MQ-9 Propeller Optimization

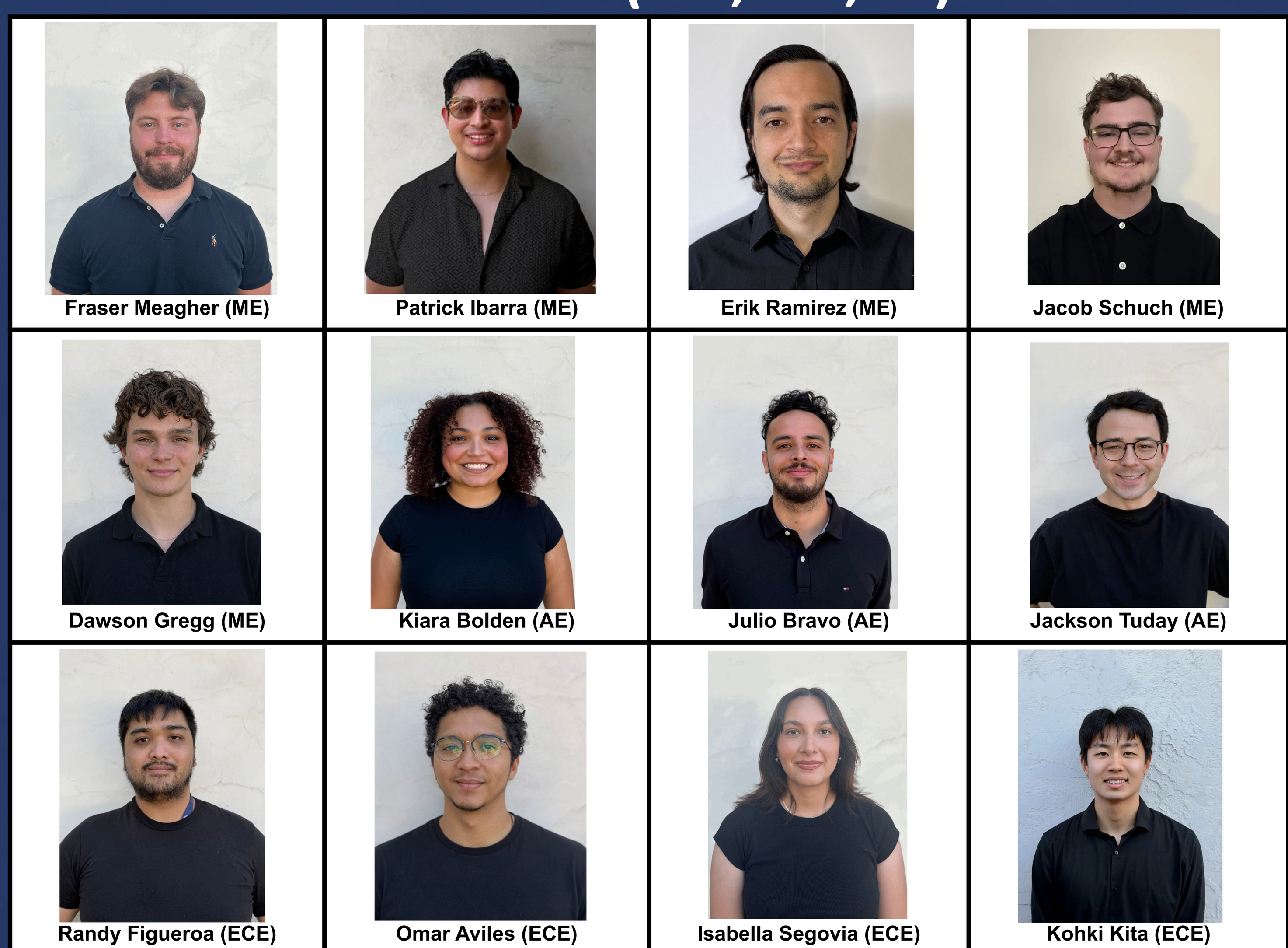
PropOps

San Diego State University

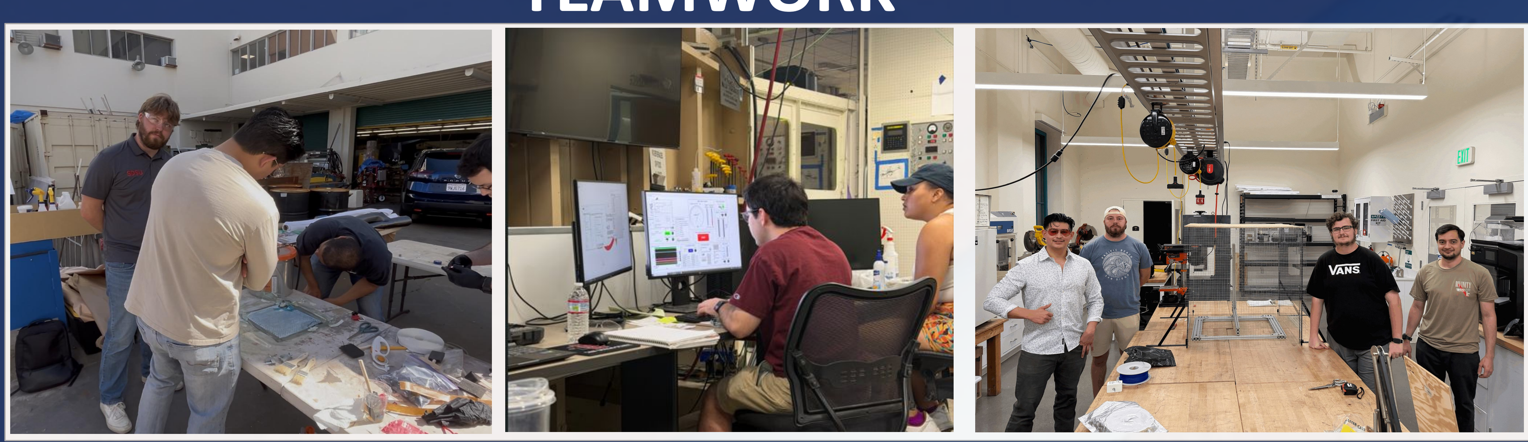
PROJECT OVERVIEW

The MQ-9 Reaper is a long-endurance unmanned aircraft where propeller efficiency and acoustic signature are critical to mission performance. This project focuses on the design, fabrication, and testing of an optimized propeller system to improve aerodynamic efficiency while reducing noise. A scaled propeller model and modular test stand were developed to experimentally evaluate performance. The system enables measurement of thrust, torque, RPM, velocity, and sound characteristics. The goal is to analyze tradeoffs between efficiency and noise reduction and provide data-driven design improvements relative to a baseline propeller. The final phase is manufacturing a propeller assembly out of aerospace grade materials.

THE TEAM (ME,ECE,AE)



TEAMWORK



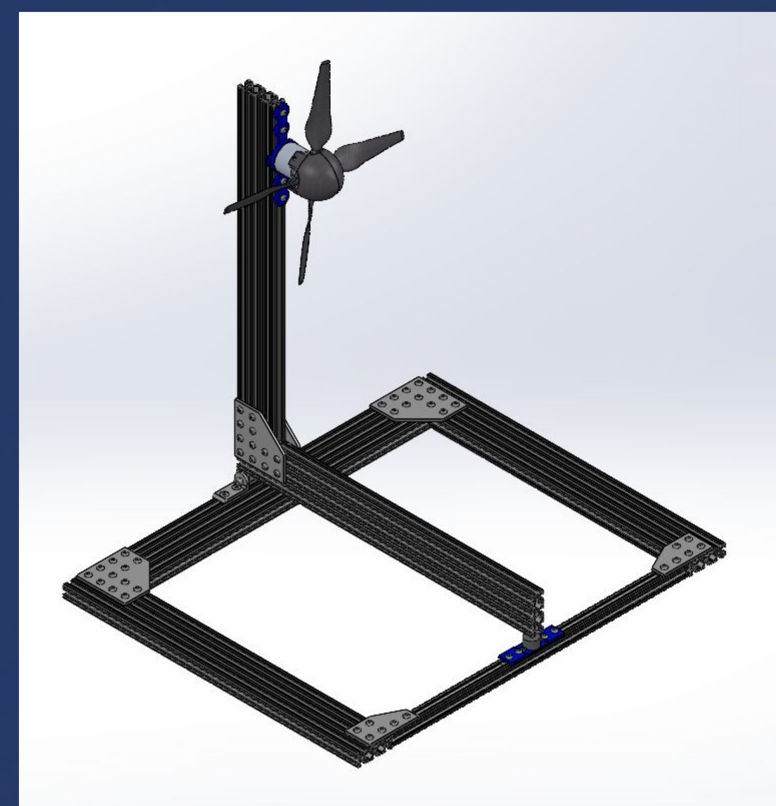
ABOUT OUR SPONSORS

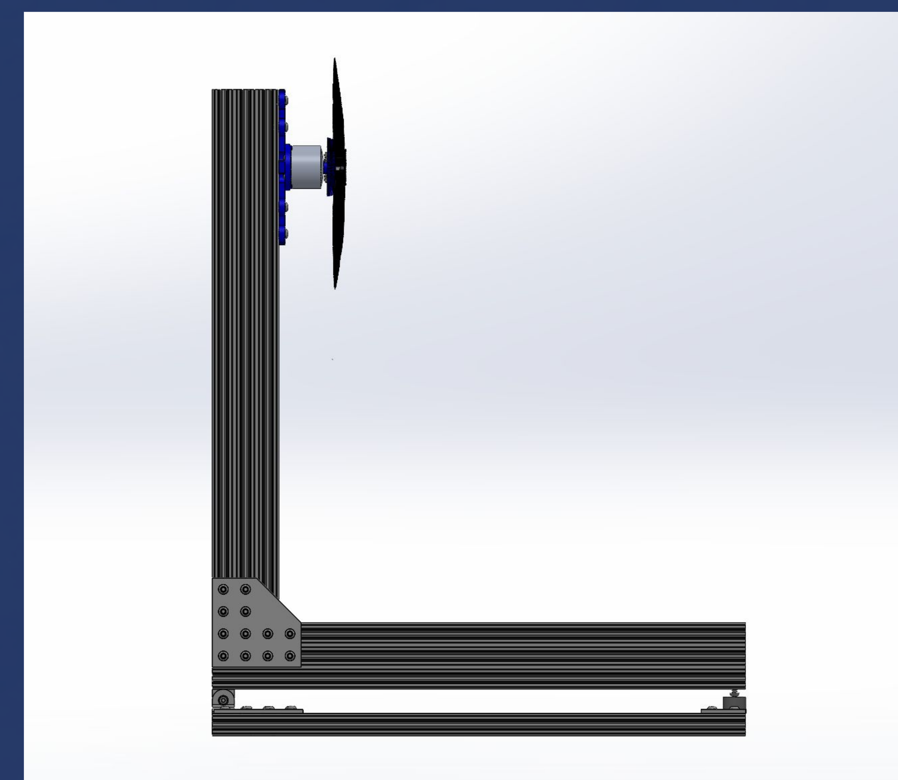
General Atomics Aeronautical Systems is a leader in unmanned aircraft systems like the MQ-9 Reaper

ACKNOWLEDGMENTS

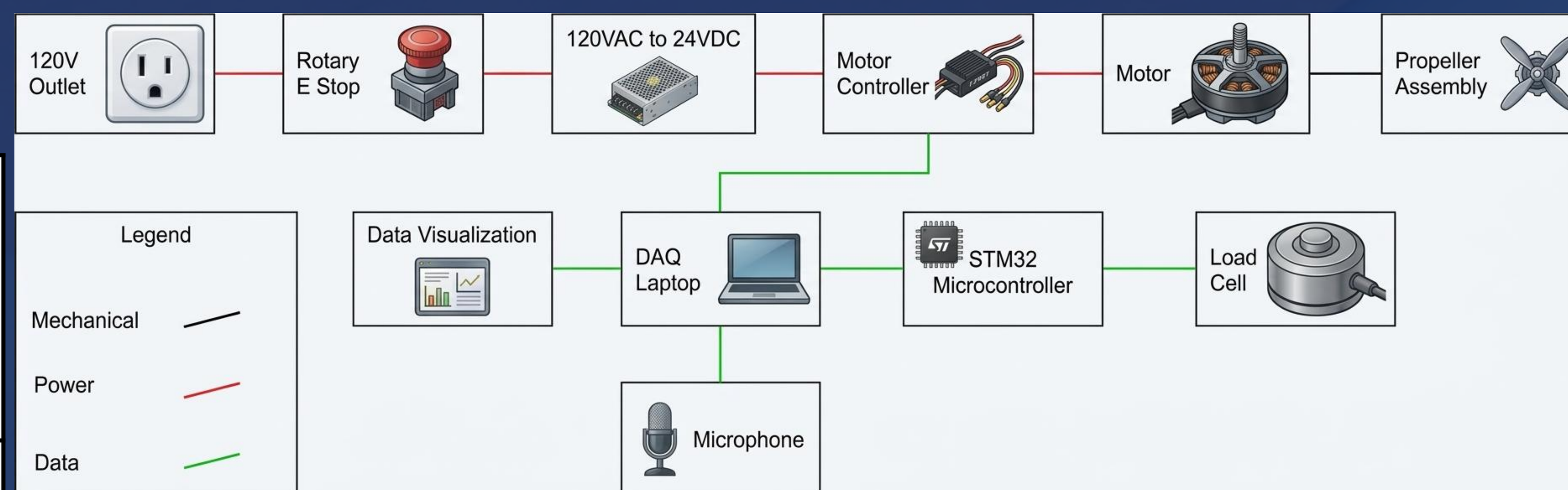
The team would like to thank our sponsors at General Atomics Aeronautical Systems Chris Sam,with help from Tallon Mcdonough and Christopher Aguilar from General Atomics. Thanks to Dr. Shaffar and San Diego State University Mechanical Engineering Department.

TEST STAND



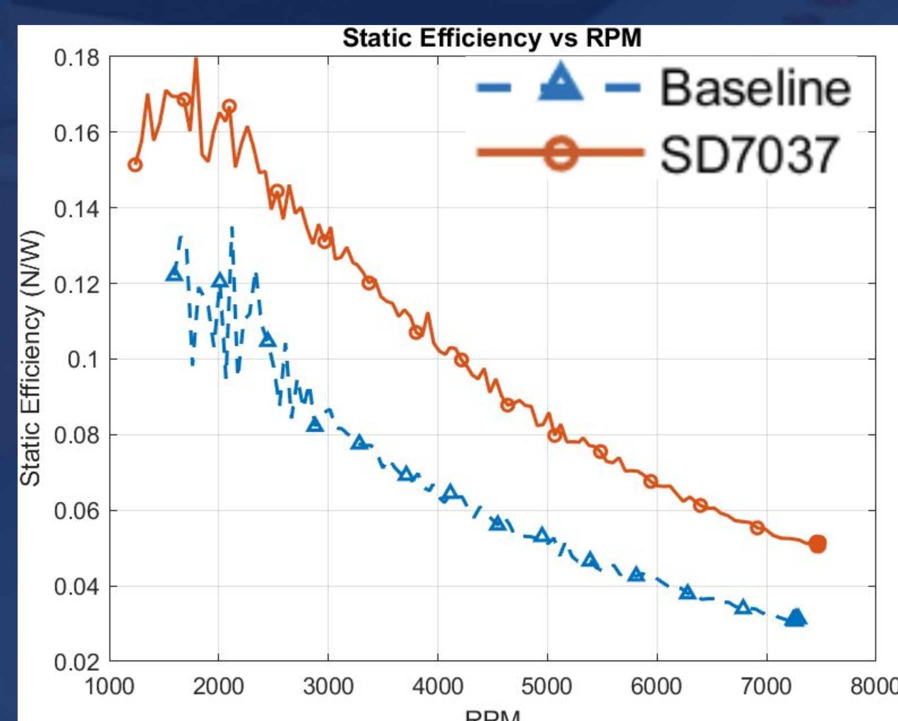


SYSTEM LEVEL DIAGRAM

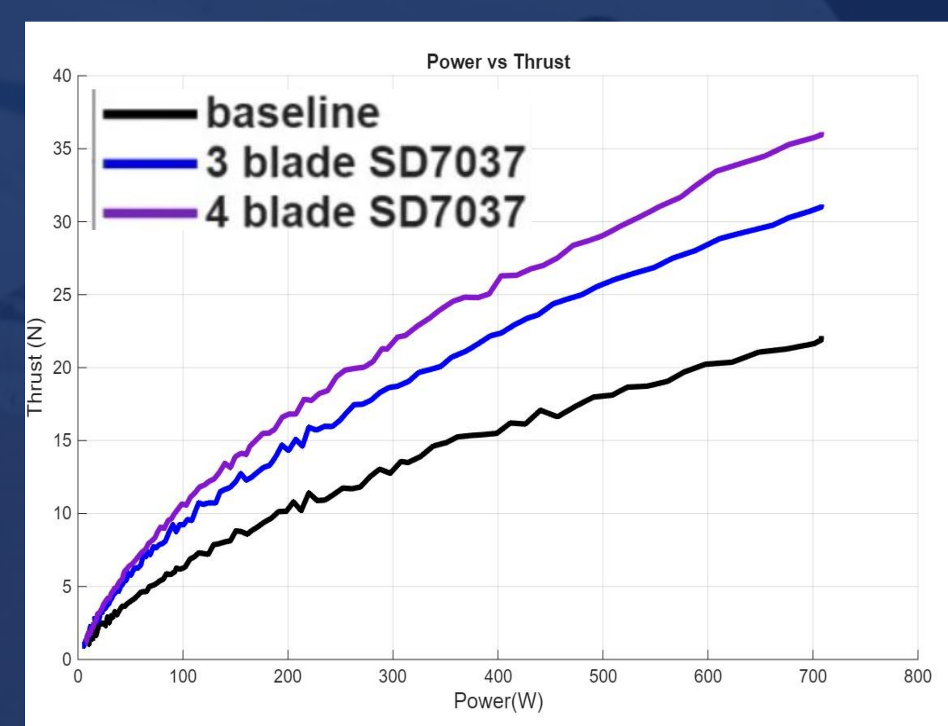


RESULTS

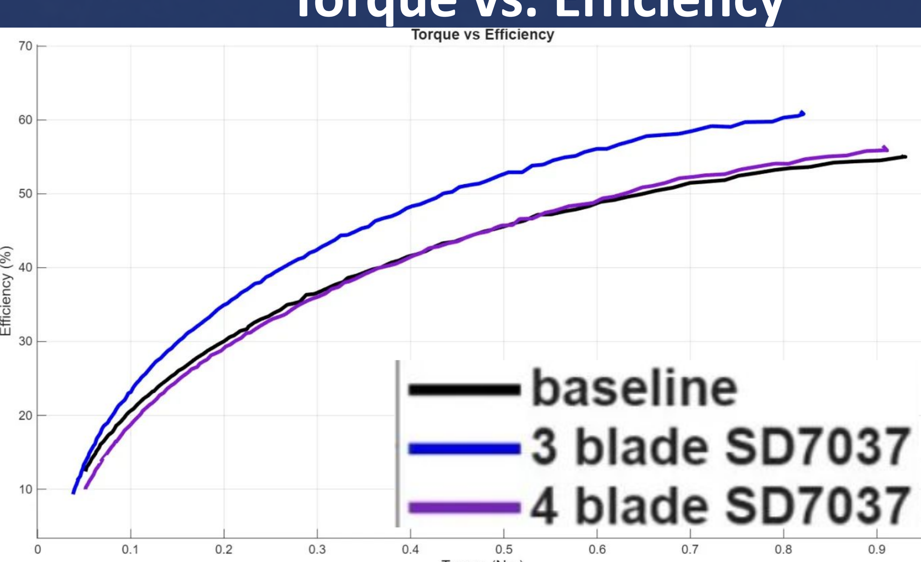
Static Efficiency vs. RPM



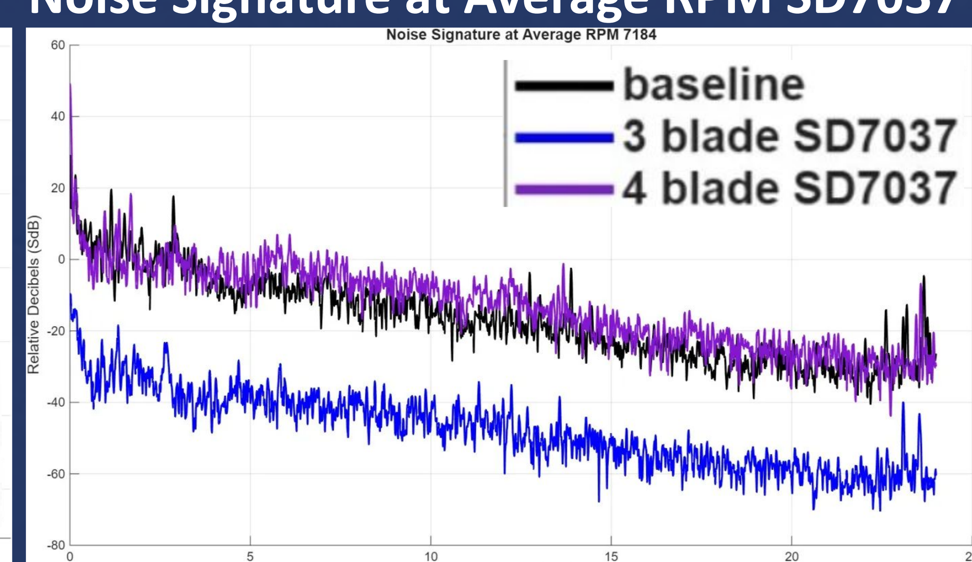
Power vs. Thrust



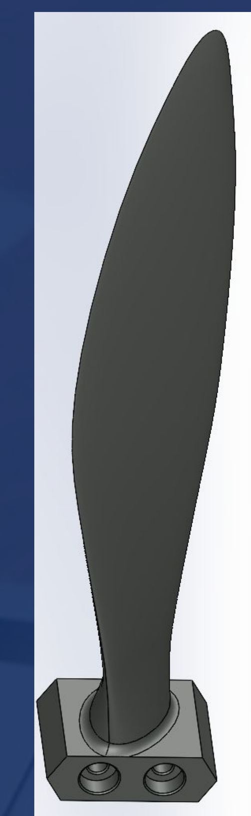
Torque vs. Efficiency

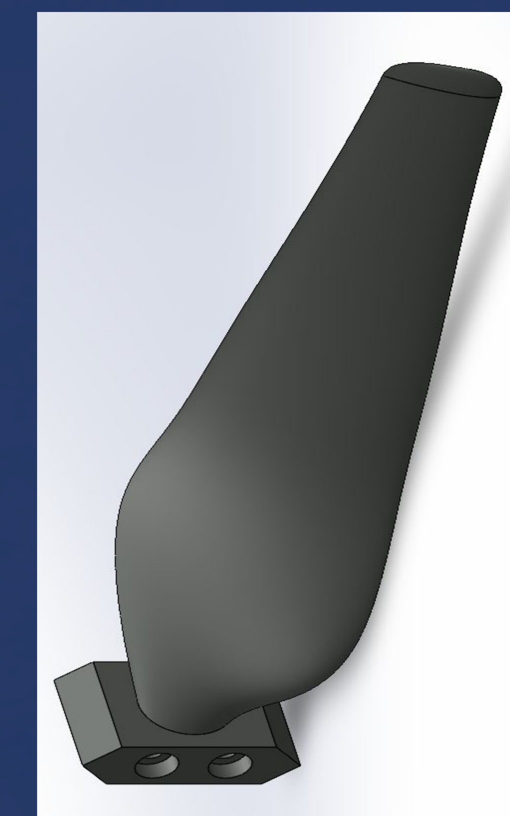


Noise Signature at Average RPM SD7037



PROPELLER DESIGNS

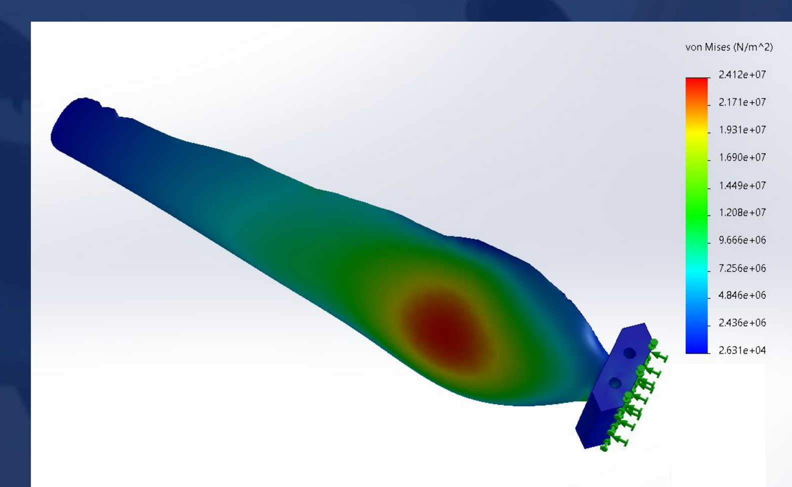




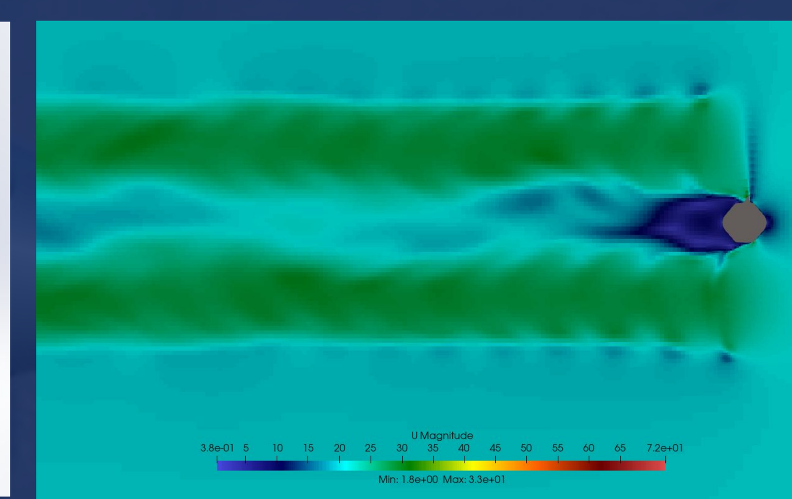
Aerospace-grade blades and hub were fabricated using forged carbon fiber, a carbon fiber spinner, and a machined aluminum hub. The **full assembly (left)**, **GA-ASI baseline (middle)**, and **SD7037 V2 (right)** are shown, with the baseline used for consistent performance comparison. The SD7037 V2 was developed through a collaborative, iterative design process, initially guided by BEMT and subsequently refined using CFD and experimental testing, resulting in improved efficiency.

ANALYSIS METHODS

FEA

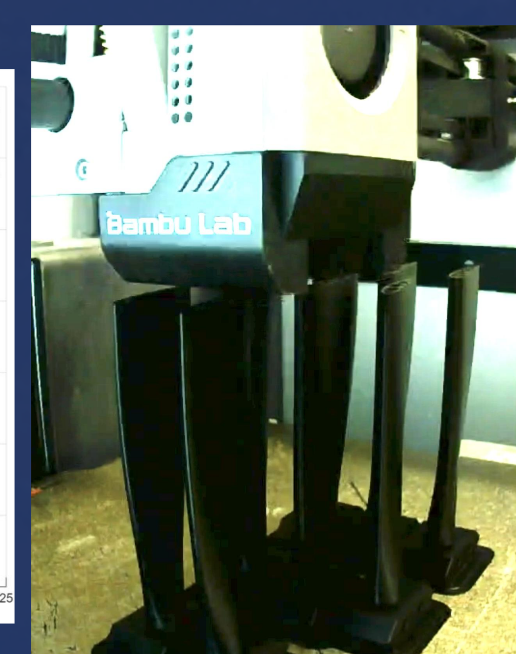


CFD



Finite Element Analysis (FEA) using von Mises stress identified peak blade maximum stresses under maximum thrust, confirming structural integrity with adequate safety margin. **Computational Fluid Dynamics (CFD)** evaluated aerodynamic performance across RPMs, capturing pressure distribution and tip vortices. Results guided blade refinement and validated BEMT predictions, confirming improved efficiency in the SD7037 V2 design.

MANUFACTURING



3D Printing Propellers (Left) and Carbon Fiber Forged Propeller (Right)

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