COLIN DUFFY
ENGINEERING PORTFOLIO

Skilled Generalist Mechanical Engineer.

Specialization is for insects!

ABOUT ME

From **Omaha, Nebraska** (Go Big Red!)

BS, MS Mechanical Engineering @ USC

CURRENT: Mechanical Engineer @ Lumindt:
abundant long duration energy storage

Avid surfer, reader, musician when OOO

Past internships @ **Virtual Incision** *(surgical robotics)* + **NovaSignal** *(neural imaging)*

Mechanical Engineer @ Lumindt: *a license to build*

Scrappy, do-it-all engineer owning unit storage cell for long-duration energy storage startup!

- **Scale-up:** lab-scale → mid-size → production
- Prod QTY 150; 5”⌀ x 20’ L; 750lb; 60kWh ea.
- ***Critical and Comprehensive Testing Campaigns!!!***

Critical Support Structures: **FEA** + **Fabrication**

Parts: **sheet**, **CNC**, **ceramics**, **extrusion**, **plastics**

Custom **Tooling** and **Jigs**

Weld Procedure Definition, Qualification, Proof, NDE

Top: x3 production vessel stack
Bottom: Exothermic Charge, Endothermic Discharge

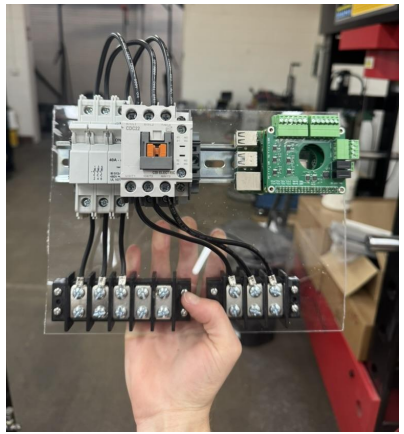
Mechanical Engineer @ Lumindt: *a license to build*

Other Responsibilities + Side Quests

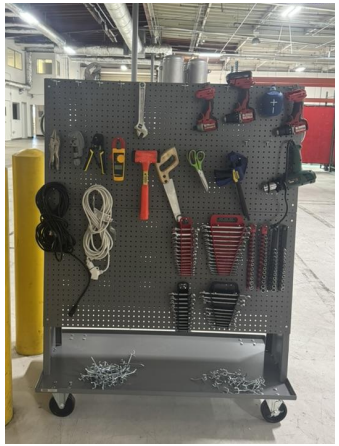
- Many Custom **Test Benches: Experimental Design + Automation**
- Electrochemical Salt Reactor Design/Build - **Corrosive Environment**
- Bespoke **High-Power Kiln** design
- Exploring 2ax **TIG welding robot**

Self-Fixturing Weldments

Salt Reactor



High-Power Distributor



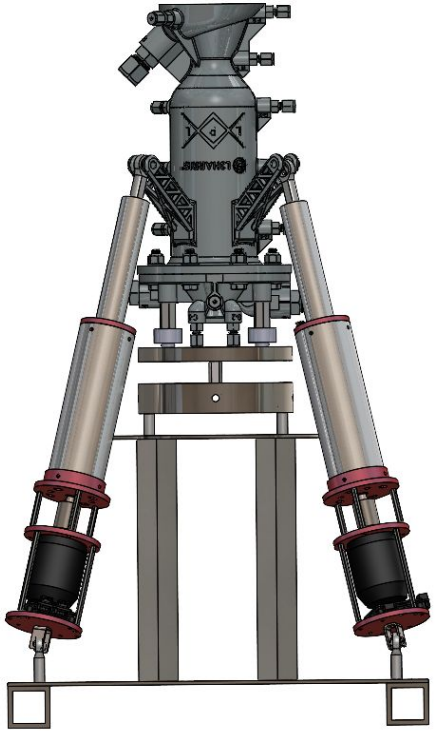
New Office Setup

Water-Cooled Vessel

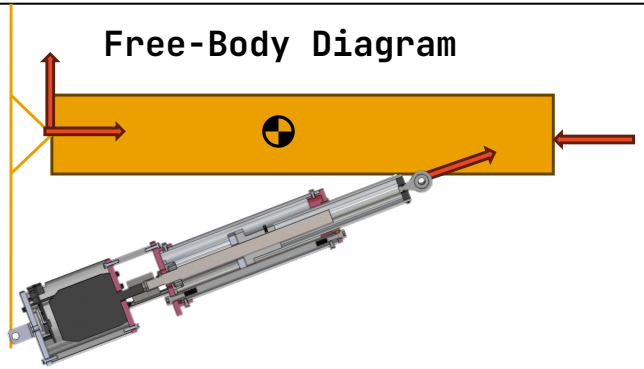
Introduction: Thrust Vector Control RE

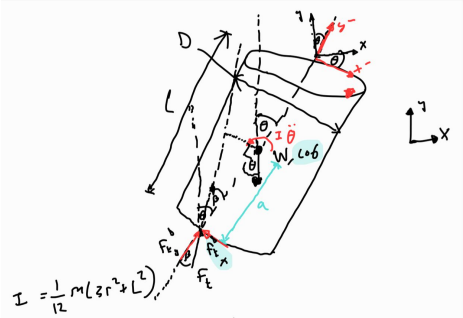
Led small + scrappy team (4) to design VTVL hopper flight-quality stabilization system in 10 weeks!

- System architecture, project planning
- **Owned design of $300 actuators** exceeding performance of $3000 OTS comparison
- Streamlined **pad integration** w/ integrated thrust structure
- Manufactured parts w/ variety of methods + **machine shop tools**
- **Managed** controls, MFG, EE engineers!



Kinematics + System Sizing





Hopper dynamic model

→ solve min θ’ required for flight stability

→ convert to linear actuator speed

0.5 rad/s || 5 in/s

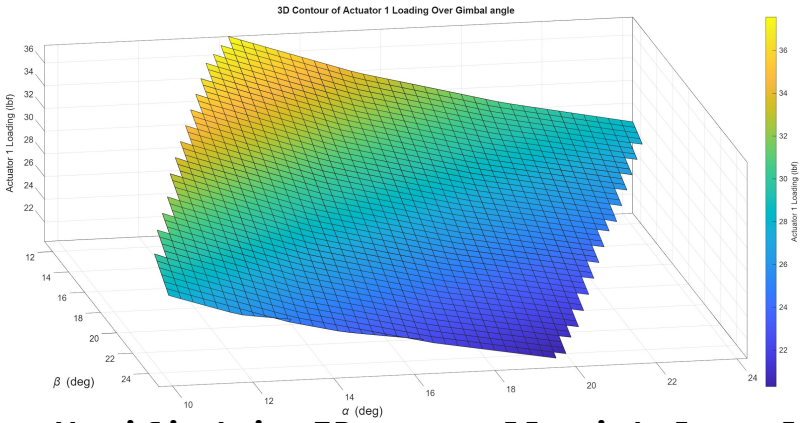
Equilibrium Equation, solve for F_A, R_Gx (actuator axial load, gimbal thrust load)

$$\sum F_x = F_A \cos\alpha - T + R_{Gx} = 0$$

$$\sum F_y = F_A \sin\alpha - Mg + R_{Gy} = 0$$

$$\sum M_G = F_A l_{GAx} \sin\alpha - Mg\, l_{CG} + F_A l_{GAy} \cos\alpha = 0$$

F_A = 21.12 lbf | **R_Gx = 685 lbf**

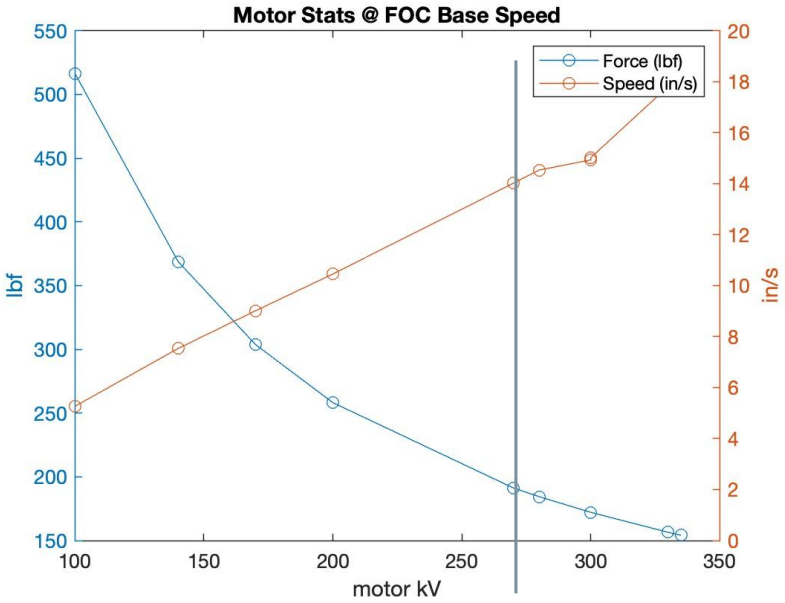


Engine mass moment, not thrust, drives loading!

Verified in 3D over all gimbal angles

BLDC Sizing // Field-Oriented Control

Goal: Spec a BLDC from motors available on Amazon



15.5 in/s

191 lbf

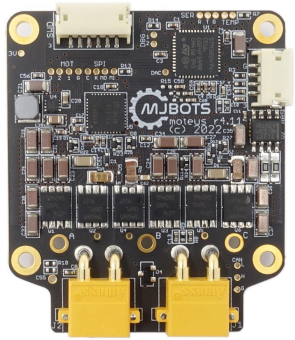
270KV: Large FoS for forwards-compatibility

Why Field-Oriented Control?

- Fast Acceleration
- High torque @ low speed

270 Kv Motor Specifications

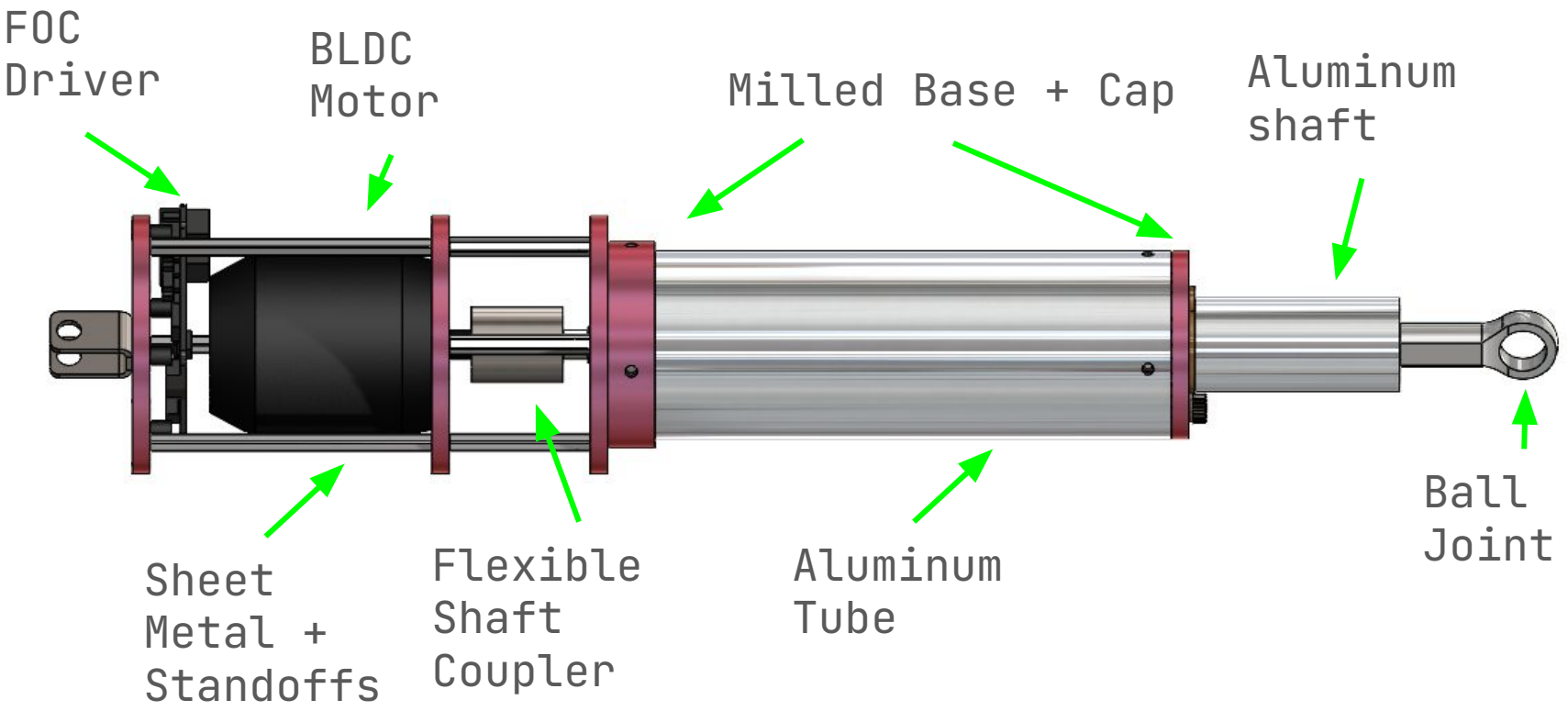
- Torque: 0.665 N/m
- Max current: 80A



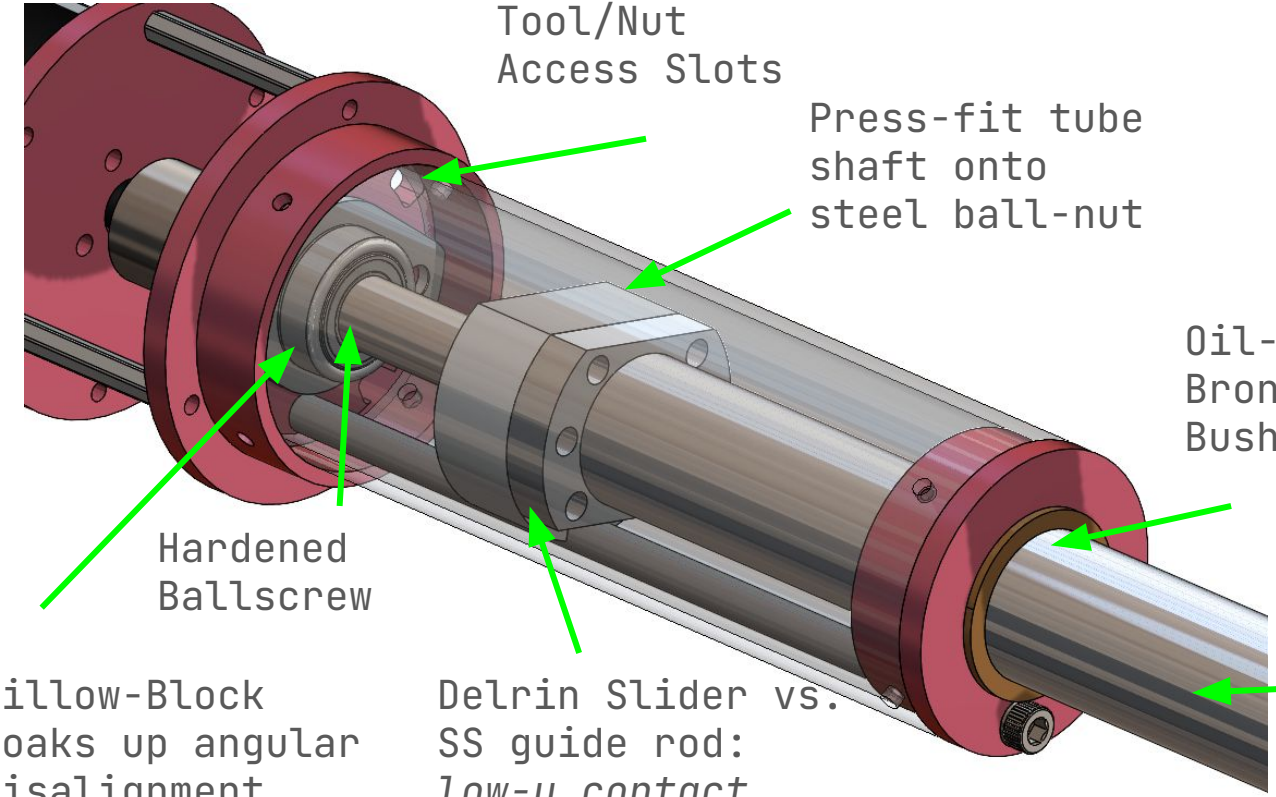
Moteus Motor Controller

- 3-phased FOC driver (500W)
- Strong Open-Source Community

Anatomy of an Actuator



Anatomy of an Actuator pt.2: *smooth linear motion*



Tool/Nut
Access Slots

Press-fit tube
shaft onto
steel ball-nut

Oil-filled
Bronze
Bushing

Hardened
Ballscrew

Pillow-Block
soaks up angular
misalignment

Delrin Slider vs.
SS guide rod:
low-μ contact

Aluminum tubing
shafts provide
rigidity, controlled
OD

GOAL: avoid overconstraint, stay simple!

Copious amount of grease

Articulated Gimbal Ring

Waterjet rings + McMaster ball-joints

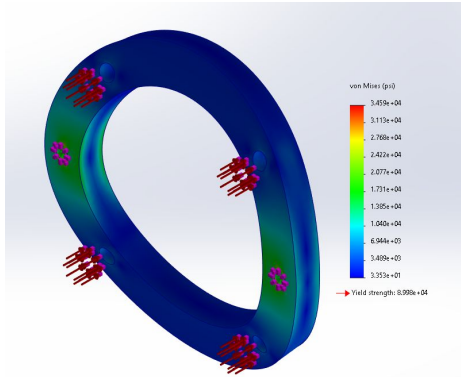
Ring-shaped for axial hose pass-thru

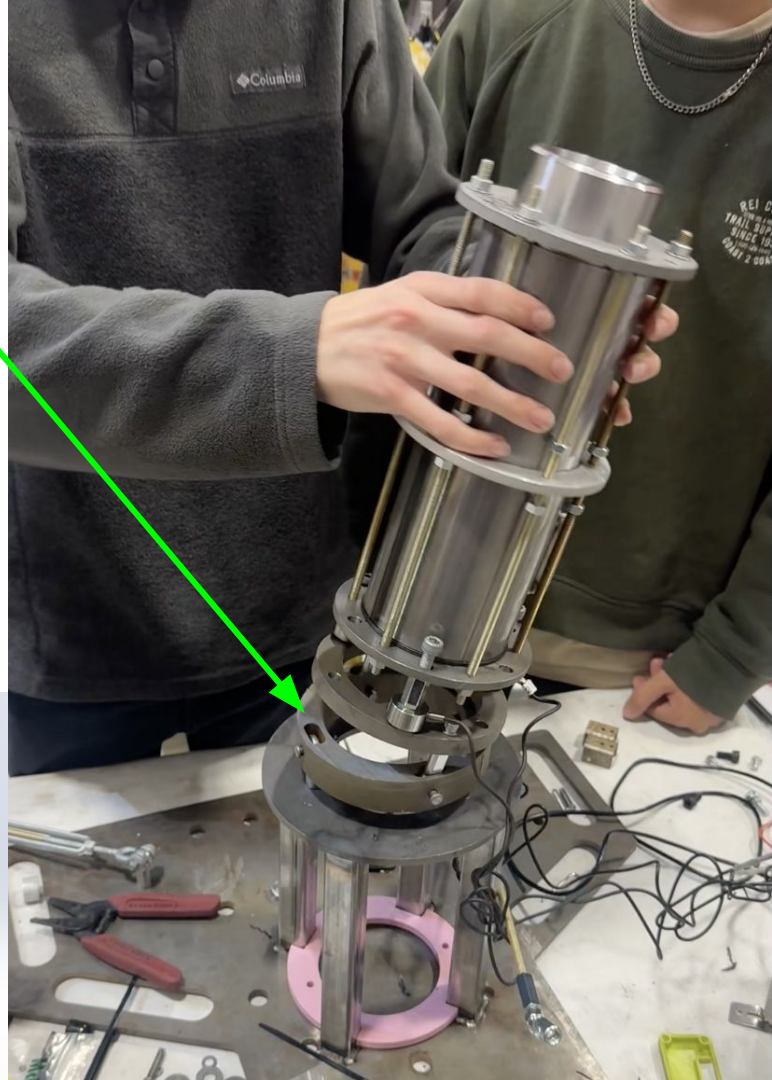
Load cells between engine and gimbal ensure clean thrust reading

Guaranteed 12° of XY gimballing

Easy setup + teardown

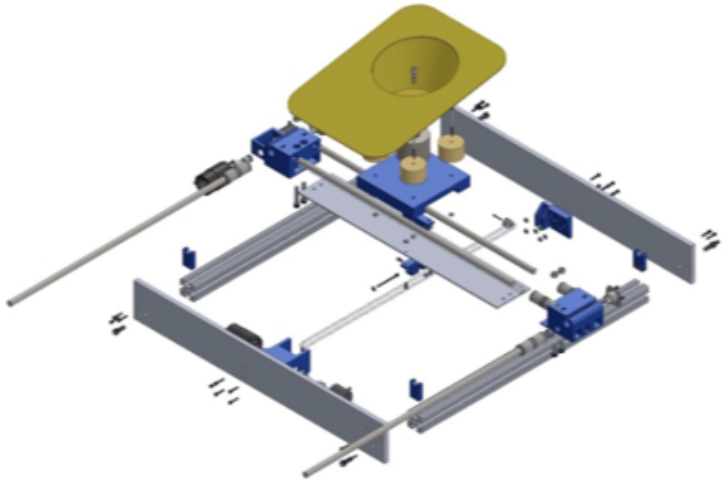
Made from scrap stock!

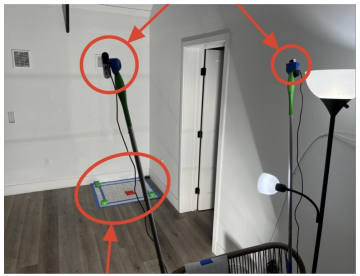


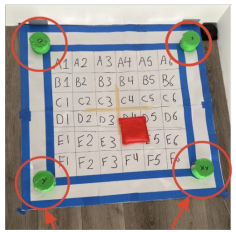


CAD’s cool, but there’s nothing like watching your team’s hardware rock IRL!

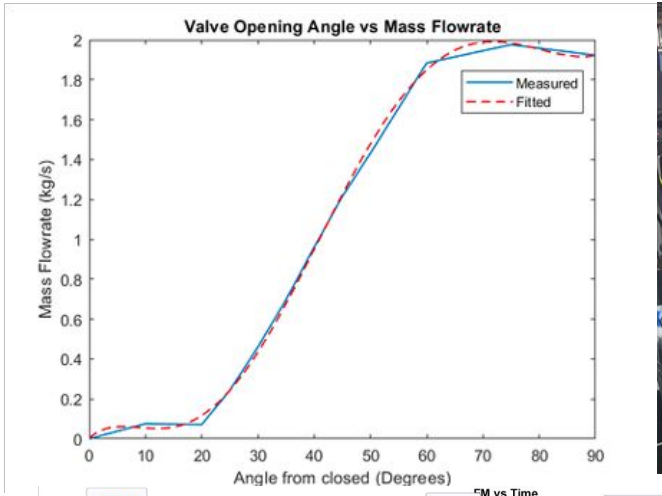
Other Projects

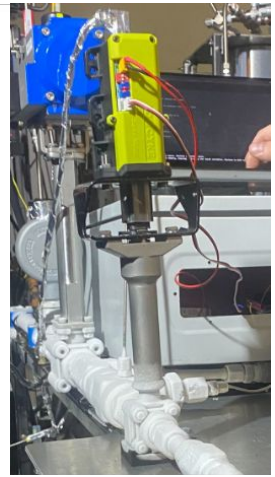


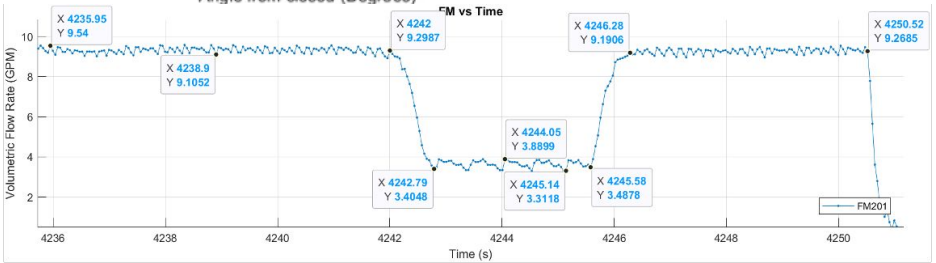




Stereoscopic Vision Beanbag-Catching Robot







USC LPL: Closed-Loop Throttle Valve Control

Making Beyond Engineering *(even when it's not, it's always engineering)*

Hand-shaped + glassed surfboard reclaimed from broken board (composite layup process)

Goes like a dream!

Laser-engraved redwood coasters

Hand-embroidered pants

PEAKS & PROFESSORS

President of USC's largest outdoors club, led team of 50

Giant shark parade float for local middle school

Bonus: Noriega Dunes Autonomous Filmer

Pursuit of beautiful, functional technology

Project Overview

Aug 2025 - present:

I want surfing clips of myself + friends. There's an existing product, but it has this bulky wearable and costs $1500.

I will do better.

Goal: make something **beautiful + functional under Industrial Design constraints,** provided by friend Jackson Rench (Eight Sleep)

It will be so cheap and easy I won't feel bad if it gets stolen from the SF dunes while I surf

Project Roadmap

Wearable PCB 1 - functional prototype

DONE

Wearable Housing V1 CAD - fit PCB 1

DONE

Board Bring-Up

IN PROGRESS

Camera Housing CAD + PCB

IN PROGRESS

Wearable PCB 2 + Housing 2 Co-Design

Final Product Test

wearable durability testing (surf hours in ocean)

Kelp Head-influenced camera base concept

Mixed-Signal Board Design

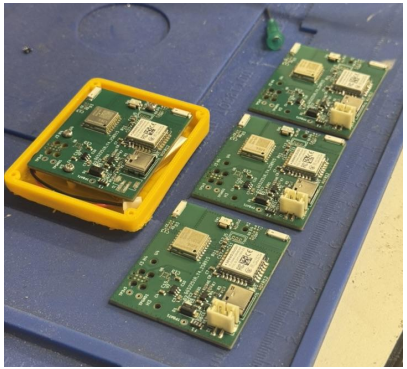
Goal:

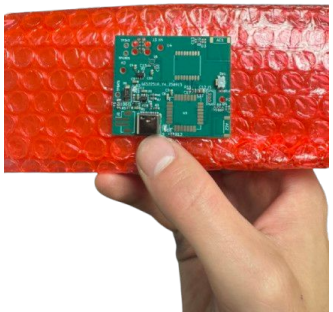
- Use sensor fusion to track bearing of surfer.
- Transmit over LoRa protocol to base station

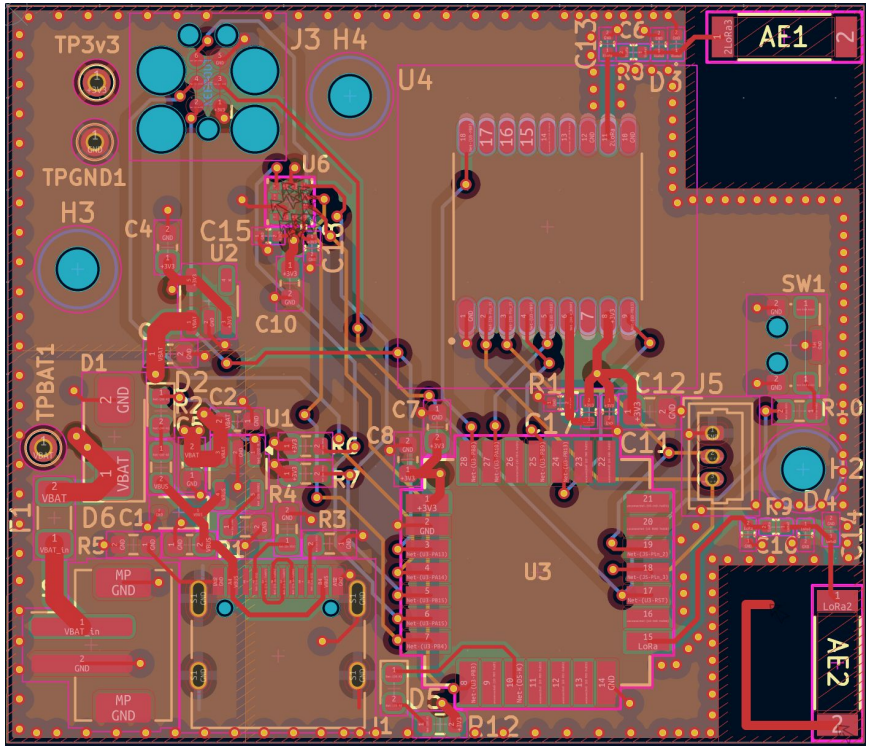
Stats:

40 x 45mm outline
2x RF antennas
Battery mgmt circuit
GPS, IMU, STM32
Hand-soldered QFPs

Next rev half-size!





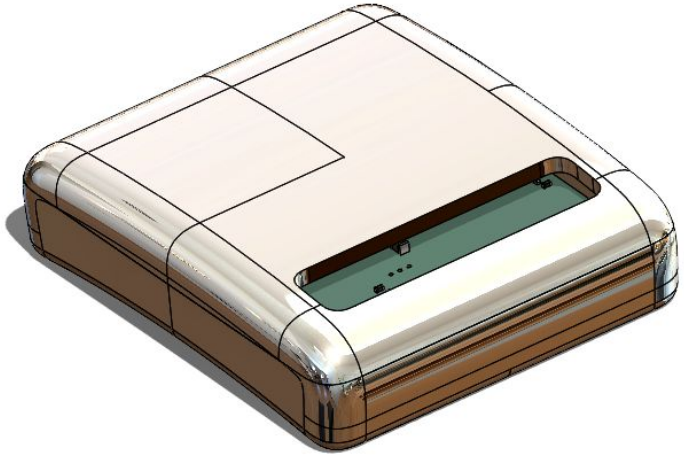


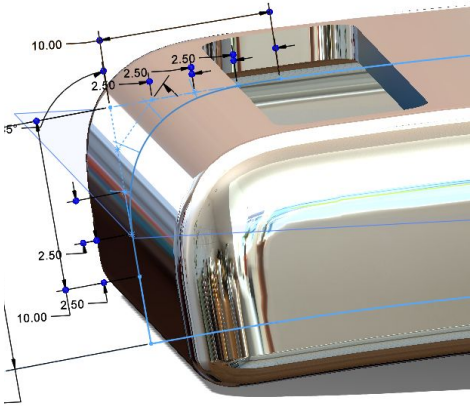
Layout: note RF grounding + keepouts for integrity, Pi-pad for antenna tuning. Hand pic for scale

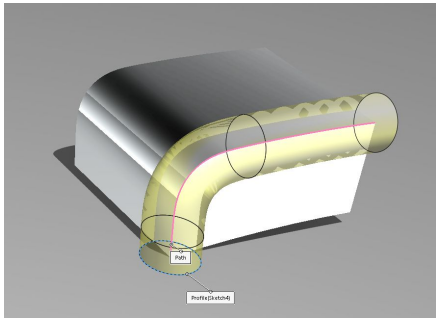
Designing with ID Constraints

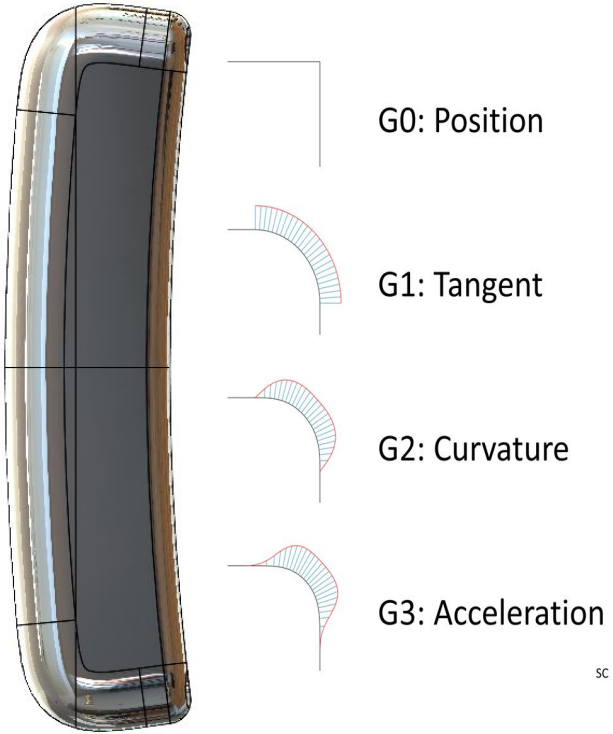
(how Colin finally learned surfacing)

Given G2+ ID concept, add functional features (RF window, PCB mounts, o-rings, screw bosses/ holes)









1. *Design + validate housing around PCB*
2. *Shrink housing → design new PCB to fit*