Engineering Portfolio

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Monte Flow Simulation

Problem:

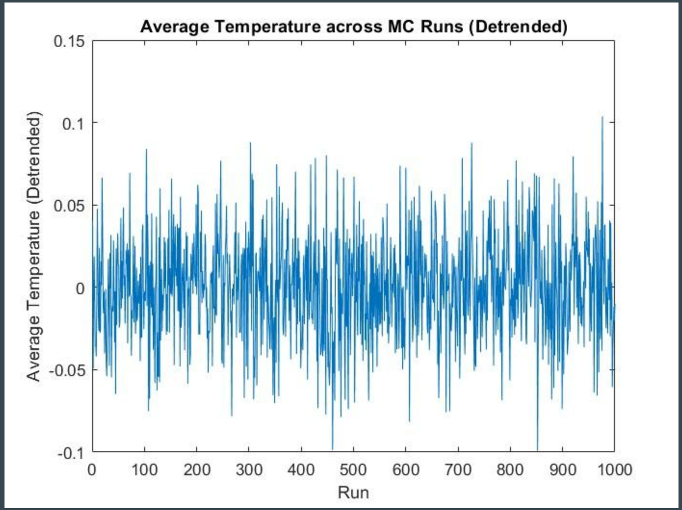
Model 2D heat conduction in a square plate while capturing uncertainty on one boundary. The solver needed to stay accurate under noisy inputs and produce statistics (not just one CFD run) for design decisions.

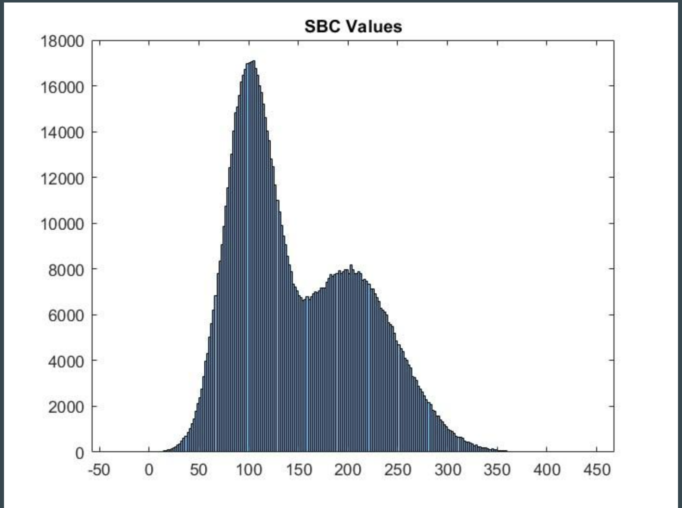
Method:

Custom MATLAB finite-difference (FDM) solver with three stochastic boundary models: Gaussian noise, bimodal switching, and Brownian motion. Ran >1,000 Monte Carlo trials; analyzed frequency content via FFT. Validated the deterministic case against a high-fidelity Abaqus FE model.

Solution:

- Deterministic solution matched Abaqus within < 0.1 °C.
- Monte Carlo runs produced stable temperature distributions and clear frequency signatures, demonstrating robustness to boundary noise.
- Deliverables: solver code, statistical plots (PDF), and method notes for repeatability





Jet Engine Intake Fan

Problem:

Visualize compressible flow through a custom axial intake fan and compare subsonic vs. transonic inflow to identify shock formation, swirl, and wake behavior in an open-rotor configuration.

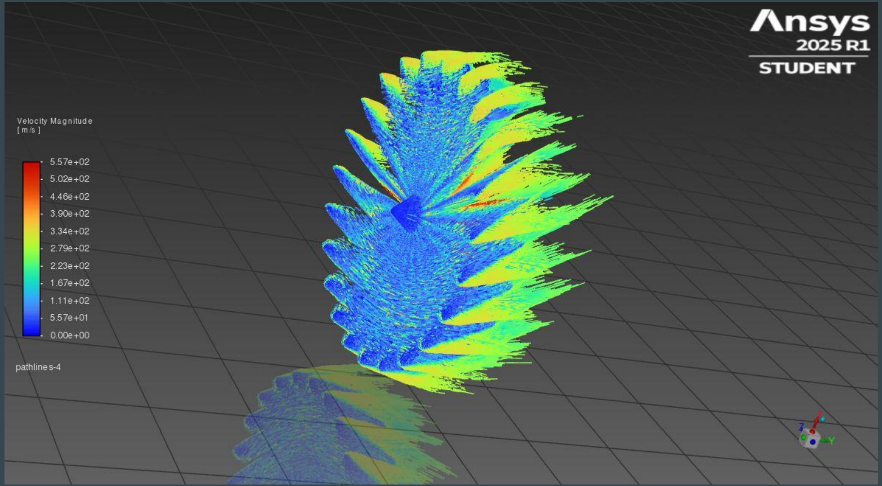
Method:

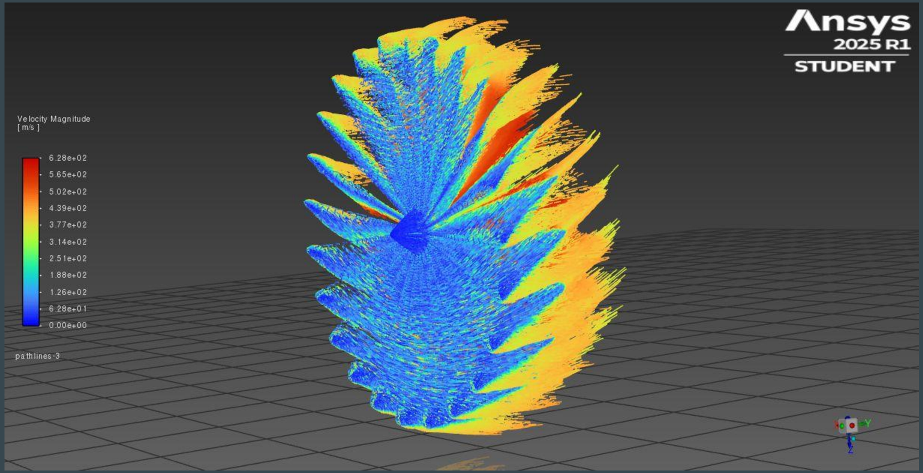
Fusion 360 geometry → ANSYS Fluent 2025 R1. Steady compressible RANS, k–ω SST, single-zone MRF for the rotor. Pressure far-field at 1 atm, T ≈ 300 K with two cases: $M_\infty=0.8$ and $M_\infty=1.0$. Unstructured mesh with LE/TE refinement and inflation layers targeting $y^+\approx 30$–50; convergence to residuals $\le 1\times10^{-4}$ with pressure/mass-flow monitor plateaus.

Solution:

$M_\infty=0.8$M: attached flow across most of the span; thin wakes; clean helical pathlines (swirl).

$M_\infty=1.0$: stronger suction-side gradients and localized shocklets near the outer span; thicker wakes and higher loss signature.





Vertical Tail Stabilizer

Problem:

Size and place the vertical tail early in configuration design to balance static/dynamic stability and rudder authority. Needed a fast way to see how geometry and placement affect the main stability derivatives.

Method:

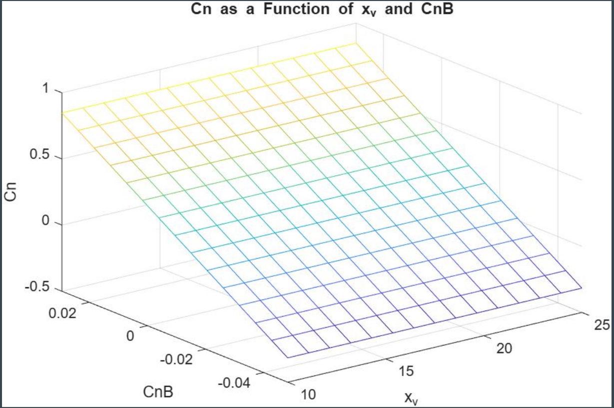
MATLAB tool that sweeps area, aspect ratio, height, taper ratio, and longitudinal position xvx_vxv. Computes CnB, C_n, andC_n_r and generates sensitivity maps and trend surfaces for quick trade studies.

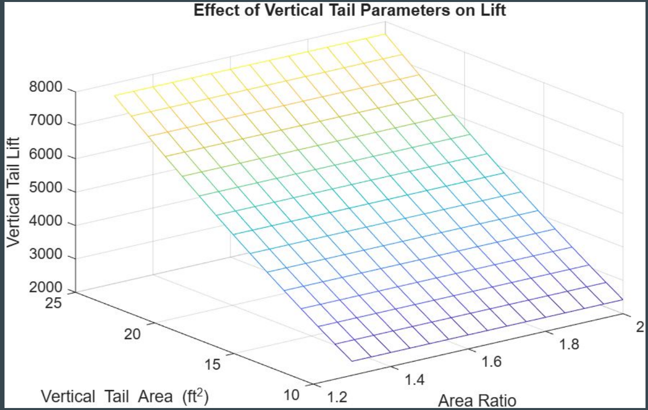
Solution:

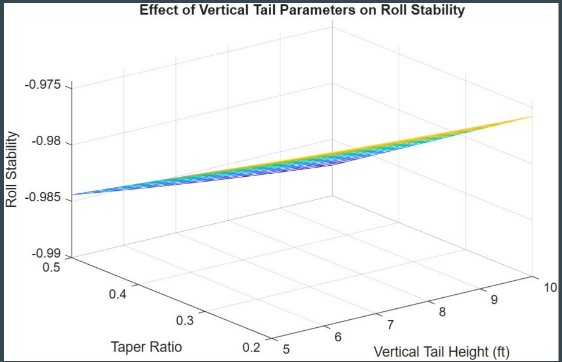
Stability: roll/yaw stability generally increases with tail height and lever arm (CG distance).

Control authority: rudder effectiveness scales with tail volume and is highly sensitive to xvx

Outputs include derivative maps and “what-if” plots that make early sizing decisions transparent.







Thorlabs: Vacuum Feedthrough Jig

Problem:

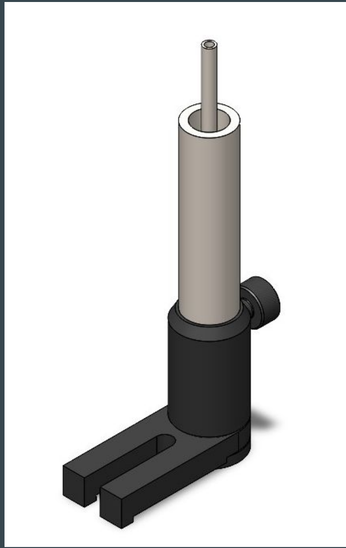
Describe the problem/objective. Give some details about the requirements/constraints of project, # of team members, budget

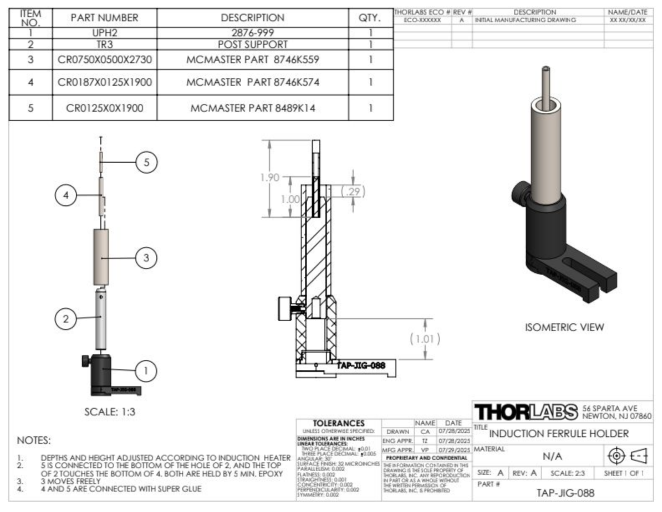
Method:

Describe how you went about solving problems. What software/tools used, how you validate your findings

Solution:

Explain your results. Providing number is crucial here. Can also mentioned what you learned from this project





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4	CR0187X0125X1900	MCMASTER PART 8746K574	1
5	CR0125X0X1900	MCMASTER PART 8489K14	1

THORLABS ECO #	REV #	DESCRIPTION	NAME/DATE
ECO-XXXXXX	A	INITIAL MANUFACTURING DRAWING	XX XX/XX/XX

NOTES:

1. DEPTHS AND HEIGHT ADJUSTED ACCORDING TO INDUCTION HEATER
2. 5 IS CONNECTED TO THE BOTTOM OF THE HOLE OF 2, AND THE TOP OF 2 TOUCHES THE BOTTOM OF 4. BOTH ARE HELD BY 5 MIN. EPOXY
3. 3 MOVES FREELY
4. 4 AND 5 ARE CONNECTED WITH SUPER GLUE

TOLERANCES
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
LINEAR TOLERANCES:
TWO PLACE DECIMAL: ±0.01
THREE PLACE DECIMAL: ±0.005
ANGULAR: 30'
SURFACE FINISH: 32 MICROINCHES
PARALLELISM: 0.002
FLATNESS: 0.002
STRAIGHTNESS: 0.001
CONCENTRICITY: 0.002
PERPENDICULARITY: 0.002
SYMMETRY: 0.002

	NAME	DATE
DRAWN	CA	07/28/2025
ENG APPR.	TZ	07/28/2025
MFG APPR.	VP	07/29/2025

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THORLABS 56 SPARTA AVE NEWTON, NJ 07860
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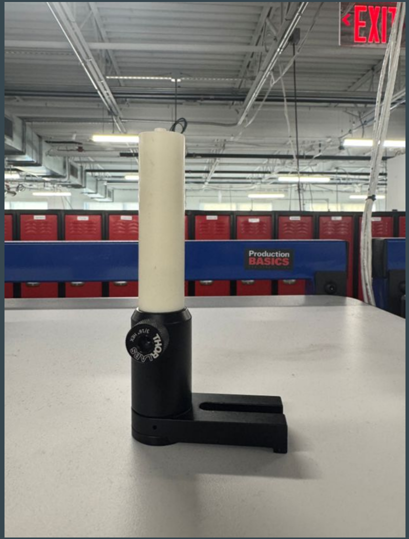
MATERIAL N/A
SIZE: A REV: A SCALE: 2:3 SHEET 1 OF 1
PART # TAP-JIG-088



Thorlabs: Automatic Screw Feeder Cap

Problem:

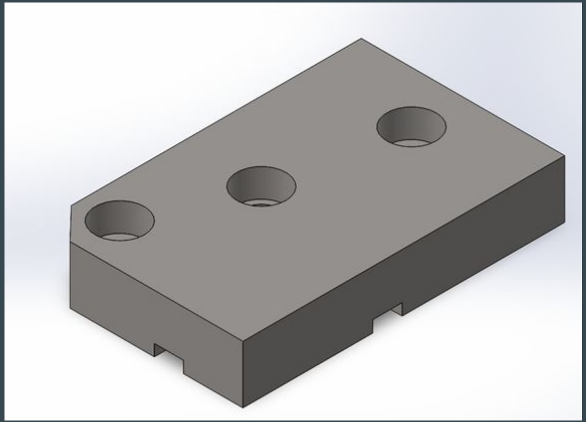
Describe the problem/objective. Give some details about the requirements/constraints of project, # of team members, budget

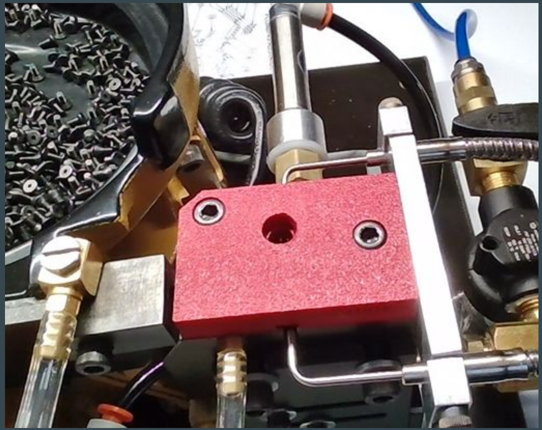
Method:

Describe how you went about solving problems. What software/tools used, how you validate your findings

Solution:

Explain your results. Providing number is crucial here. Can also mentioned what you learned from this project





Thorlabs: CCM* Assembly Jig

Problem:

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Method:

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Solution:

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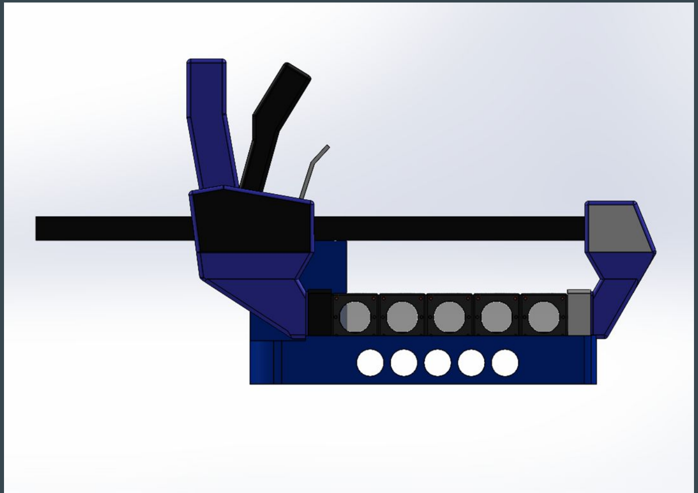

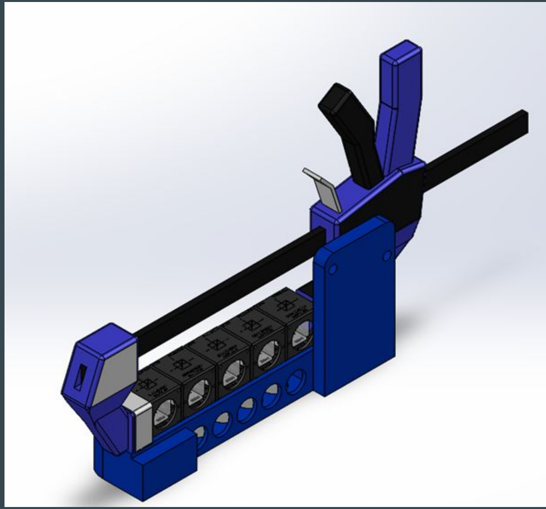

Thorlabs: CAPSM-1 Jig

Problem:

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Method:

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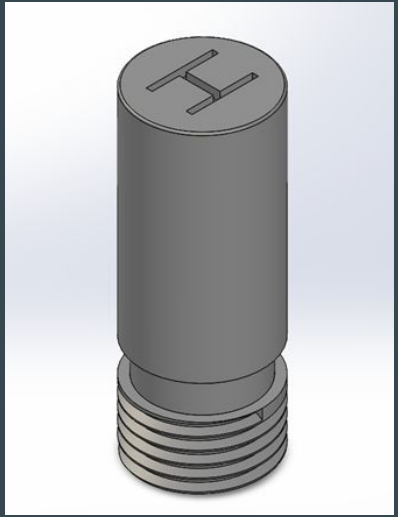
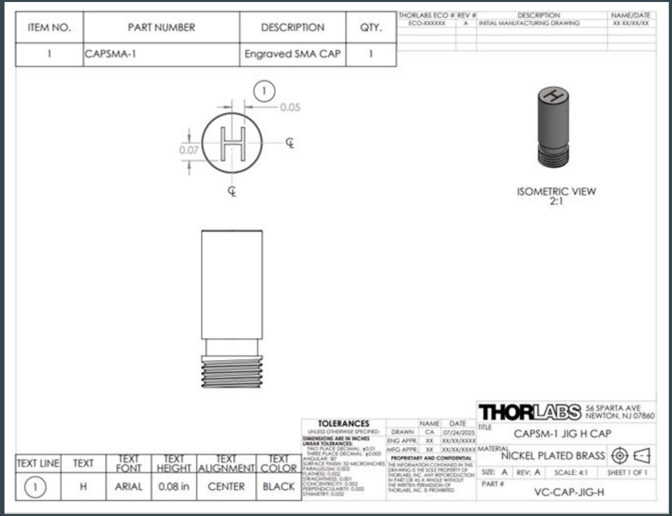
Solution:

Explain your results. Providing number is crucial here. Can also mentioned what you learned from this project





Thorlabs: BT-FSSMA Pull Test

Problem:

Describe the problem/objective. Give some details about the requirements/constraints of project, # of team members, budget

Method:

Describe how you went about solving problems. What software/tools used, how you validate your findings

Solution:

Explain your results. Providing number is crucial here. Can also mentioned what you learned from this project