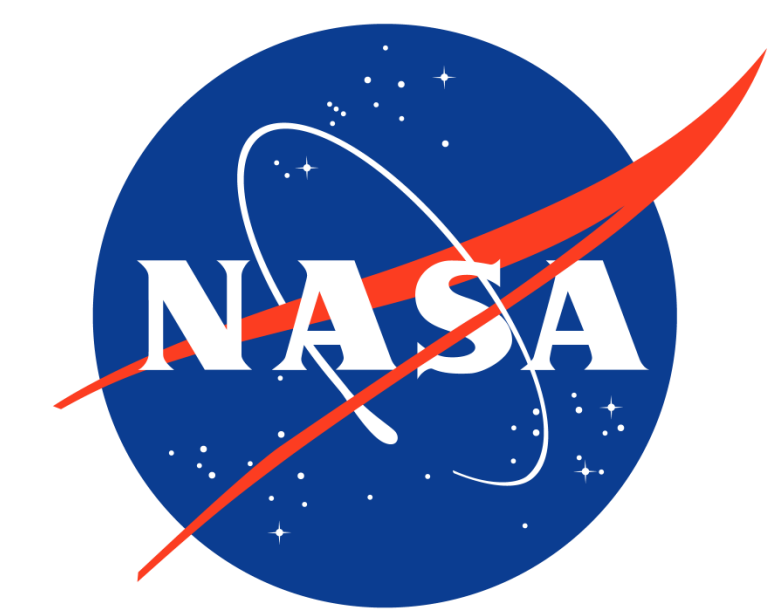
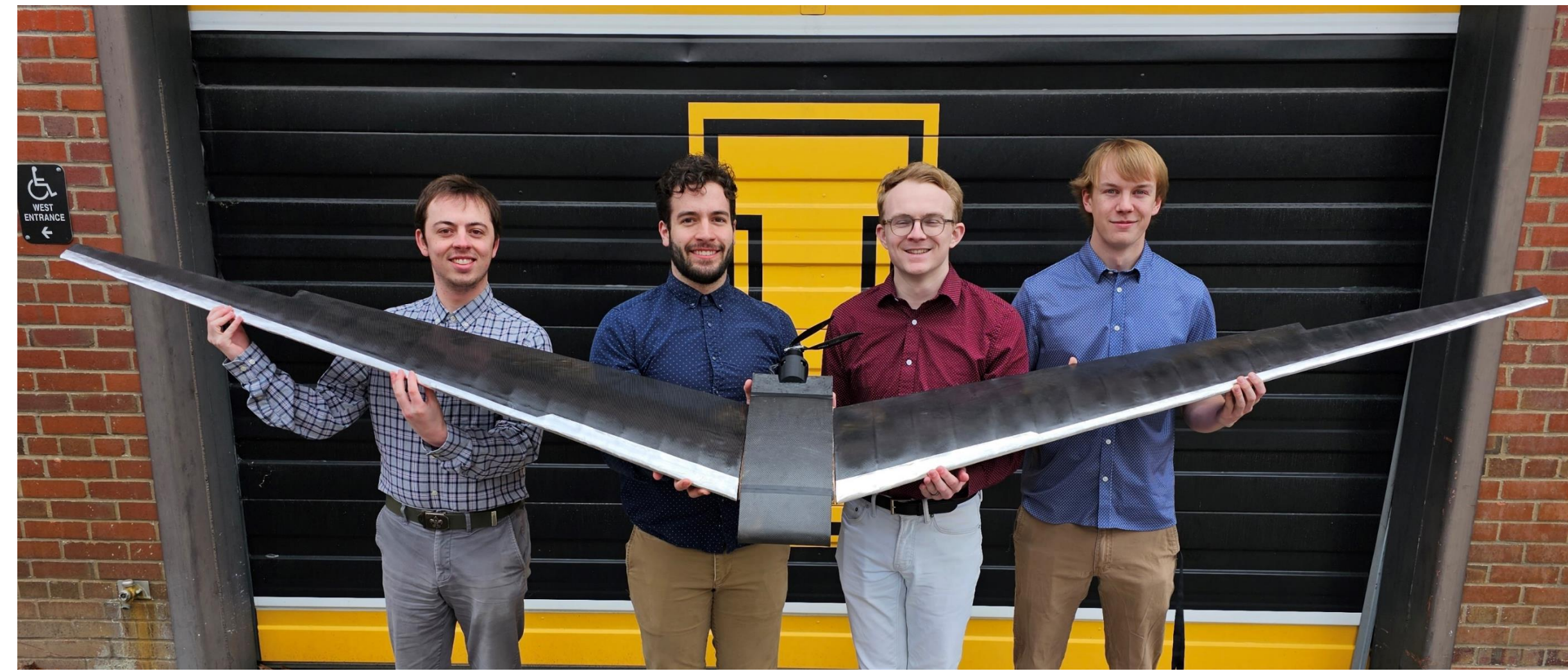




PRANDTL-D FLYING WING DEMONSTRATION



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OBJECTIVE

Build a flying prototype unmanned aerial vehicle (UAV) using the NASA Prandtl-D wing design to demonstrate the commercial viability of the design driven by improved aerodynamic performance.

BACKGROUND

Advantages of Prandtl-D wing design:

- 12% less drag by eliminating the need for a vertical stabilizer.
- Increased stability in turns as a result of proverse yaw.

Disadvantages of Prandtl-D wing design:

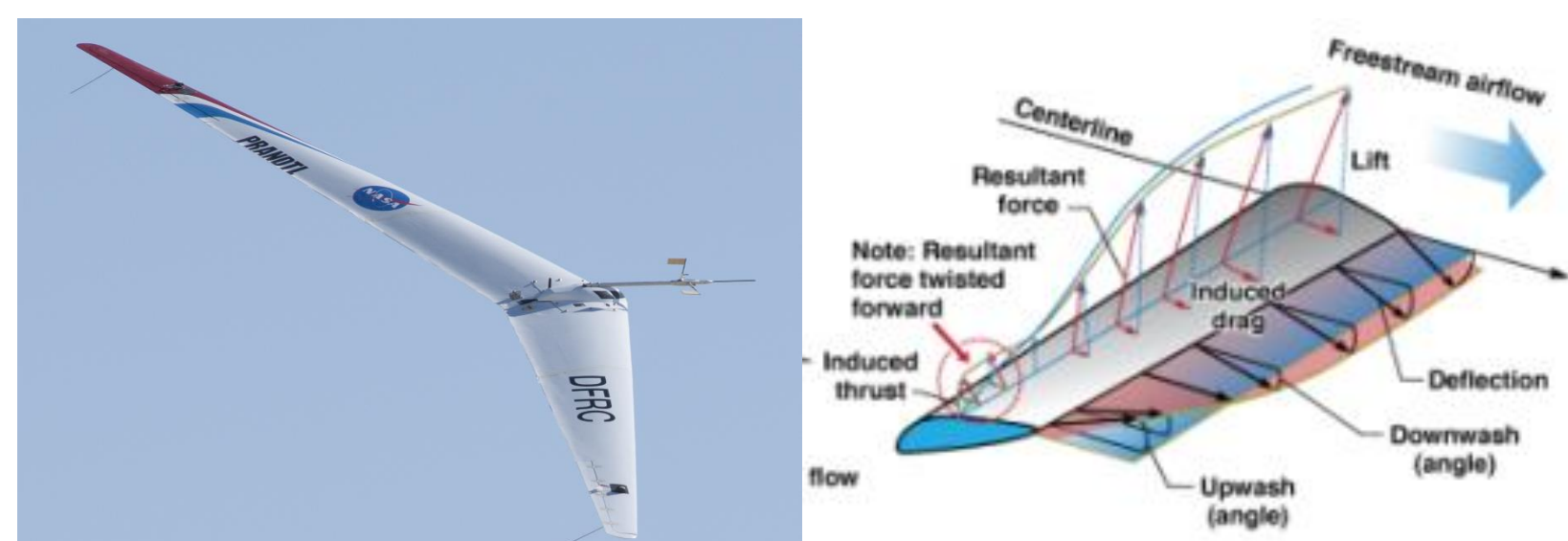
- Difficult to manufacture due to complex twist along wingspan.
- Limited internal volume for payloads.

Previous Research:

- NASA – Demonstrated 11% increase in glider efficiency.

Impact:

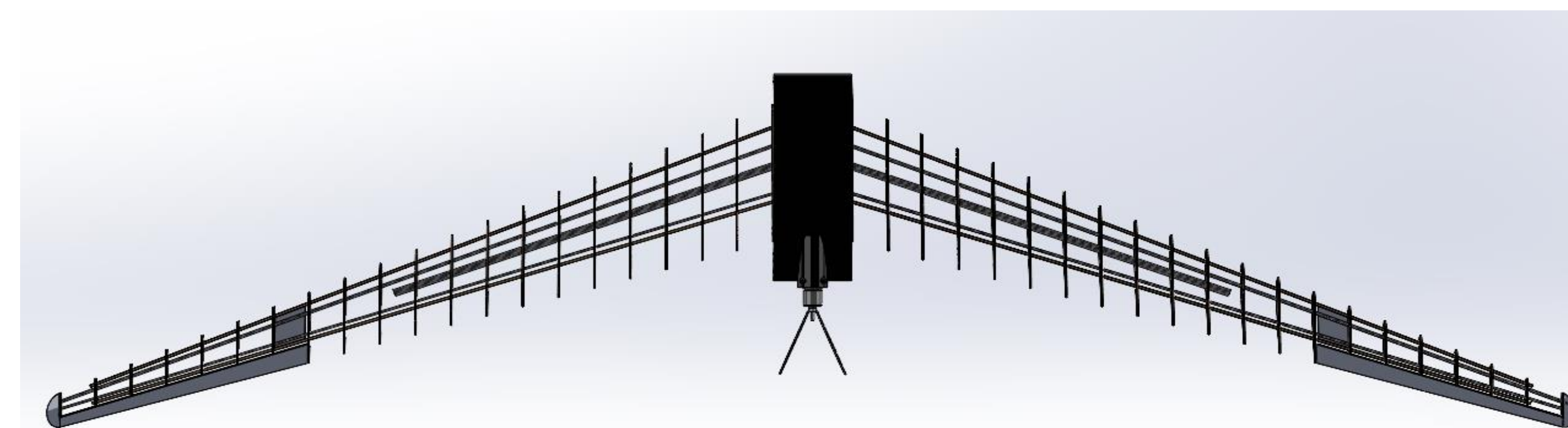
- Reduce the overall environmental impact related to flight.



REQUIREMENTS

- PRANDTL-D Wing Shape – From Patent
- Capable of Carrying a 1lb Payload
- Minimum Flight Speed: 25mph

SOLUTION



Structure

3 Piece modular design constructed from: Balsa, Foam, PLA, and Carbon Fiber.

Electronics

550KV motor and 70A ESC powered by a 25.2V 10,000mAh LiPo battery.

Payload

Pixhawk flight controller and FPV camera connected to a Raspberry PI with feature recognition to follow flight plans and loiter over objects of interest.

UAV Performance Results

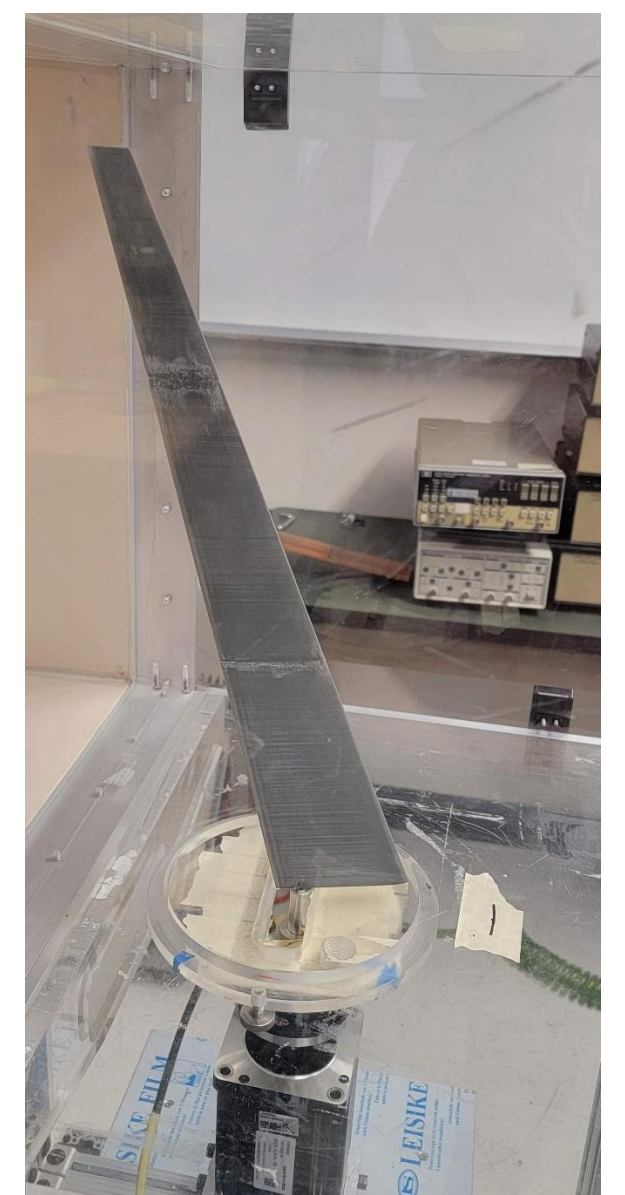
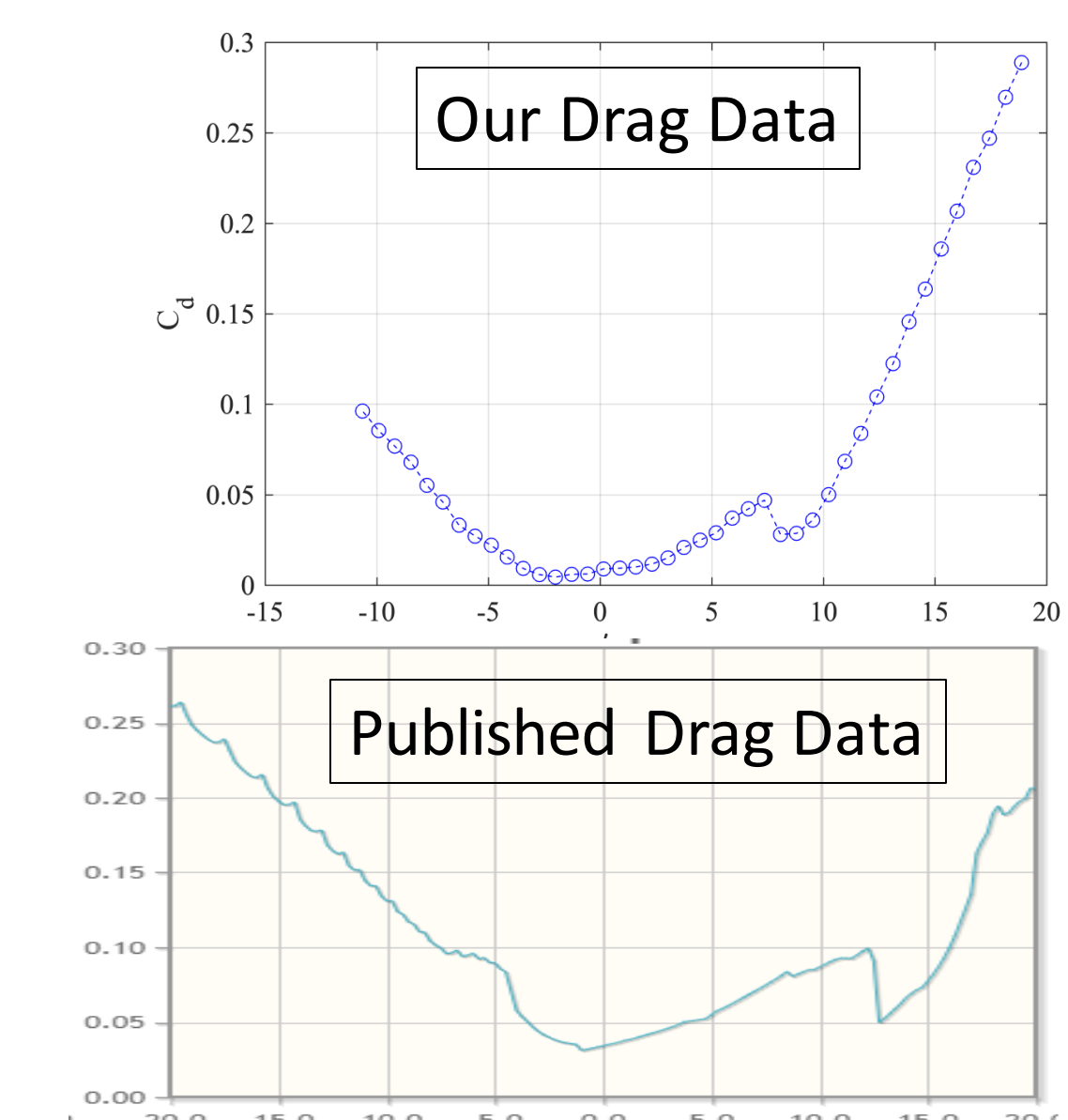
- Wingspan: 11.63 ft.
- Stall Speed: 25 mph
- Cruise Speed: 35mph
- Max Speed: 55 mph
- Endurance: > 45 min
- Climb Rate: 500ft/min
- Range: 30 mi.
- Max Thrust: 8 lbs.
- Max Weight: 10 lbs.
- Payload Capacity: 1.5 lbs.



VALIDATION

Applied Methods of Design Validation:

- CFD Simulations (FlightStream/SolidWorks)
- Wind Tunnel Testing
- Flight Testing (Glide and Powered)



CONCLUSIONS

The Prandtl-D wing design is commercially viable. The airfoil provides an excellent platform for a wide variety of UAV applications through increased efficiency, stability, and control simplicity.

Manufacturing of the wing is challenging, but with a female composite mold, it is greatly simplified and only needs solved once prior to mass production.

FUTURE WORK

- Construct and test alternate wing shapes
- Collect more data on aerodynamic performance
- Conduct wind tunnel test at higher Reynolds #'s
- Implement autonomous take-off

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2023 Capstone Project