Caiden Bonney – Engineering Portfolio

Mechanical Engineering, Cal Poly San Luis Obispo
Mechatronics Concentration | Computer Science Minor
Incoming MS Mechanical Engineering Student – Fall 2026
Email: caiden.bonney@gmail.com | Phone: 951-434-9724
LinkedIn: linkedin.com/in/caidenbonney

About This Portfolio

This portfolio showcases my propulsion test engineering experience, fluid systems modeling work, and hands-on propulsion hardware design.

Portfolio Overview

Technical Overview

I am a mechanical engineering student focused on propulsion systems, fluid networks, and analytical engineering tools. My experience includes propulsion test engineering at Frontier Aerospace Corporation, where I returned for a second internship focused on fluid system verification and test stand diagnostics. During my first internship, I worked in a design-focused role supporting injector tooling, standardized user-defined features, and engineering documentation. Across both roles, I developed analytical models and gained experience supporting propulsion hardware through both design and test phases.

In parallel, I have led propulsion hardware design projects with San Luis Obispo Propulsion Technologies (SPT), including a self-pressurizing liquid propellant tank system and a small-scale rocket engine designed for manufacturability and test stand integration. I also develop engineering analysis tools through coursework and independent projects, such as pump and system curve models, bolted joint stiffness calculators, and mechatronics control systems, to support data-driven design and testing decisions.

Key Strengths

- Fluid system diagnostics and flow balancing
- Pump and system curve modeling for real systems
- Test engineering mindset: validate, isolate, iterate
- Design for manufacturability and integration
- Analytical tool development for engineering decision-making
- Clear technical communication in multidisciplinary teams

Frontier Aerospace Corporation

Propulsion Test Engineer – Summer 2025

Background

For the past two summers, I have interned at Frontier Aerospace. During Summer 2025, I returned for my second internship, supporting propulsion testing operations alongside test engineers. My work focused on fluid system verification, instrumentation setup, and test stand readiness, with primary responsibility for diagnosing and resolving flow distribution issues in a multi-branch recirculation system supporting hot-fire testing.

Challenge

The propulsion test stand relied on a multi-branch recirculation system where each component required a specific flow rate. Actual system performance did not match analytical predictions, and the team needed the recirculation system to meet required flow rates in advance of upcoming hot-fire test configurations.

Approach

1. System Characterization
   Mapped the physical piping network to understand branching, component location, and expected flow paths. Collected datasheet specifications, including valve coefficients, pump characteristics, and loss parameters.

2. Analytical Modeling
   Built an Excel-based system model incorporating:
   - Branch pressure drop estimates and component losses
   - Manufacturer pump curve data
   - Predicted system curve and operating point

   This created a baseline for expected performance.

3. Physical Verification
   Conducted flow tests at predicted operating points and compared measured values with model outputs.

4. Diagnostic Investigation
   When data did not align, I performed iterative isolation testing on individual branches to systematically remove variables.
   Through testing, I identified two major root causes:
   - Several flow meters were malfunctioning and giving false readings
   - One butterfly valve appeared open, but was internally damaged and restricted flow
5. Corrective Actions
   - Reinterpreted flow rates using pressure-based estimations from component datasheets
   - Retested the system after valve replacement for flow rate requirements
6. Optimization
   - Determined the minimum pump speed that would still satisfy all branch flow requirements, reducing energy consumption and system wear.

Result

Delivered a stable fluid system that met the required component flow rates at a significantly reduced pump speed. Improved diagnostic reliability and provided a validated system model for future test stand operations.

Additional Contributions

- Sourced pneumatic safety equipment and configured relay schematics for an emergency response system
- Assisted with vacuum chamber operations, including wiring organization, thrust stand configuration, and optical instrumentation
- Supported engine removal, teardown, and thrust measurement calibration

San Luis Obispo Propulsion Technologies (Student Project Team)

Propellant Tanks System Lead – Penguin Rocket Project

Challenge

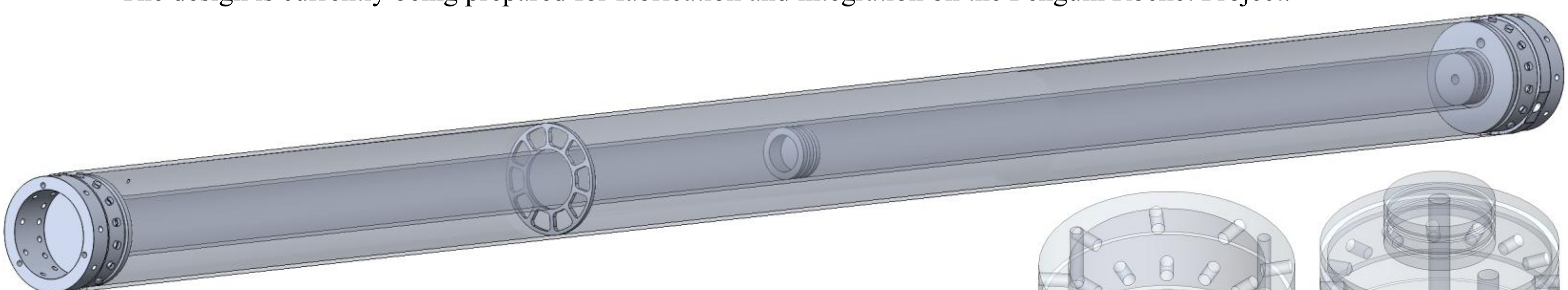
Design a self-pressurizing blowdown liquid nitrous oxide-ethanol propellant tank system for a ~500 lbf class engine. The system needed to balance structural integrity, manufacturability, internal volume, integration constraints, and expected thermodynamic behavior during blowdown.

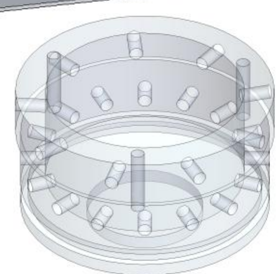
Approach

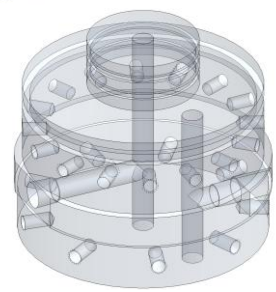
- Developed general tank geometry and component layouts
- Performed structural reasoning calculations for material selection, thickness, and bolt selection
- Considered liquid fill behavior, ullage sizing, and pressurization characteristics with the team
- Coordinated manufacturability, machining, and assembly planning, such as valve placement, mounting points, and feedline interfaces

Result

Produced a manufacturable tank design aligned with propulsion, structural, and systems integration requirements. The design is currently being prepared for fabrication and integration on the Penguin Rocket Project.





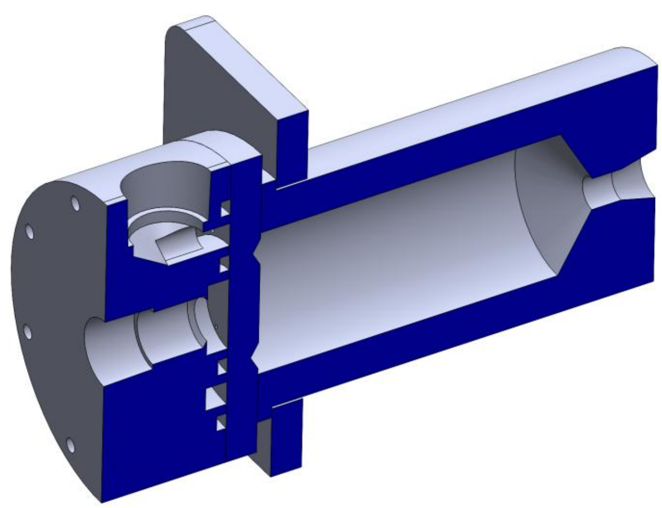


Chamber and Injector Design – Tiny Rocket Engine

Challenge

Create a small-scale GOX IPA rocket engine suitable for interfacing with the club's test stand. The design needed to be simple to manufacture, with a chamber created from phenolic, an ablative material which had previously never been worked with at the club.

Approach



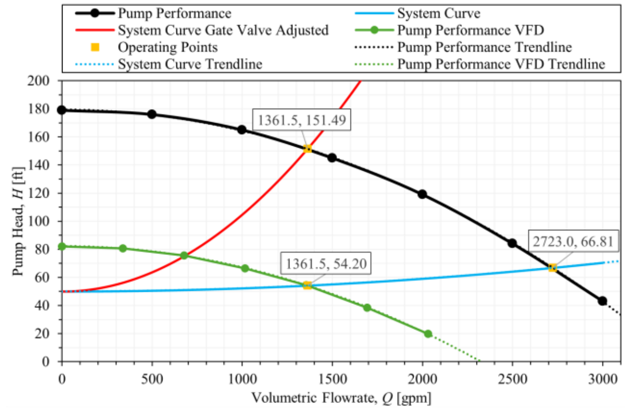
- Designed a cylindrical phenolic ablative chamber with an emphasis on manufacturability and compatibility with available machining processes
- Designed manifold and faceplate with impinging injector orifices
- Modeled mounting bracket for integration with test stand

Result

Produced a complete, manufacturable injector and chamber design package suitable for integration with the club's small-scale test stand. The design emphasized simplicity, accessibility of machining operations, and ease of assembly, allowing the team to evaluate an ablative chamber approach using phenolic material. The project established a physical design baseline that could be safely tested on the club's existing infrastructure and informed future engine development efforts before the test stand was decommissioned.

Excel-Based Analytical Tools and Coursework Projects

Pump and System Curve Excel Modeling (ME 347)



Purpose: Estimate the operation point of the given system for variable pump speeds and gate valve percentage open.

Capabilities:

- Computes head loss, system curve, and operating point
- Includes gate valve adjustments and VFD behavior
- Supports multiple curve trendlines and diagnostics
- Uses power trendline to estimate K_{valve} for various percent open based on given data points.

Bolt, Frustum, and Joint Stiffness Calculator (ME 328)

Purpose: Compute stiffness contributions of bolts, washers, frustums, and members under preload.

Lectures 7&8 Bolt and Member Stiffness Calculations

INPUTS	Units:	Metric		
Member Properties			Elastic Modulus	
Top Washer Length, t_{tw}	3.5	mm	E top washer	207.0E+09 Pa
Top Member Length, t_{tm}	20	mm	E top member	207.0E+09 Pa
Bottom Member Length, t_{bm}	25	mm	E bottom member	100.0E+09 Pa
Bottom Washer Length, t_{bw}	3.5	mm	E bottom washer	207.0E+09 Pa
Bolt Properties	M12-1.75-65 UNC Grade 9.8			
Bolt elastic modulus, E	207.0E+09	Pa		
Bolt diameter, d	12.00	mm		
Series	UNC			
Bolt Length, L	65	mm		
Grade No.	9.8			
Grip length, l	52	mm		
Threaded bolt length, L_T	30	mm	Fully Threaded	☐
		mm	Override threaded length	☐
Unthreaded bolt length, l_d	35	mm		
Threaded bolt length in grip, l_t	17	mm		
Area of unthreaded portion, A_d	113.0973	mm^2		
Area of threaded portion, A_t	84.3	mm^2		
	84E-06	m^2		
Bolt pitch, p	1.75	mm		
Threaded into bottom member	☐	<---- Note that if this option is selected also change Bottom Washer Length to 0		
Threaded into nut	☑			
Unthreaded Fastener Stiffness, k_d	668.89E+09	mN/m		
	668.89	MN/m		
Threaded Fastener Stiffness, k_t	1.03E+12	mN/m		
	1026.48	MN/m		
Fastener Stiffness, k_b	404.99E+09	mN/m		
	404.99	MN/m		

OUTPUTS

Apex angle, α: 30 degrees

Frusta Dimensions

Segment	Thickness [mm]	D [mm]	E [Pa]	k [mN/m]	1/k
1	3.5	18	207.0E+09	11.6E+12	86.2E-15
2	20	22.0415	207.0E+09	6.7E+12	150.0E-15
3	2.5	45.1355	100.0E+09	63.6E+12	15.7E-15
4	22.5	22.0415	100.0E+09	3.1E+12	326.3E-15
5	3.5	18	207.0E+09	11.6E+12	86.2E-15

Thickness check	52	mm
Grip length, l	52	mm
Half grip length, l/2	26	mm
Member Stiffness, k_m	1.50E+12	mN/m
	1504.66	MN/m
Joint Compliance, C	0.2121	

Capabilities:

- Computes bolt and joint stiffness, including bolt, washer, frustum, and clamped member contributions
- Calculates joint compliance and load distribution between the bolt and clamped members
- Estimates preload force and resulting bolt load under external loading
- Evaluates joint safety factors against separation and bolt yielding
- Generates supporting values for torque estimation based on preload assumptions

Romi Robot Mechatronics System (ME 405)

Purpose: The Romi Project involved designing and programming a two-wheeled robotic vehicle to autonomously navigate a waypoint-defined course using sensor-based control.

Key Elements:

- Line sensor arrays, IMU, wheel encoders
- MicroPython-based control architecture
- Closed-loop control for motors, line sense centroid position, and IMU heading
- Observer algorithm estimating global position based on physical dynamics