# COLIN DUFFY ENGINEERING PORTFOLIO

# ABOUT ME

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

**BS, MS Mechanical Engineering** @ USC

Liquid Propulsion Lab Alum *(where I cut my engineering teeth)*

**CURRENT:** Mechanical Engineer @ Lumindt: cheap long duration energy storage

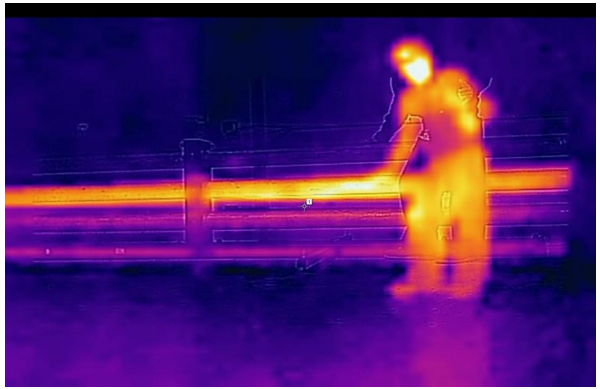
Avid surfer, reader, musician when OOO

Likes sheet metalling (*verb*), dislikes lead times

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

# Mechanical Engineer @ Lumindt - San Francisco CA

- RE for energy storage cell for 5 MWh product!
  - Owns Pressure Vessel Design and MFG
    - QTY = 150; 5”∅ x 20’ L, 750lb, 60kWh ea.
  - Critical and Comprehensive Test Campaigns **!!!**
  - Support Structures FEA + Fabrication
  - Parts: sheet, CNC, ceramics, extrusion, plastics
  - Custom Tooling and Jigs
  - Thermal Management Subsystem + Analysis
  - Weld Procedure Definition, Qualification, NDE
  - Supplier interface + management
- Other Responsibilities + Side Quests
  - Many Custom Test Benches + Automation
  - Electrochemical Reactor Design + Build + Test
  - Hacking anything - kilns, CANBus,
  - Exploring 2-ax TIG welding robot

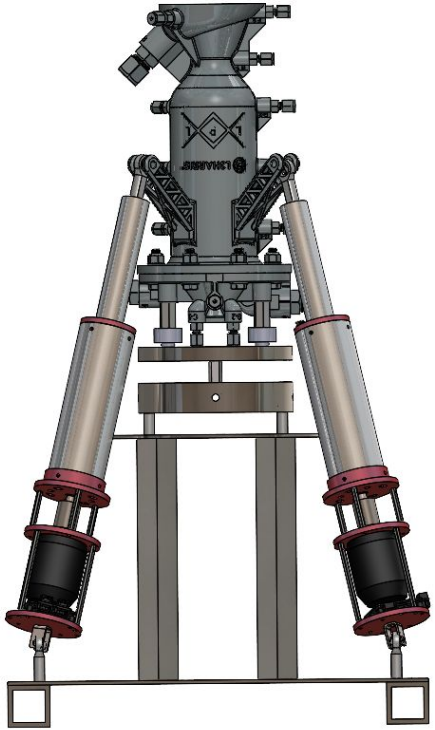


***Exothermic Charge, Endothermic Discharge***

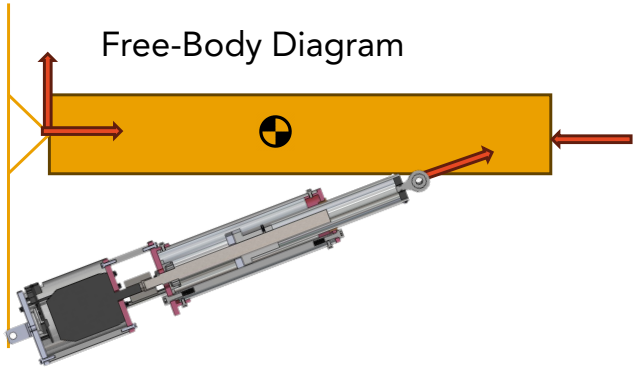
# RE: Thrust Vector Control System

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

- Owned design of $300 actuators exceeding performance of $3000 OTS comparison
- Streamlined pad integration w/ integrated thrust structure/gimbal/load cell setup
- Manufactured parts w/ variety of methods
- Managed controls, MFG, EE engs!
- 10 weeks from clean-sheet to finished system
- Validated at hot-fire (post-handoff)



# Kinematics + System Sizing




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

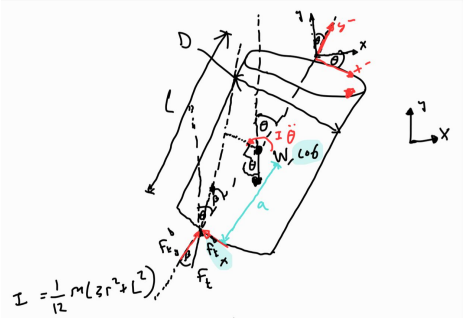
$$\sum F_x = F_A \cos\alpha - T + R_{Gx} = 0$$

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

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

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

Engine mass moment, not thrust, drives actuator loading!

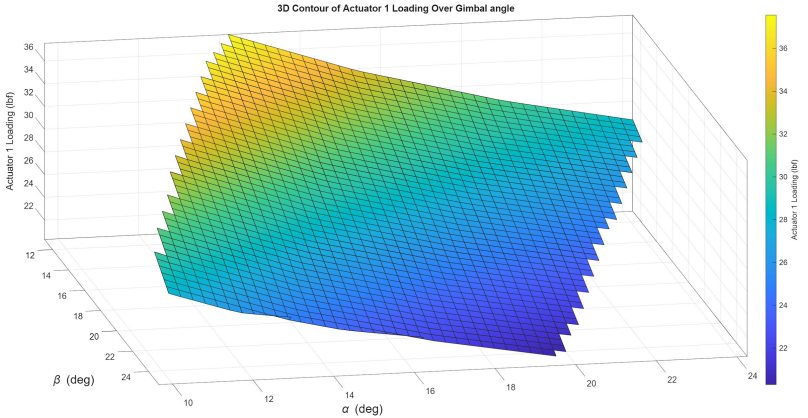


*Hopper dynamic model*

→ solve min θ’ required for stability

→ convert to linear actuator speed

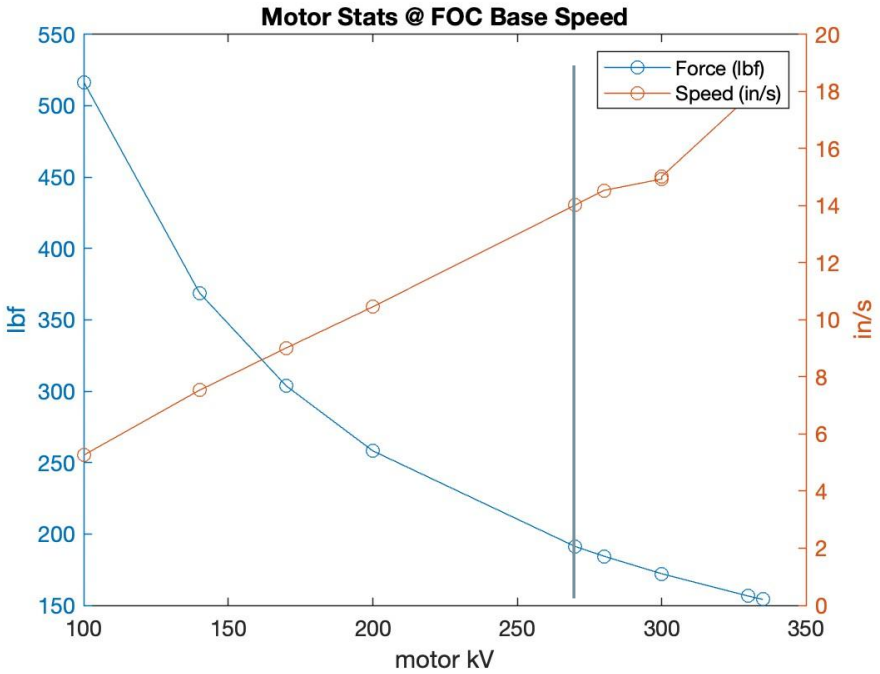
**0.5 rad/s || 5 in/s**




Verified loading in 3D over all gimbal angles

# BLDC Sizing + Field-Oriented Control

## Goal: Choose BLDC from a selection of motors available on Amazon



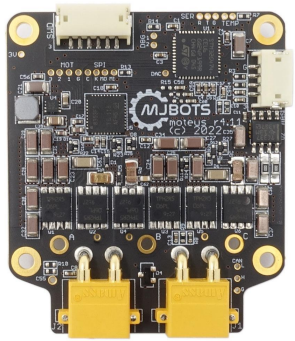

**15.5 in/s**

**191 lbf**

***Large FoS for forwards-compatibility***


**270 Kv Motor Specifications**

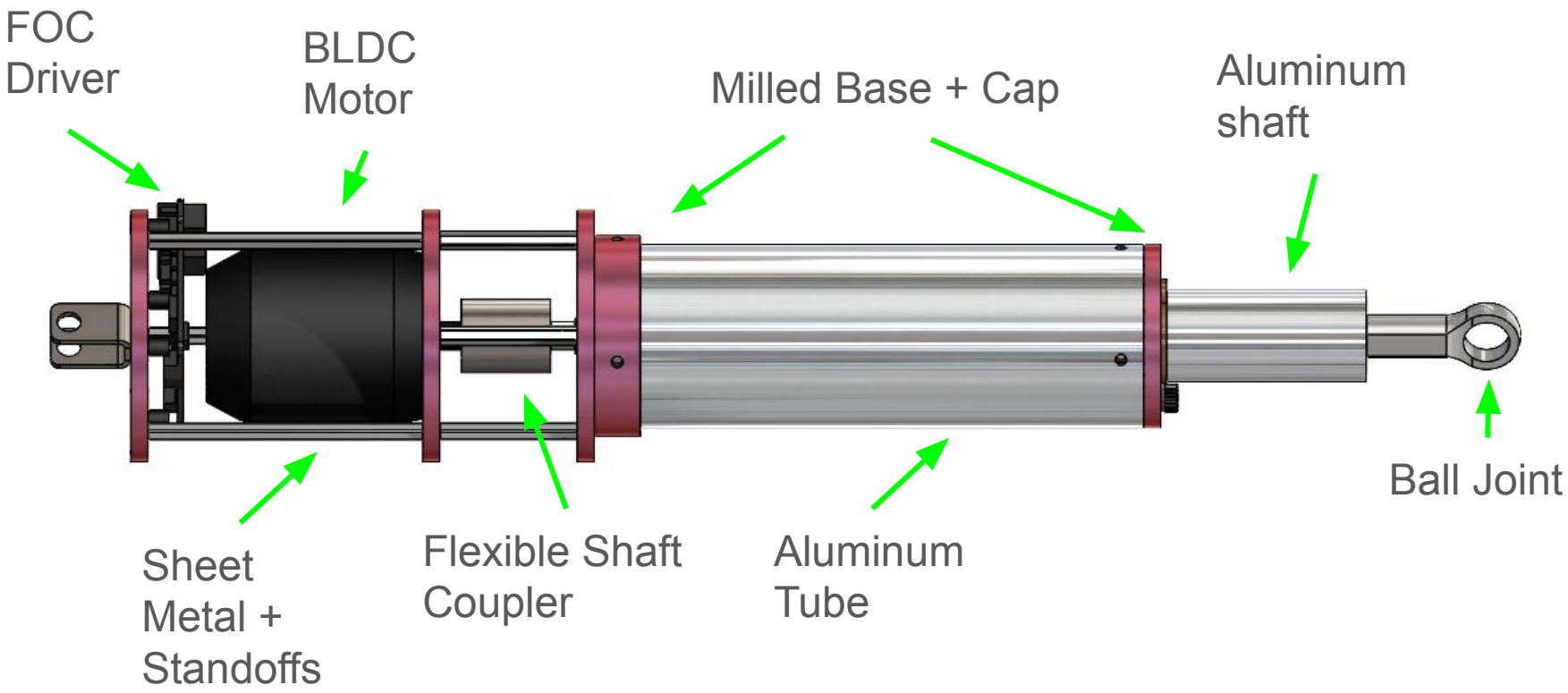
- Torque: 0.665 N/m
- Max current: 80A
- Price: $50



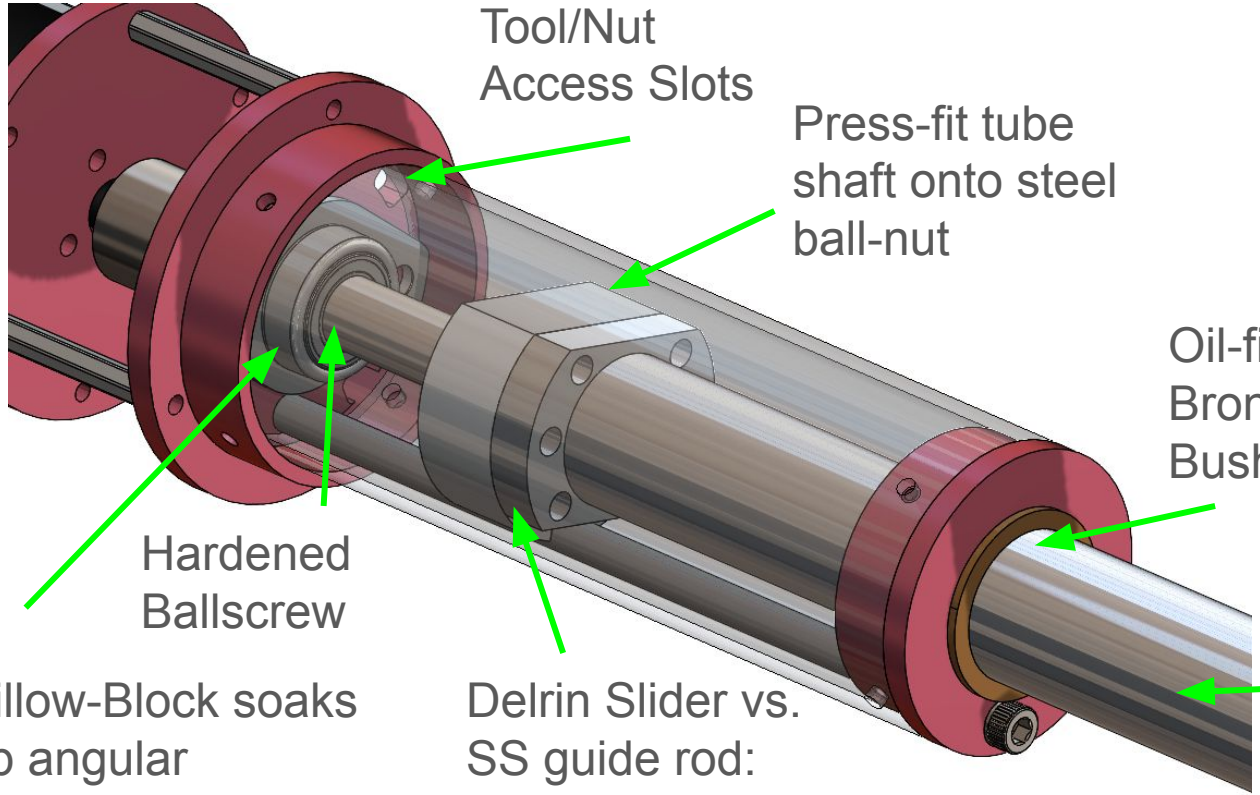

**Moteus Motor Controller**

- 3-phased FOC
- Strong OS Support Community
- Price: ~$100

# 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

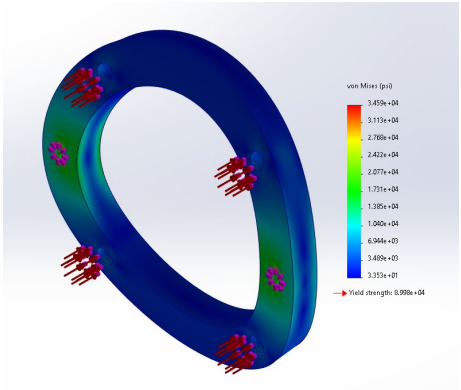
Load cells between engine and gimbal ensure clean thrust reading

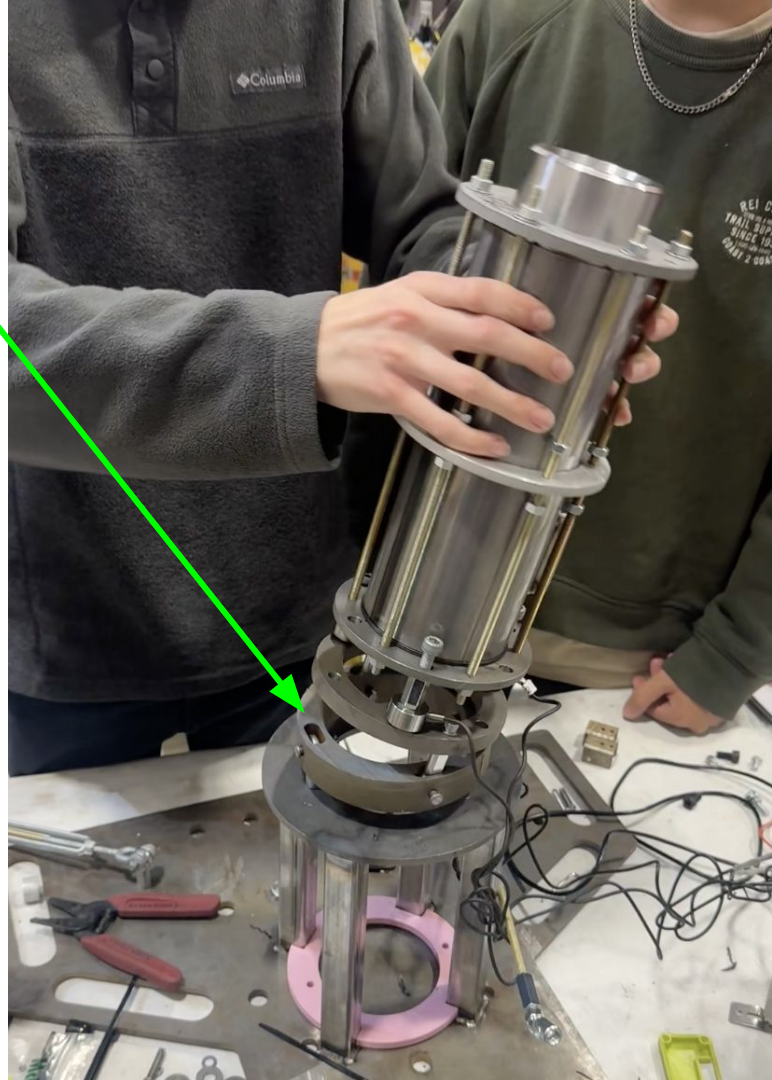
Guaranteed 12º of XY gimballing

FEA check passed

Easy setup + teardown

Made from scrap stock!



*CAD is cool, but there's nothing like watching your team's hardware rock in real-life!*

# 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 Auto-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 → Board Bring-Up → Wearable Housing V1 CAD - fit PCB 1 → Camera Housing CAD + PCB → Wearable PCB 2 + Housing 2 Co-Design

Final Product Test

→ wearable durability testing (surf hours in ocean)

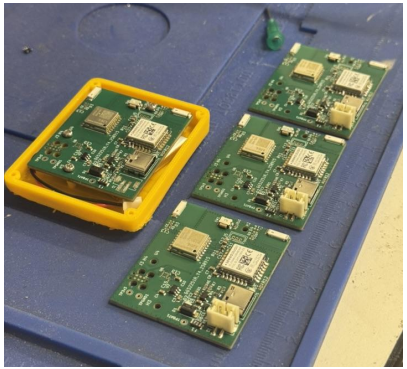
***Kelp Head-influenced camera base concept***

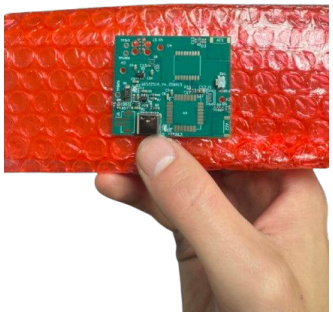
# Mixed-Signal Board Design

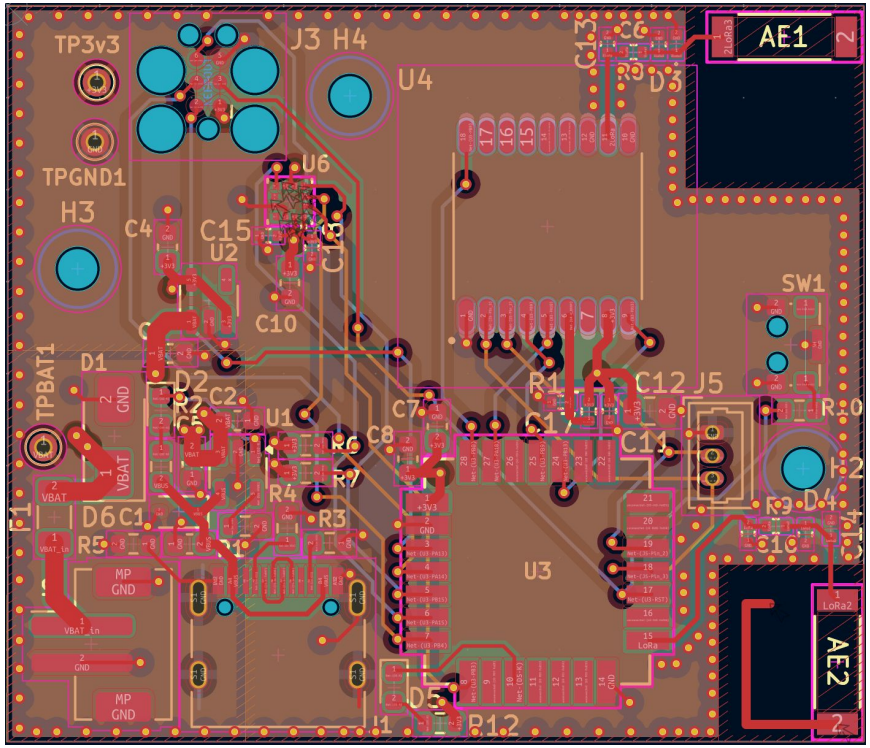
**Goal:**
Use sensor fusion to track bearing of surfer
Transmit over LoRa protocol to base station

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

***Next rev half-size!***





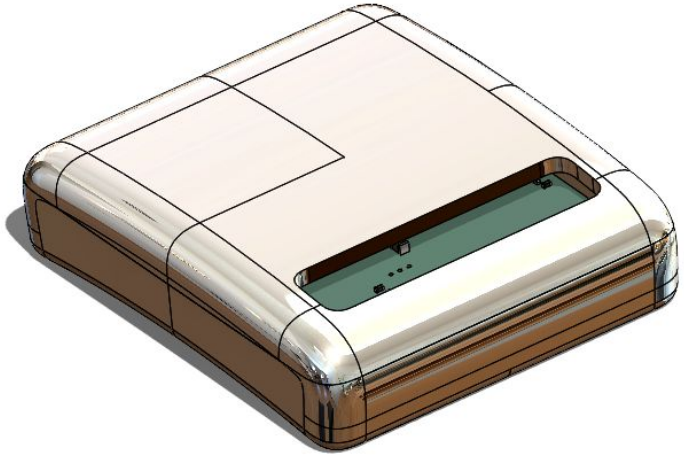


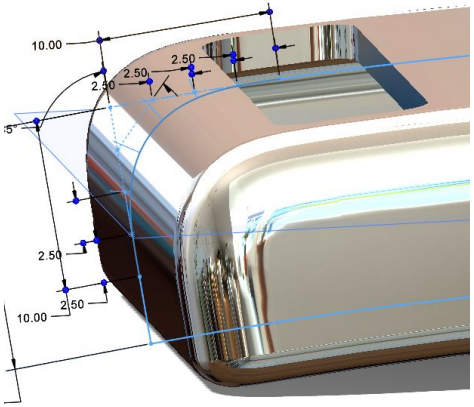

***Layout: note RF grounding + keepouts for integrity, Pi-pad for tuning. Hand pic for scale***

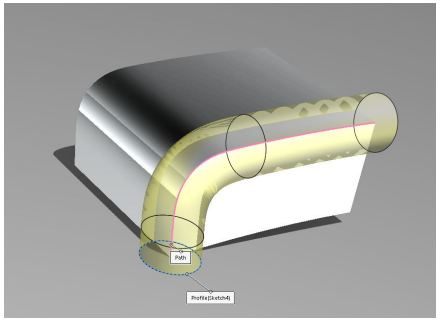
# Designing with ID Constraints

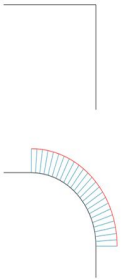
*(how Colin finally learned surfacing)*

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





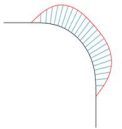





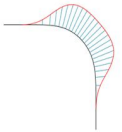
G0: Position



G1: Tangent



G2: Curvature



G3: Acceleration

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