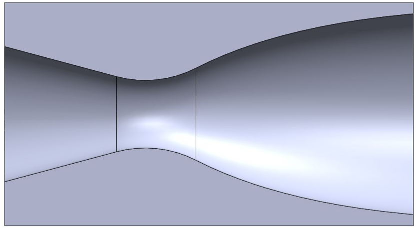
Conical nozzle for ideal expansion at sea level

G4



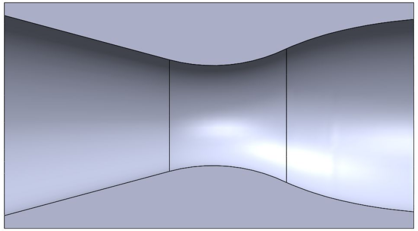
Bell nozzle for ideal expansion at 20 km

G5



Bell nozzle for ideal expansion at 10 km

G6

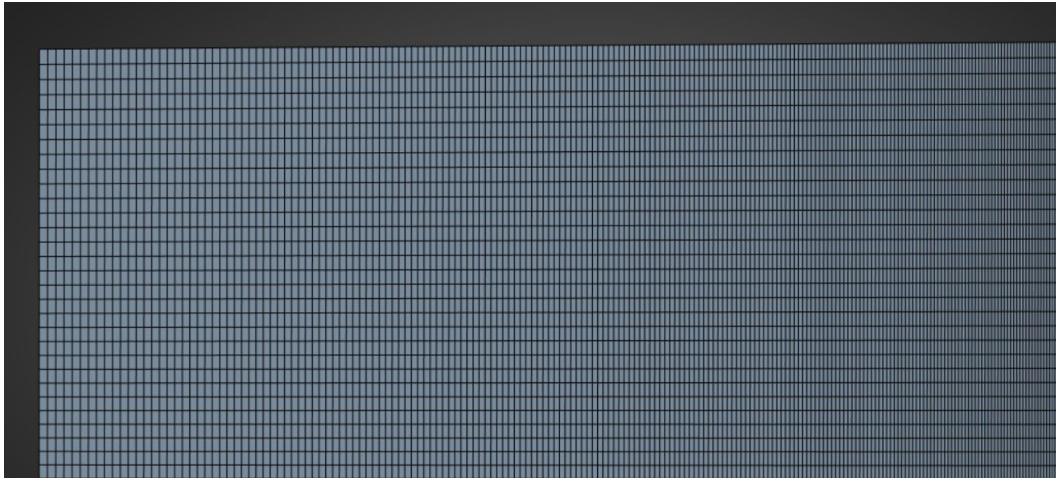


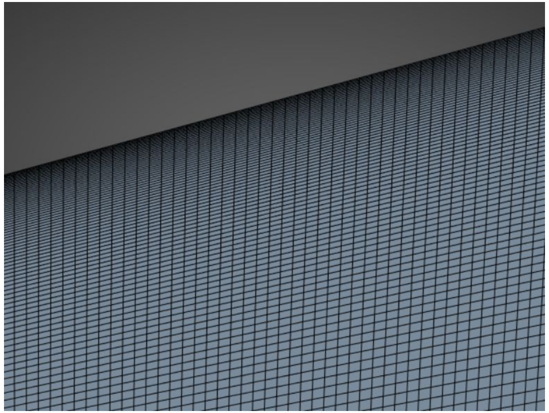
Bell nozzle for ideal expansion at sea level

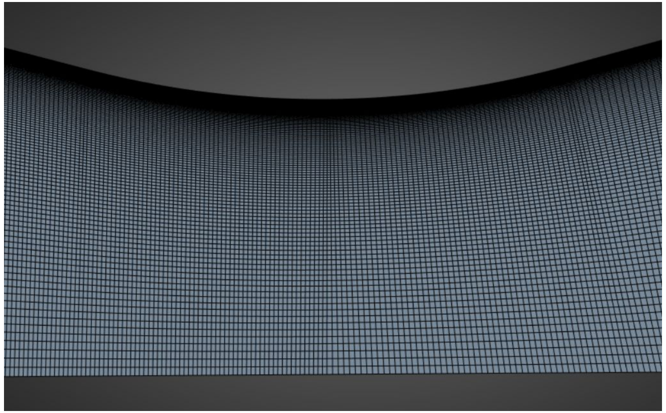
Meshing

Quad face meshing was used to generate a structured, contour-aligned grid that provides smooth cell transitions, refined throat resolution, and stable shock capturing throughout the nozzle.

These views show the refined throat region for accurate mass-flow prediction, the boundary-layer inflation created through wall edge-biasing, and a section of the farfield biasing used to smoothly transition from the nozzle contour to the outer domain.







Setup

Type: Density-Based (for high speed compressible flow and shock resolution)

Time: Steady

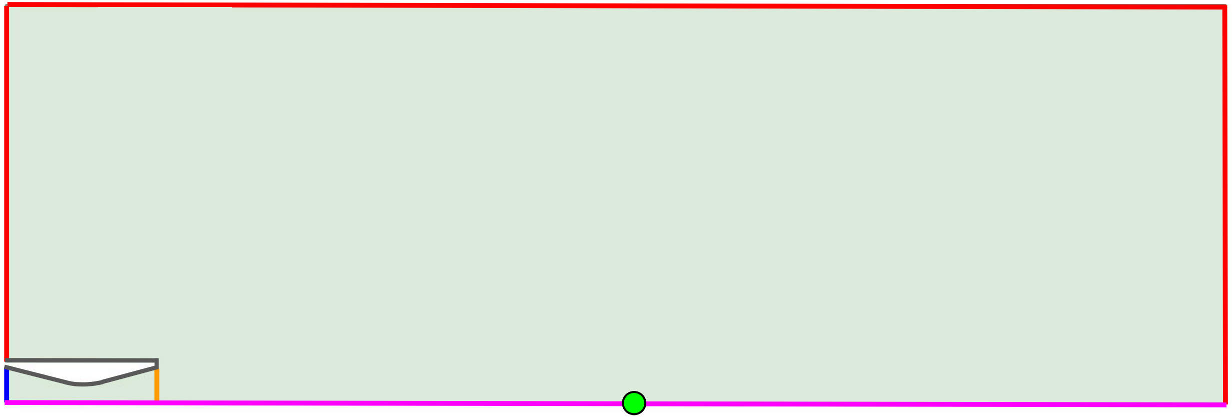
Space: 2D Axisymmetric (nozzle centerline symmetry)

Models: Energy; k-omega SST

Initialization: Standard initialization from inlet

Materials: Air (ideal gas, constant Cp, sutherland viscosity)

Spatial Discretization: First Order Upwind (for initial stabilization ~10,000 iterations) and Second Order Upwind (to capture shock structure and overall flow behavior ~40,000 iterations)



- Wall Boundary (no slip)
- Total Pressure Inlet (3000000 Pa)
- Axis of Symmetry
- Fairfield Static Pressure Boundary (5474.8, 26499, or 101325 Pa)
- Nozzle End (static pressure and mass flow rate monitors)
- Plume Monitor (mach number point monitor)

Results - Coming Soon

The nozzle geometries have been created, meshed, and validated, and I am currently running the CFD simulations and processing the resulting flow field data through MATLAB, so final performance results are still in progress.

Matlab Quadcopter Simulation

Aerospace Dynamics Course

Atlanta, GA, Fall 2026

MATLAB | ODE Modeling

Project Overview

Background:

- The quadcopter is modeled as a rigid 3D system with mass properties (total mass, center of mass, inertia matrix) computed from its cuboid body, rods, motors, and payload.

- Full 3-D equations of motion are derived using Body 3-2-1 angles, combining thrust, drag in the body frame, and gravity in the inertial frame.

- The simulation integrates these dynamics to reproduce steady-state vertical/horizontal flight and controlled paths like a helix.

Objective:

- Build a complete 3D quadcopter simulation by calculating mass properties, deriving equations of motion, and implementing thrust/moment control.

- Validate the model through three steady-state cases (vertical, roll-based horizontal, pitch-based horizontal).

- Determine the control inputs for a helical trajectory and simulate both the 3D path and orientation.

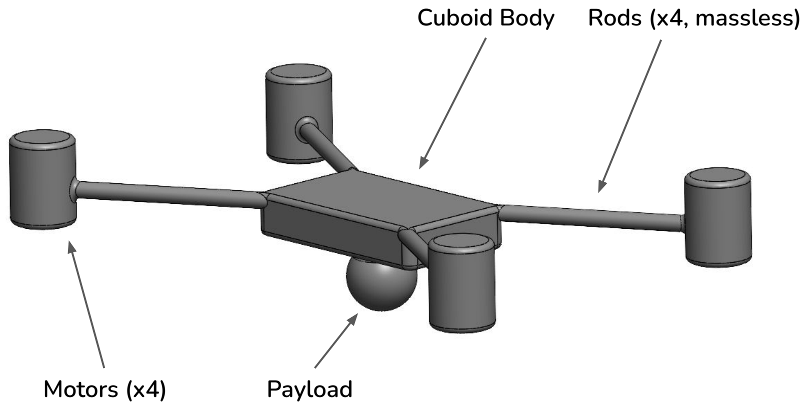
Quadcopter Modeling

Simplified Rigid-Body Model

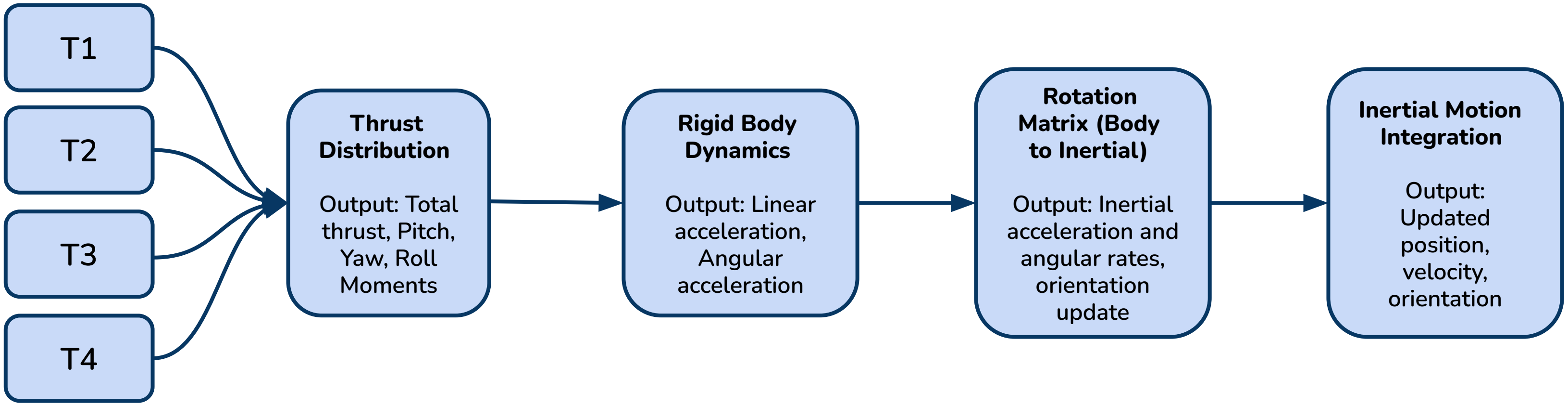
The quadcopter is reduced to basic geometric primitives (cuboid body, cylindrical rods/motors, spherical payload) to compute mass, center of mass, and inertia exactly.

This abstraction preserves the essential mass distribution and symmetry of a real quadcopter while making analytical modeling and simulation tractable.

The simplified CAD model serves as the foundation for all dynamics, control, and aerodynamic calculations used in the 3-D simulation.



Dynamics & Control Framework



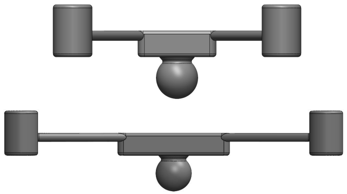
Summary:

- Motor thrusts are converted into total thrust and roll/pitch/yaw moments for control.
- Body-frame forces and moments are transformed into inertial motion using 3-2-1 Euler rotations.
- The simulation integrates 12 coupled first-order ODEs to compute full 3-D translational and rotational behavior.

Simulation Setup

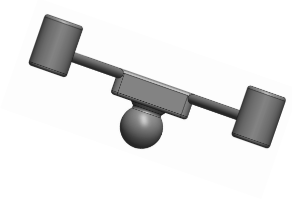
Vertical Case:

Vertical flight
$\theta = \Phi = \psi = 0$



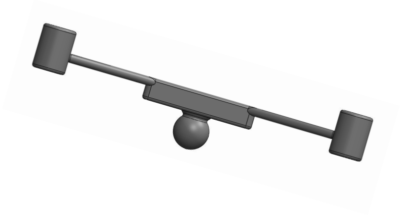
Roll Case:

Roll = 26.891°



Pitch Case:

Roll = 22.384°



Simulation Flow:

Initial Conditions → Forces (Thrust, Drag, Gravity) → 12 ODEs → Trajectory

Simulation Assumptions:

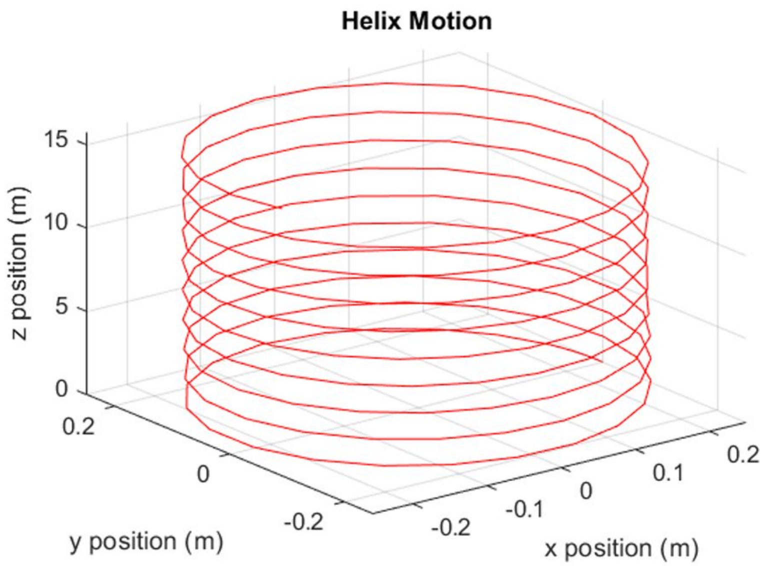
- Aerodynamic drag computed in body frame using Ax, Ay, Az, CD
- Gravity applied in inertial frame
- Thrust capped at 5 N per motor

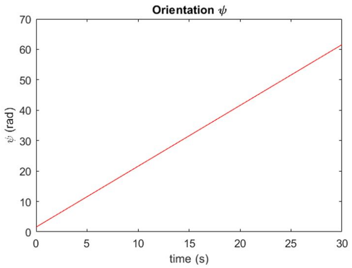
Results

Summary:

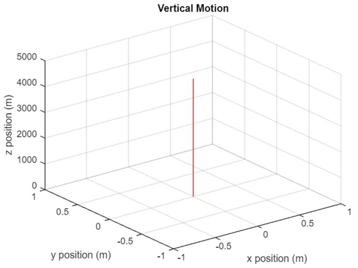
- Steady-state vertical and horizontal velocities match earlier analytical predictions.
- Helical trim achieved with constant roll/pitch and linear yaw.
- Full 3-D trajectory and orientation behavior validated through simulation.

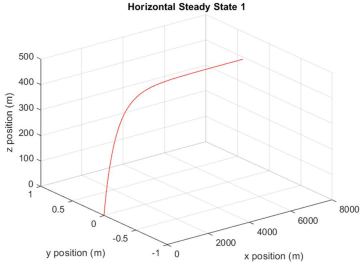
Helix Case and Yaw Angle:

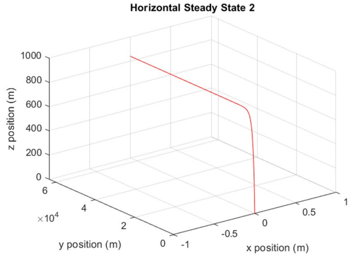




Validation Cases:







Structures Engineer

The following three projects were completed as a member of Georgia Tech Propulsive Landers' Structures Team.

Propulsive
Landers
AT GEORGIA TECH

Shock-Absorbing Rocket Foot

Georgia Tech Propulsive Landers - Structures Engineer

Atlanta, GA, August 2025 - May 2026

SolidWorks | FEA | Instron Testing

Propulsive Landers
AT GEORGIA TECH

Project Overview

Background:

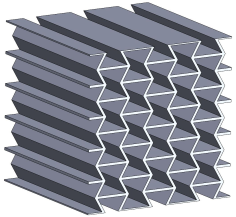
- TPU landing feet developed for a 70 kg self-landing rocket to absorb touchdown loads during vertical descent.
- Lattice-based shock absorber sized for the box-tube landing legs and designed for ≤0.5 m/s touchdown velocity.
- System must tolerate ±15° off-axis impacts and redistribute loads during uneven, single-leg contact events.

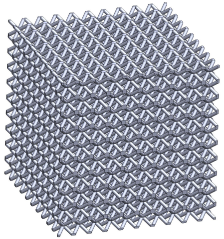
Objective:

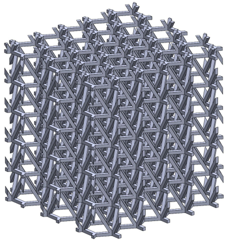
- Identify a TPU lattice geometry that maximizes impact energy absorption through controlled deformation under load.
- Validate lattice behavior using Instron compression testing and SolidWorks FEA with worst-case 875 N loading.
- Produce a lightweight, manufacturable foot design ready for full-scale printing and integrated lander testing.

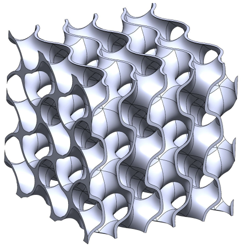
Lattice Design & Testing

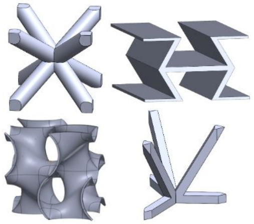
- Six TPU lattice families- Squigle, Cube, Gyroid, Inverted Hex, Control Hex, Shaped Hex (only 4 are pictured)- were iterated with 0.7-1.3 mm wall thicknesses and 0.5-0.75 cm cell sizes to tune stiffness and collapse behavior.
- TPU lattice blocks (2×2 in) were compression-tested on an Instron at 0.05 cm/s, with non-symmetric lattices tested across all unique orientations and stopped at densification onset to capture the full plateau region.
- Force–displacement curves were integrated in MATLAB to compare energy absorption, with the Inverted Hex lattice producing the most rectangular response and strongest impact-mitigation potential.

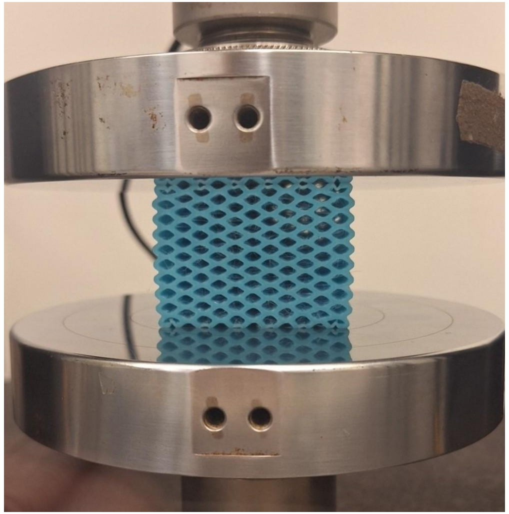


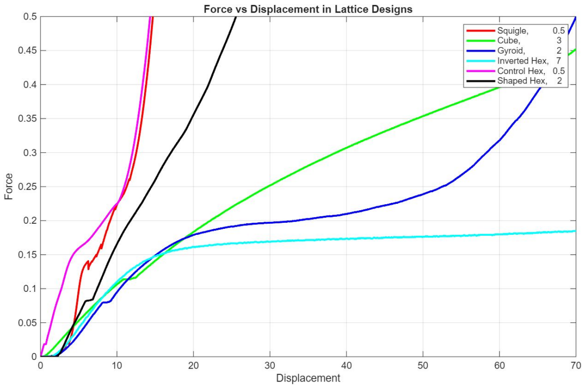




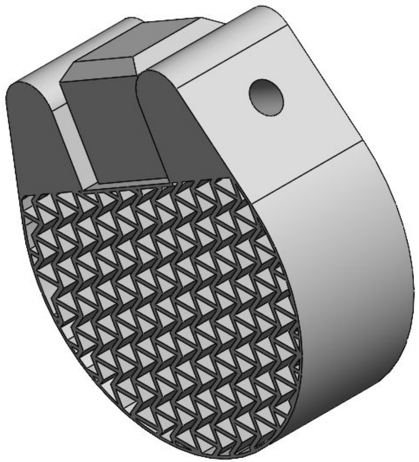








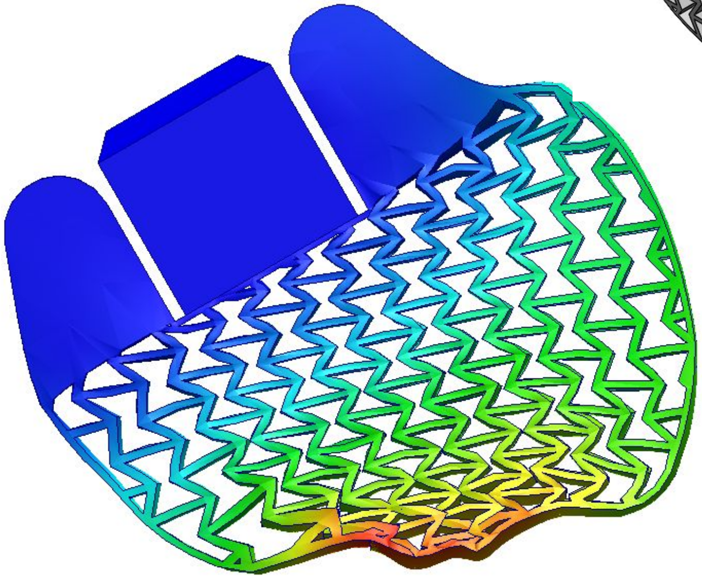
FEA & Design Evolution



- This shaped foot design was selected after testing showed the Inverted Hex lattice had the strongest plateau behavior and best energy absorption.

- SolidWorks FEA was then run on this shaped design using a 875 N worst-case load and ±15° off-axis compression to replicate single-leg touchdown conditions.

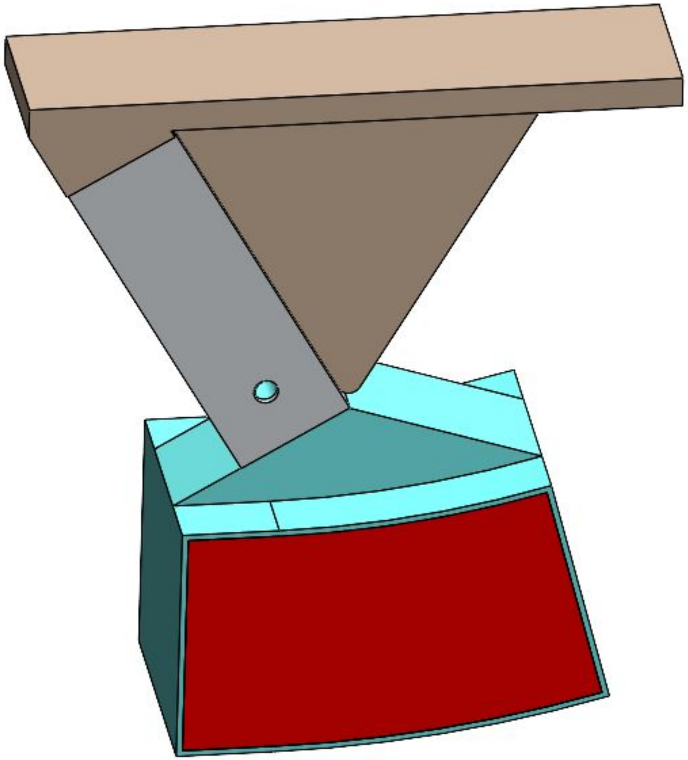
- FEA deformation patterns guided mass removal and geometry refinement, producing the updated foot design shown on the next slide.



Final Foot & Test Plan

- The new landing-foot design is shown here, built around the Inverted Hex lattice and printed as two components due to TPU limitations- the red lattice insert is printed separately and slides into the outer foot structure, forming the current design moving forward.

- A PLA angled test mount with leg box tube is also shown and will be 3D-printed for Instron testing, allowing controlled off-axis compression that replicates real touchdown conditions and defines the next phase of validation.



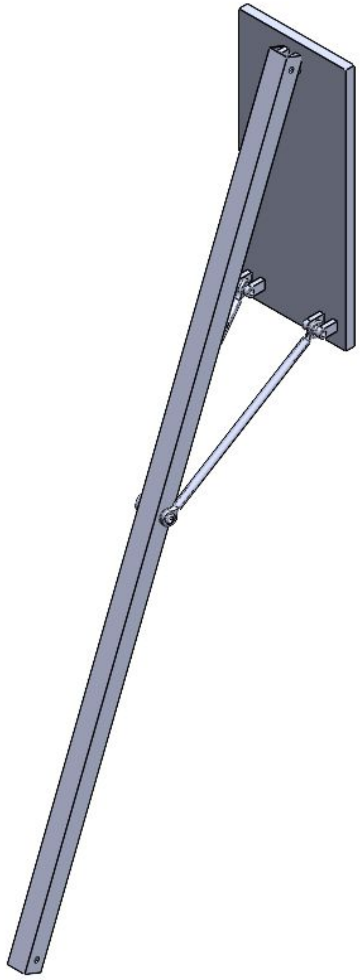
1000N Rocket Fixed Landing Gear

Georgia Tech Propulsive Landers - Structures Engineer

Atlanta, GA, August 2024 - December 2025

SolidWorks | FEA | Machining

Propulsive Landers
AT GEORGIA TECH



Project Overview

Background:

- Fixed landing gear system developed for the 1000 N Propulsive Landers vehicle, the team's primary Lander's Challenge rocket.

- Design kept intentionally simple, low-cost, and manufacturable, relying on off-the-shelf aluminum tubing with minimal custom machining.

- Led the project alongside vice-lead to establish a baseline landing system before transitioning to retractable gear on future rockets.

Objective:

- Develop and compare three-leg and four-leg landing gear architectures under identical footprint and touchdown-load requirements.

- Evaluate each configuration using CAD, FEA, and BOM-driven mass/cost analysis.

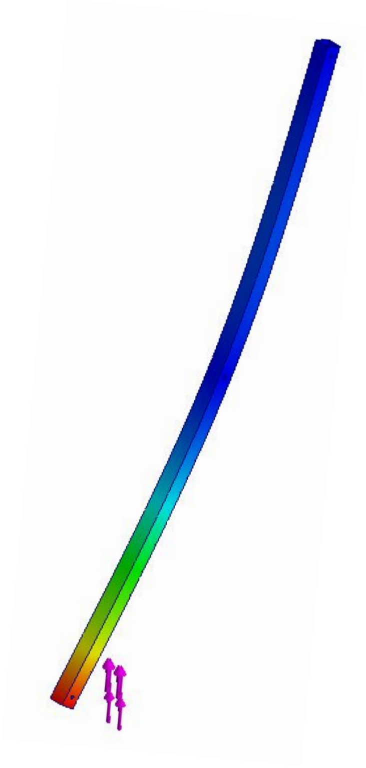
- Select the architecture offering the best balance of stiffness, load distribution, mass, cost, and manufacturability.

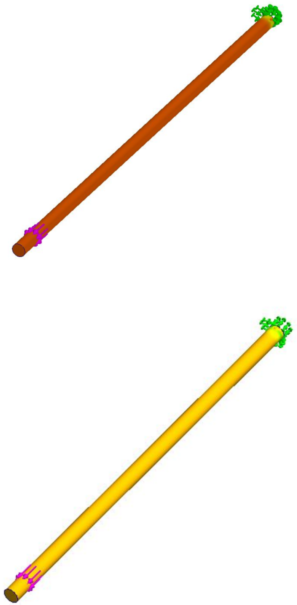
Architecture Development

- Full CAD assemblies created for three-leg and four-leg designs, each tuned to the same radial footprint and touchdown-load envelope.

- SolidWorks FEA used to compare support-rod thickness between architectures and to determine the optimal connection point along the main tube.

- Identical loading conditions applied to both designs to ensure a fair structural comparison.





Results

- The four-leg configuration showed superior touchdown performance: lower peak stress, better load distribution, and improved stiffness.

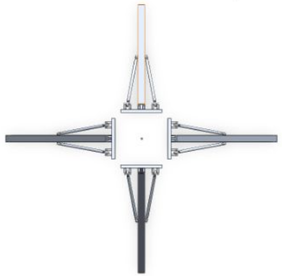
- FEA confirmed optimal rod thickness and connection location for the four-leg architecture under the 1000 N touchdown load.

- BOM analysis showed the four-leg design was lighter (3.46 → 2.63 kg, −24%) and cheaper (−9%), despite having more structural members.

- Combined structural + cost findings led to selecting the four-leg architecture as the final landing gear.

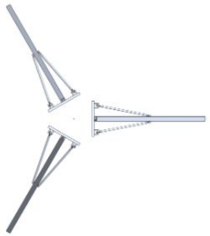
4 Leg

Part	Mass (kg)	Cost	Total Mass (kg)	Total Cost
Main Leg (Box Tube)	0.42	16.2975	1.68	65.19
Supporting Legs (Rods) (2x)	0.084	0.884	0.336	3.536
Rod Joints (4x)	0.008	3.75	0.032	15
Aluminum Stock (attachment to frame)	0.0368	5	0.1472	20
Fasteners	0.05	2	0.2	8
Foot	0.06	Free	0.24	
			2.6352	**111.726**



3 Leg

Part	Mass (kg)	Cost	Total Mass (kg)	Total Cost
Main Leg (Box Tube)	0.869	28.64375	2.607	85.93125
Supporting Legs (Rods) (2x)	0.116	1.225	0.348	3.675
Rod Joints (4x)	0.008	3.75	0.024	11.25
Aluminum Stock (attachment to frame)	0.0368	5	0.1104	15
Fasteners	0.05	2	0.15	6
Foot	0.075	Free	0.225	
			3.4644	**121.85625**



Sloshing Nitrous Oxide Paper

AIAA, Georgia Tech Propulsive Landers

Atlanta, GA, Fall 2026 - Spring 2026

ANSYS Fluent | MATLAB

AIAA

Propulsive Landers
AT GEORGIA TECH

Project Overview

Background:

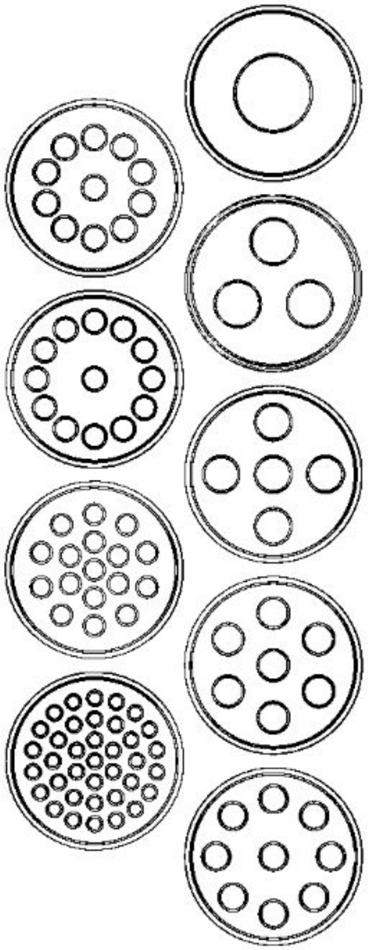
- Student-led CFD study for Georgia Tech's Propulsive Landers team, analyzing sloshing behavior in a nitrous-oxide hybrid-rocket tank.
- Sloshing forces can destabilize guidance and shift center of mass, making baffle design a key part of tank stability.
- Prior research explored baffle shapes and counts; perforation count remained an under-studied variable in multiphase sloshing.

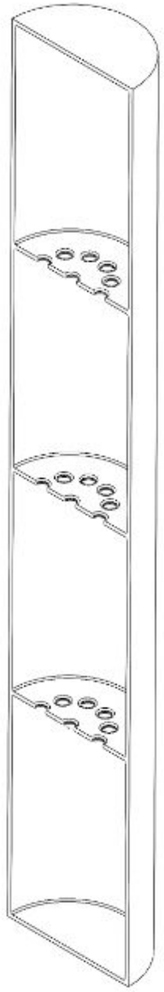
Objective:

- Evaluate how disc-baffle perforation count affects sloshing damping while keeping total perforated area constant.
- Use CFD to measure horizontal/vertical forces and extract damping ratios across nine perforation configurations.
- Identify whether an optimal perforation density exists for multiphase nitrous-oxide sloshing.

Core Approach

- Modeled a 1.37 m × 0.203 m cylindrical tank with three evenly spaced disc baffles and a 3:1 liquid-to-gas N_2O mixture.
- Tested perforation counts from 1 to 37, initiating sloshing with a 1 m/s horizontal excitation using Fluent's multiphase Eulerian model.
- Damping ratios extracted by fitting horizontal-force curves to a spring-mass-damper model, enabling comparison across designs.
- **My contribution:** validated CFD settings and physical assumptions, assisted with analysis interpretation, contributed to writing and figure preparation, and supported the team at the AIAA Regional Student Conference.





Key Results

- Moderate perforation counts (~7-13 holes) produced the strongest damping, reducing horizontal force oscillations more effectively than sparse or dense perforations.

- Very high perforation counts (e.g., 37 holes) behaved more like a flow filter, shifting sloshing behavior and reducing damping consistency.

- Results indicate an intermediate perforation density balances momentum transfer and energy dissipation, improving tank stability for hybrid-rocket sloshing conditions.

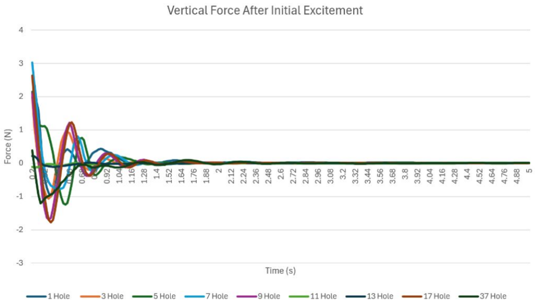


Fig. 4 Vertical Force on Tank During Sloshing

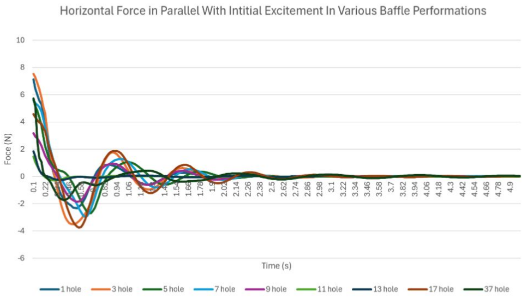
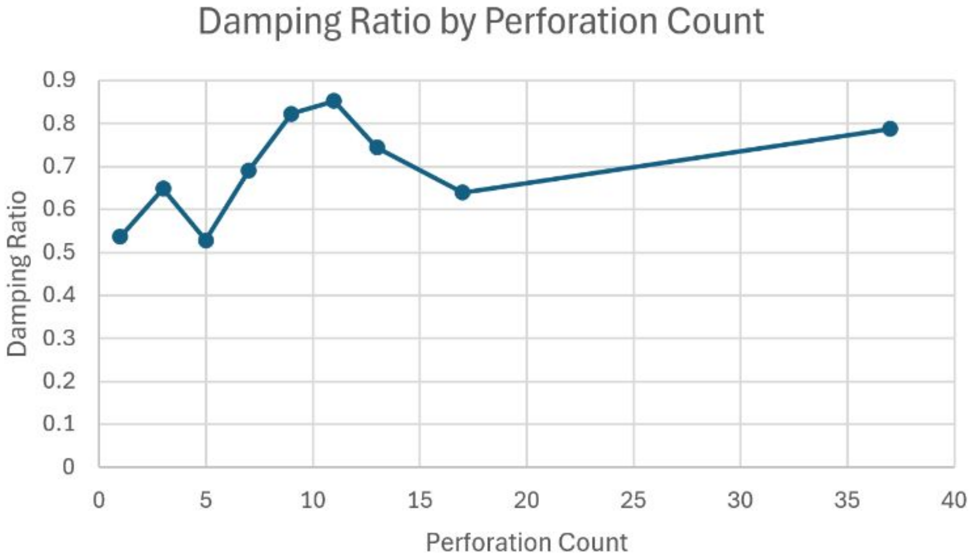


Fig. 3 Horizontal Force on Tank During Sloshing



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