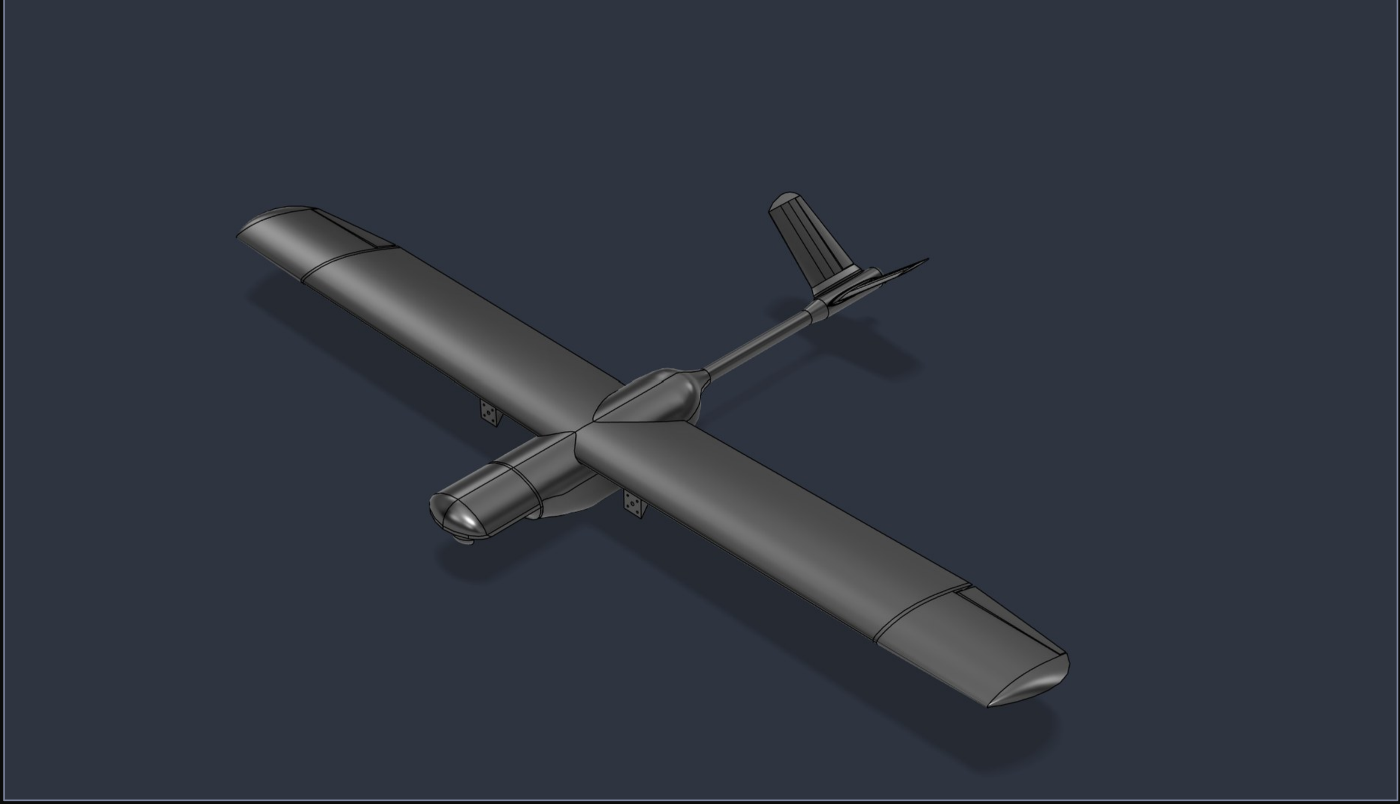
AEROSPACE & MECHANICAL ENGINEERING · DARTMOUTH '30

# Michael Znachonok

Engineering Portfolio

CAPSTONE UAV · FLIGHT-TESTED



Engineering student building and testing UAV hardware, CAD-driven prototypes, and flight-control software.

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Autodesk Fusion Certified User | Verify credential on Credly

PROJECT · CAPSTONE

COMPLETED · FLIGHT-TESTED

# Fixed-Wing UAV Capstone

Six-month high-school capstone | Led a three-person team | Design, fabrication, analysis, and flight testing

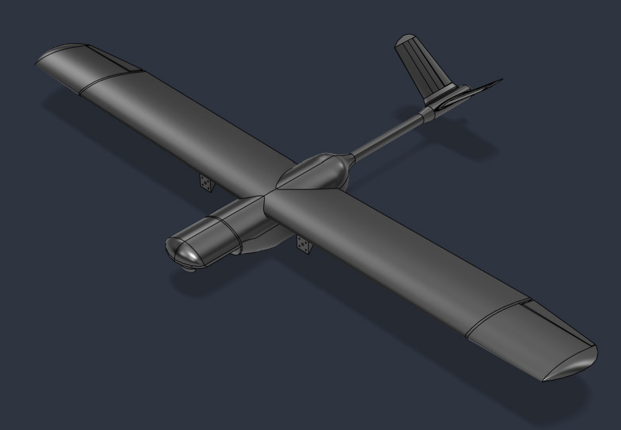
| SPAN | AIRFRAME | INTENDED PAYLOAD | AIRFOIL |
|---|---|---|---|
| **7 ft** | **~5 kg** | **~5 kg** | **NACA 4412** |

Designed and iterated a 7-foot-wingspan fixed-wing UAV with an approximately 5 kg airframe and an intended 5 kg camera-and-electronics payload. The airframe was built around a carbon-fiber rod with laser-cut balsa ribs and a vacuum-formed PETG skin, and the project closed with bench-thrust testing, spar-flex testing, and a short successful flight that met the capstone's test requirements.

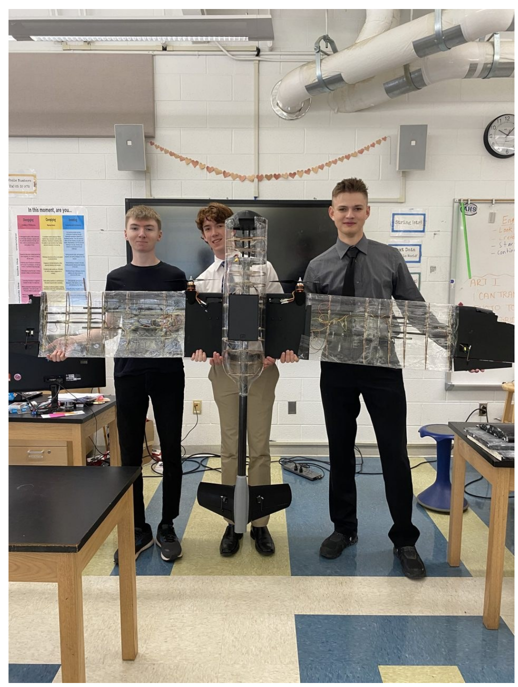
### What I made

- Designed the wings, electronics bay, and V-tail configuration.
- Modeled a four-piece snap-together 3D-printed V-tail with flexible TPU print-in-place hinges, plus 3D-printed wingtips.
- Used Autodesk CFD to compare lift and drag behavior and inform a wing extension, nose rework, and NACA 4412 airfoil selection.
- Built the vacuum formers and ran the forming of the PETG skin (see Vacuum Formers).
- Diagnosed a center-of-mass measurement error during testing and moved the wings forward to improve stability.

ISO VIEW · CAD

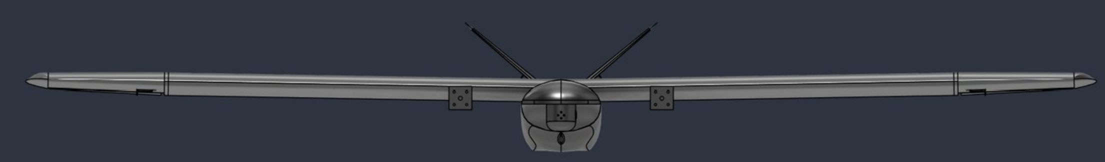


Capstone airframe CAD model.



The three-person team with the completed aircraft. **I'm on the far right.**

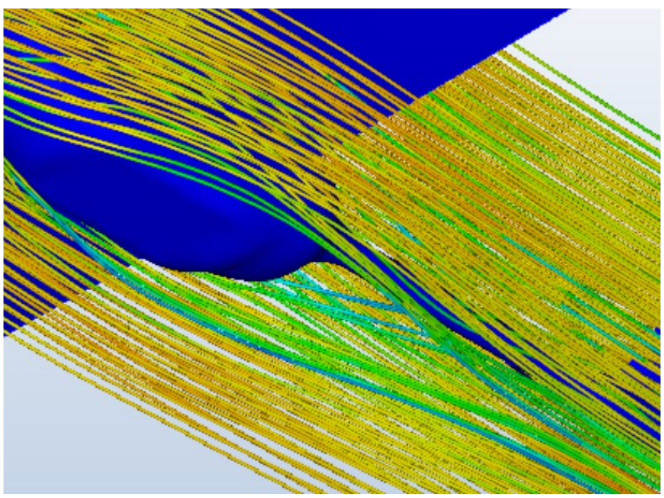
FRONT VIEW · CAD



Capstone airframe, front view.

## Engineering decisions

I used Autodesk CFD to simulate the airframe in flight and find the magnitudes of the force vectors acting on it, and used those results to make the necessary adjustments: a wing extension, a reworked nose, and selection of the NACA 4412 airfoil. A center-of-mass instability found in testing was corrected by moving the wings forward. The project ended after meeting its capstone flight requirement and was not extended into a longer flight-test campaign.



Autodesk CFD streamlines.

Summary

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Total area, 19740.8, cm^2
TOTAL FX, 0.107715, Newton
TOTAL FY, 28.917, Newton
TOTAL FZ, 138.03, Newton
Center of Force about X-Axis (Y-Z), 202.023, -3.05033, cm
Center of Force about Y-Axis (X-Z), -0.365997, 2.17393, cm
Center of Force about Z-Axis (X-Y), -0.0420955, 217.821, cm

Autodesk CFD force summary.

PROJECT · CAPSTONE TOOLING

COMPLETED · BUILT & USED

# Vacuum Formers

Built for the capstone UAV | Machine design and build, heater circuit, mold-making process, and forming

| FULL SIZE | PROTOTYPE | HEATER LIMIT | VACUUM |
|---|---|---|---|
| **2 × 4 ft** | **18 × 18 in** | **10 A @ 120 V** | **Shop vac** |

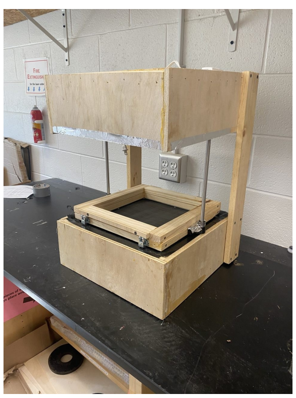
Full-size former: foil-lined heater box above the 2 × 4 ft forming bed.

I built two vacuum formers to make the capstone UAV's transparent PETG skin in-house. The full-size machine forms 2 × 4 ft PETG sheets. Its heating element is an array of heating elements salvaged from toasters, and I did the circuit math so the array draws at most 10 A and runs on a standard 120 V outlet.

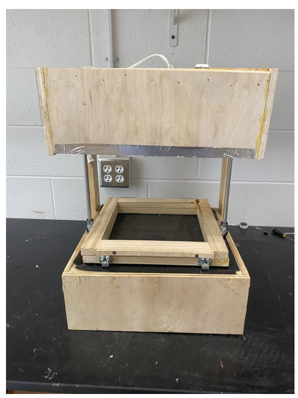
While the full-size machine was being built and tested, I built an 18 × 18 in prototype. It served as a science-fair demo and as a test bed for fine steel mesh in place of pegboard; the forming surface was then switched to steel mesh. Both machines use a shop vac for suction.

### What I made

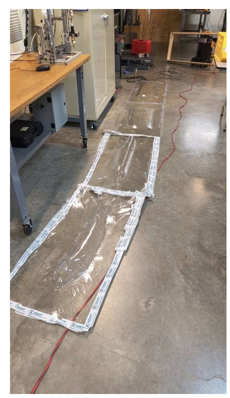
- Built both formers and designed and tuned the heating element.
- Designed the mold-making process and carried out the vacuum forming.



18 × 18 in prototype.



Prototype, front view.



Formed PETG skin sheets.

| Independent Variables | | | | | Dependent Variables | | |
|---|---|---|---|---|---|---|---|
| Version | Vecuum Surface | Plastic Used | Mold Design | Plastic Lower Method | Form Quality | Degree of Mold Degradation | Form Consistency |
| Prototype1 | Peg board | PVC | 3D print | Manual, unsupported | Med | High | Med |
| Prototype2 | Peg board | PVC | 3D print plaster fill | Manual, unsupported | Med | Low | Med |
| Prototype3 | Peg board more holes | PETG | 3D print plaster fill | Manual, unsupported | Med | Low | Med |
| Prototype4 | Peg board more holes | PETG | 3D print plaster fill | Manual, unsupported | Med | Low | Med |
| Final | Steel mesh | PETG | 3D print plaster fill | Manual, supported | High | Low | High |

Vacuum-forming iteration matrix.

PROJECT · INTERNSHIP

CLIENT WORK · COMPLETED

# Smithsonian Hubble Replica for FDM Assembly

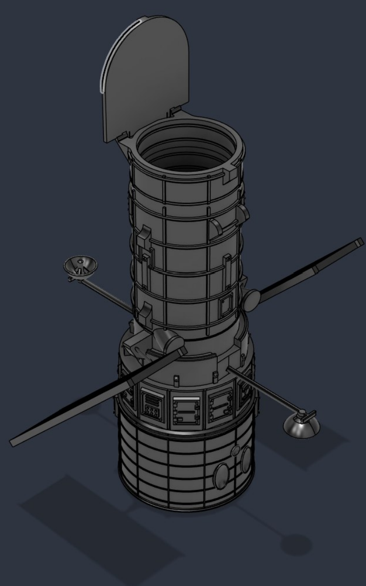
Monster Fight Club, LLC | Computer-Aided Design Intern | Smithsonian Air and Space Museum client

During a full-time CAD internship, I independently created or substantially reworked 12 Fusion 360 models of ground- and space-based telescopes and related components for hands-on museum displays. This Hubble Space Telescope replica is one approved example.

### Design-for-manufacturing responsibilities

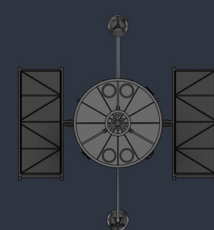
I translated reference images, dimensions, and available 3D scans into manufacturable CAD; defined part splits, assembly approach, tolerances, print orientation, and surface details; then personally sliced, printed, assembled, test-fit, and revised designs. The release packages let museum staff print replacement parts and let students or teachers download, print, and assemble them with minimal support removal or slicer-setting changes.

ISO VIEW · FUSION 360



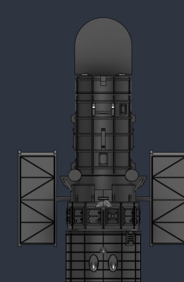
Hubble replica, isometric view.

TOP VIEW · FUSION 360



Top view.

FRONT VIEW · FUSION 360



Front view.

These rendered views and the factual description are approved for disclosure. Underlying .f3d files, source scans, and other client material are not included.

PROJECT · SOFTWARE

INDEPENDENT PROJECT · SOFTWARE

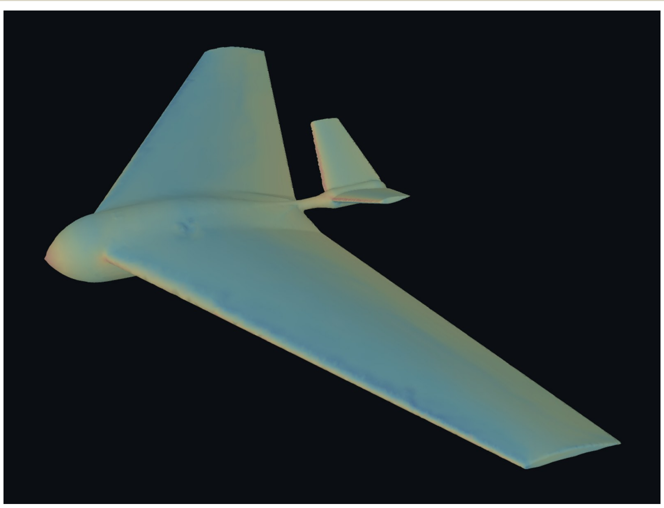
# OpenFOAM CFD Simulation GUI

Independent project | Design and implementation

| FLOW | CONDITION | CASE |
|---|---|---|
| **50 m/s** | **Sea level** | **Incompressible** |

Developed and tested an AI-assisted GUI for STL-based OpenFOAM simulation setup, configurable multi-core runs, and interactive 3D visualization of surface pressure and streamlines. I used it to analyze my Fusion-designed flying-wing concept UAV at sea level and 50 m/s in an incompressible case, reviewing pressure distribution, lift/drag behavior, and integrated X/Y/Z surface-force components.


The GUI's 3D view: surface pressure coefficient on the analyzed aircraft.



Surface-pressure render of the analyzed aircraft.

### What I made

- Developed and tested the STL-based simulation setup and configurable multi-core run workflow.
- Developed and tested the interactive 3D visualization of surface pressure and streamlines.
- Ran and reviewed an incompressible case at sea level and 50 m/s.

PROJECT · PERSONAL

COMPLETED · 3D-PRINTED PROTOTYPE

# Opposed-Output Gearbox

Personal mechanism-design project, 3D-printed and built as a working prototype

Designed a gearbox that transfers rotation from one input shaft to two output shafts rotating in opposite directions. The design uses a removable housing and an internal gear train that can be inspected through a sectioned CAD view, and the completed design was 3D-printed and built as a prototype, and it worked well.

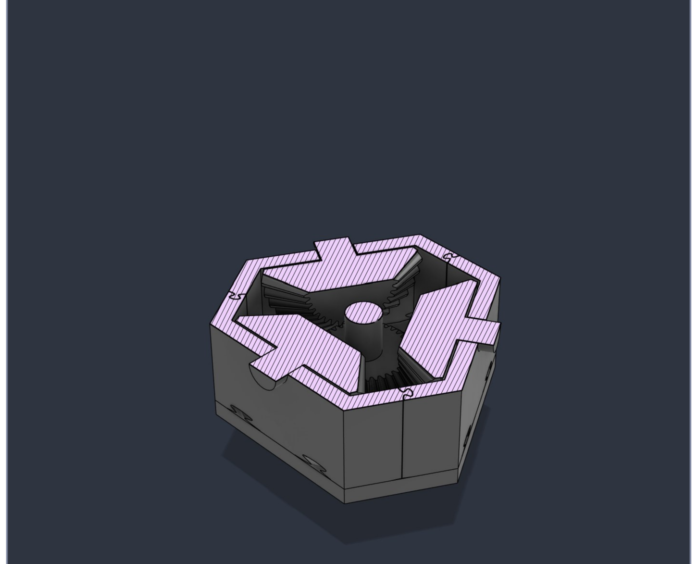
### What the views demonstrate

The exterior view documents the housing and shaft interfaces. The sectioned view shows the internal gear-train arrangement.

ISO VIEW · CAD

Exterior housing and shaft interfaces.

SECTION VIEW · CAD



Sectioned view of the internal gear train.

### Technical toolkit

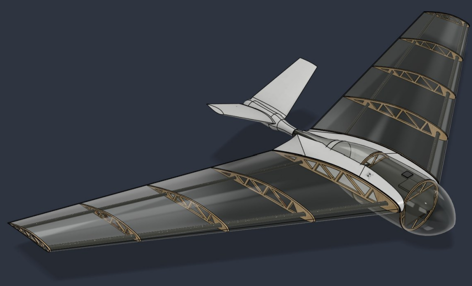
Autodesk Fusion 360 | Autodesk CFD | OpenFOAM | CAD/CAM | FDM and resin (SLA) 3D printing | Bambu Studio | vacuum forming | laser cutting | Python | C++ | MAVLink telemetry

PROJECT · PERSONAL

# Additional Design Studies

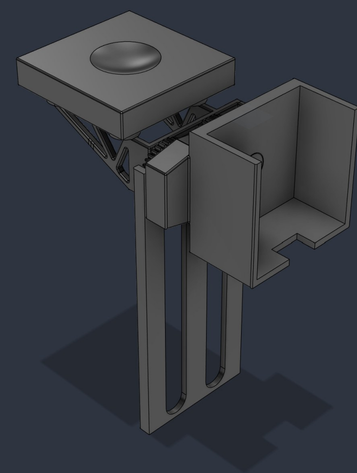
Independent personal design work

ISO VIEW · CAD



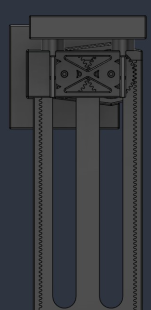
Personal fixed-wing UAV. This was a CAD and CFD study that has not yet yielded a constructed prototype.

ISO VIEW · CAD



Stepper-motor-powered rising platform, 3D-printed, built, and operated as intended.

FRONT VIEW · CAD



Rising platform, front view: paired rack geometry and internal gear interface.

**Rising platform**
This project is presented as a CAD mechanism design for stepper-motor actuation. It demonstrates housing layout, rack-and-gear geometry, and the elevated platform configuration.

**Personal UAV concept**
This was an exploration into designing a longer-range, more cost-efficient UAV, designed in CAD and then tested with simulation software.