# Nathan Kadria

Portfolio

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# About Me

I've been an engineer my whole life. As early as I can remember I've been taking things apart and trying to learn how everything works. When I was young, I was taking apart RC cars, now I enjoy working on the full sized ones - I love cars, motorcycles, and everything in between. I'm also obsessed with machines, from 3D printers to lathes to wire EDM machines.

I have two years of experience in Mechanical Engineering roles, most of which have been fast-paced prototyping environments. I'm a quick learner, and my motto is that there's always a way to get the job done. I've worked at Greensight, Orbis, Instron, and Draper.

I'm looking for full time work, especially in automotive, automation, aerospace, machining, motorsports, and additive manufacturing fields. I'm open to work anywhere that has interesting problems to solve, as long as they're not defense related!

Me and my '03 Honda CBR600RR at a track day

# WeatherHive Drone Silo (Greensight)

Requirements:

- Store 10 weather drones
- Autonomously launch, load, and charge drones
- Keep sensitive electronics with significant heat generation isolated from the elements
- Lightweight, rugged, and compact

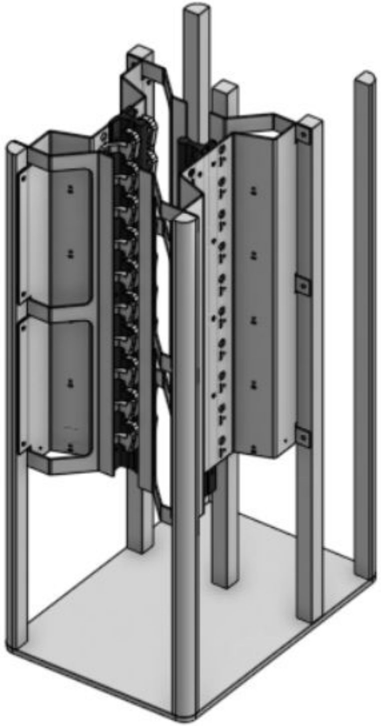
My contributions

- Solely responsible for mechanical design and build of Hives
- Managed part sourcing and manufacturing under extreme timeline - 3 months to design and build 6 Hives
- Coordinated with electrical, software, and drone-side mechanical team to ensure smooth integration
- Traveled to demonstrate Hives to customers

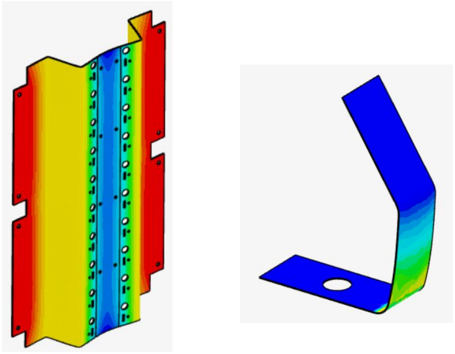
“Enhanced Hive” with loading capabilities

# Subsystem: Drone Alignment and Charging

- Stores and charges 10 drones
- Minimally invasive on drone shape
- Low part count - only 5 unique parts
- Easy to manufacture sheet metal and COTS parts used wherever possible
- FEA done on charging contacts and alignment sheet metal
- Fatigue and wear testing done on charging spines and tin contacts



Alignment and charging ASSY



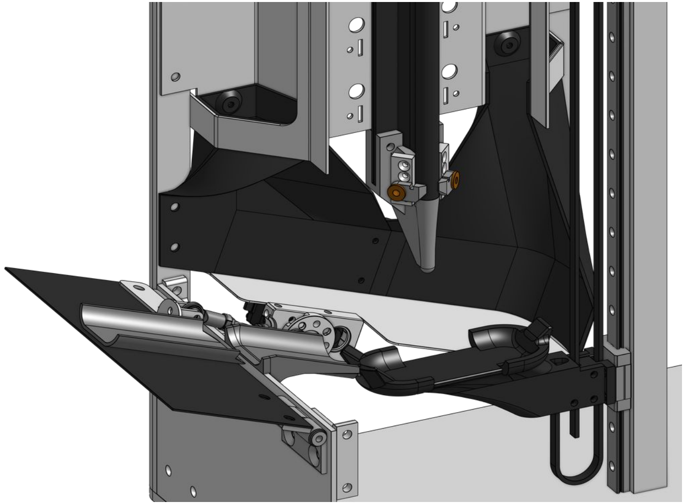
FEA on alignment and charging parts

Fatigue/wear testing setup

[Fatigue Testing]

# Subsystem: Drone Loading

- Drones land on ramp guided by vision system on Hive
- Ramp funnels drones into hive and starts to fold props
- Internal geometry passively aligns props and drone
- Zero additional actuators required with passive loading design
- Elevator actuator is reused and a passive ratchet mechanism stops drones from falling into loading zone
- Lots of iterations were tested to perfect the loading mechanism



Passive loading mechanism within hive

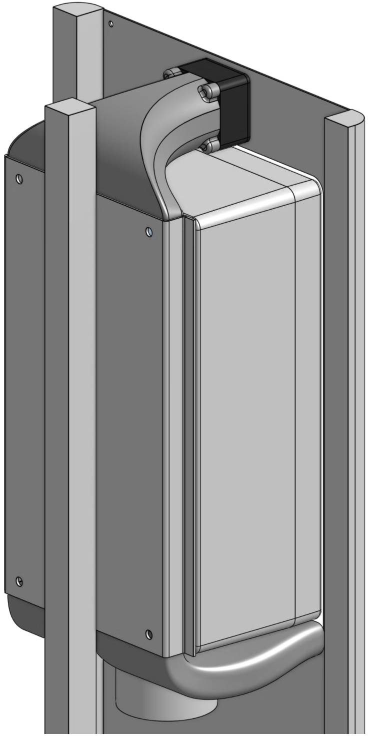
Ramp attached to hive

Loading Testing

# Subsystem: Electronics "Dry Box"

- COTS IP65 aluminum enclosure was used for all sensitive electronics
- Waterproof bulkhead connectors used
- Heat sources were mated directly to the aluminum enclosure with thermal paste
- Heat sink on outside of enclosure was actively cooled with ducting and server fan
- Hand calculations and manufacturer specs were used to guide duct design
- High power jetson orin nano was used without overheating issues

Dry box accessible from outside of hive



Dry box ducting

# What I Learned from WeatherHive

- CAD
  - Creating and maintaining a large assembly with multiple subassemblies
  - Transferred SolidWorks experience to OnShape
- Project management / collaboration
  - Established clear plan and timeline for part design and procurement of 6 Hives
  - Communicated with electrical, software, and drone-side hardware team to ensure easy integration
  - Dummy hives built for other teams to test with helped with parallel development
  - Subsystem testing conducted before final build
- Design and iteration
  - Fail early and often - design flaws caught earlier were much easier to address than those caught later in the process
  - Ironing out issues with manufacturability and assembly helped reduce part procurement / assembly time when making multiple hives

6 Hives in various stages of assembly

# Planetary Gearset Retrofit (Orbis)

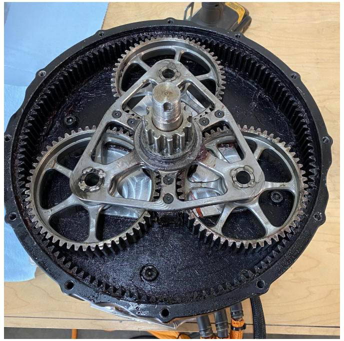
Requirements:

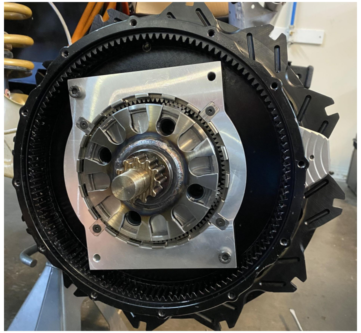
- Reduce operating NVH
- Extreme timeline
- New gearset must fit within existing assembly and use existing splines
- Cost effective

My contributions:

- Solely responsible for retrofit design and management
- Sourced gearset and worked directly with our machinist to make parts
- Tested NVH reduction with sound level meter
- Fitted to McLaren MP4-12C chassis

Me in electrified  McLaren MP4-12C chassis w/ retrofitted gearsets

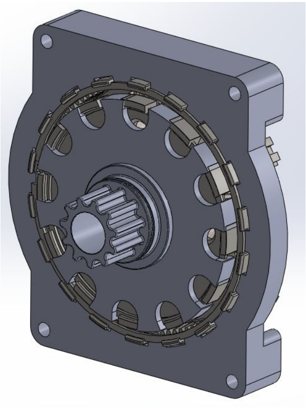




Planetary gearset assembly before and after retrofit

# Design Process and Results

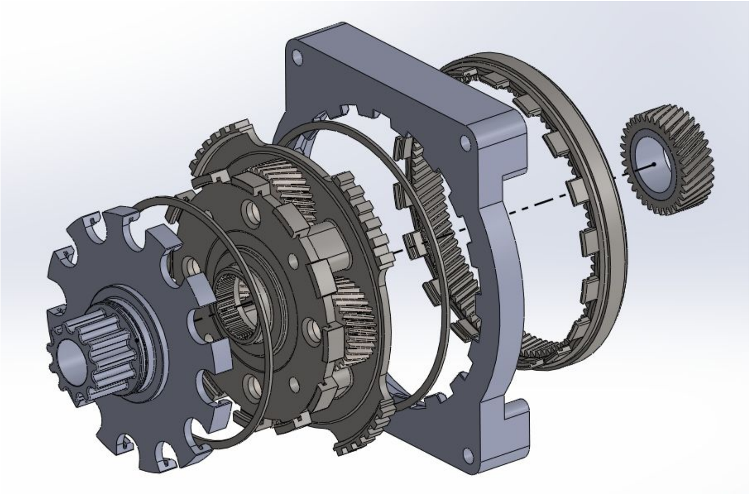
- New planetary gearset designed with helical gears
- Quotes showed that custom ring gears were too expensive and would take too long to make
- Needed to pivot - a gearset from a junkyard automatic transmission was harvested and retrofitted to the assembly
- Testing with sound level meter proved significant NVH reduction
- Engineer sent from a major automaker approved the proof of concept's NVH, resulting in a contract with the automaker



Above: NVH testing

Left: gearset retrofit assembly

Below: exploded view



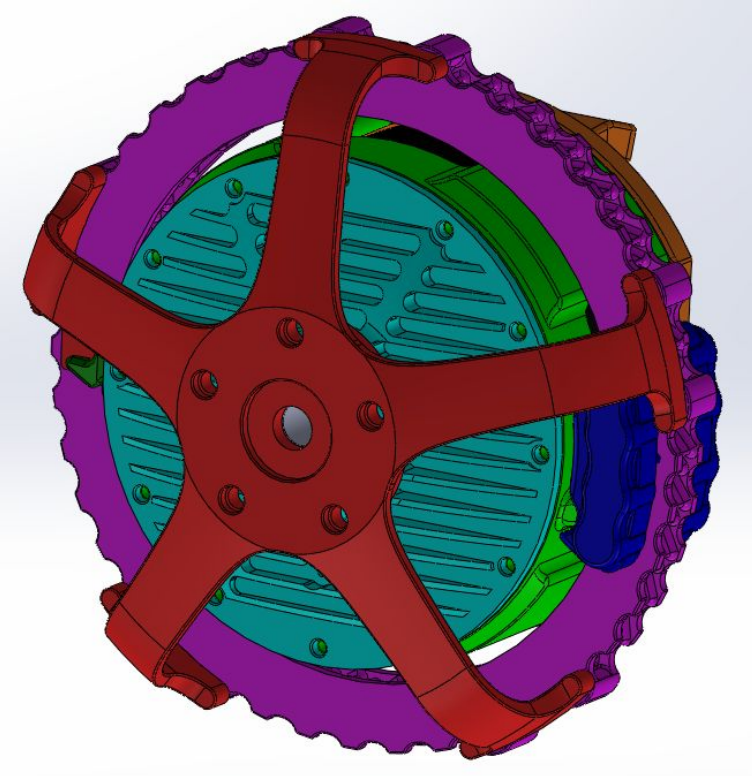
# Gearbox, Motor, and Upright Assembly

Requirements:

- Redesign previous assembly, keeping successful design elements and addressing failures
- Small form factor/stack height
- Lightweight

My contributions:

- Redesigned gearset stack - bearings, oiling, gearset selection
- Designed and optimized brake bell (red) with FEA
- Designed integrated upright (orange)
- Redesigned frustum that contains gearset (green)
- Work with machinist to make a printed model



Integrated gearbox, motor, and upright assembly

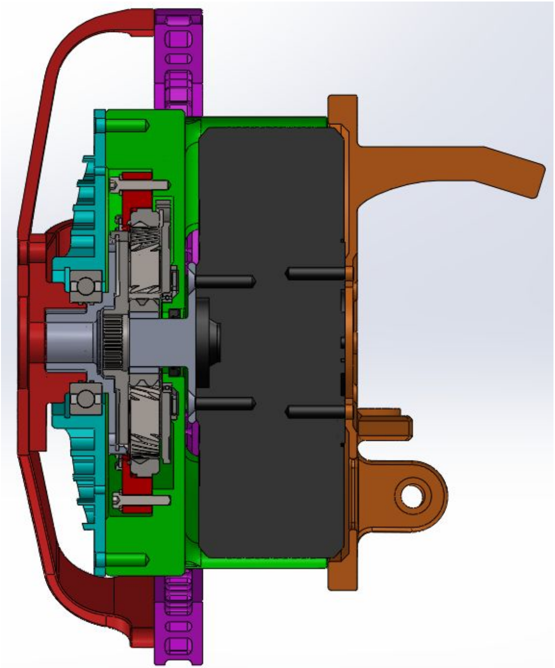
# Design Process

Address failures

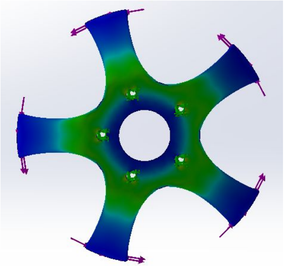
- Previous bearing solution caused gears to take load from wheels and fail - redesigned to isolate gears from external forces
- New sealing solution designed to stop leaking

Reduce assembly's stack height and weight

- McLaren MP4-12C upright integrated into motor mount
- Power dense axial flux motor used
- Lightweight brake bell with internal caliper
- FEA used to optimized brake bell, reducing unsprung and rotating mass



Section view of integrated assembly



FEA on previous brake bell iteration

# External Brake Rotor/Bell

- Designed and worked closely with machinist to make “bell” to hold external brake rotor
- Mustang GT rotor adapted to function as an external rotor
- Tested at Greening to validate performance vs. original rotor
- Underperformed compared to original rotor, but was significantly lighter
- Conclusion: promising results, but an equal mass comparison would be more valuable; brake rotor cooling optimization needed

Brake test setup at Greening


Picture of rotor pre and post test. Bell (black) holds onto outer edge of rotor

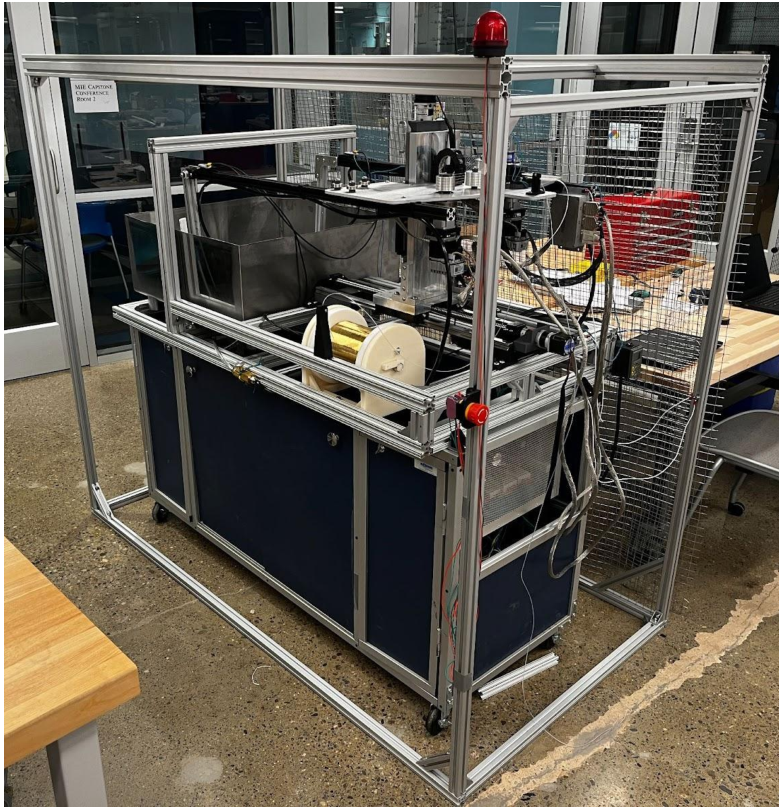
# Wire Electric Discharge Saw (NEU Capstone)

Client's requirements:

- Cut a metal 3D printed part off of a 18" build plate - previously a bandsaw or angle grinder was used
- Cuts must be flat within ±.020"
- Adjustable cut height
- Affordable (<$3000 w/o power supply)

Responsibilities:

- Work with group of 6 to brainstorm novel format of Wire EDM machine
- Design X/Z axis, wire tensioning, end effector subassemblies
- Lead build of machine over extreme timeline



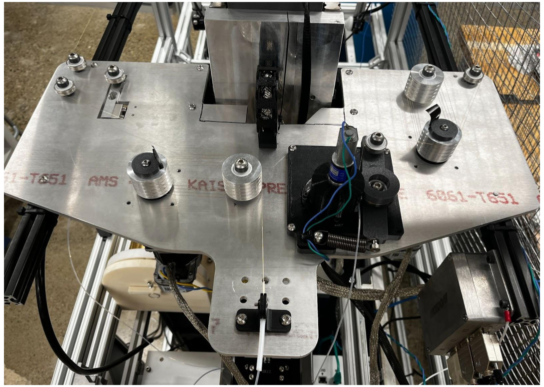
Complete WEDM machine with safety enclosure

# Subsystem: X/Z Stage and Wire tensioning

- X/Z stage driven with geared stepper motors and EtherCAT drivers
- Hand calculations used to determine vertical displacement of wire due to X axis flex
- 2 servos run closed loop with load cell to control wire tension and speed
- Wire tensioning was inconsistent, so a planetary reduction was added to servos to increase precision and torque
- Further iteration necessary to reduce skipping on output wire tensioning assembly

Wire tensioning test


X/Z axis assembly



Wire tensioning assembly

# Subsystem: End Effectors

- End effectors were suspended on cantilevered beams to reach through 18” diameter build plate
- Water block mounted diamond wire guide, nozzle, pulley, and NPT fitting
- CFD used to determine correct nozzle orifice size, hand calculations used to determine necessary post-pump pressure
- End effector designed to be extremely compact in order to machine workpiece in COTS stainless steel tank
- Machinability of water block was crucial
- More bracing on end effectors was added to deal with inconsistent wire tension

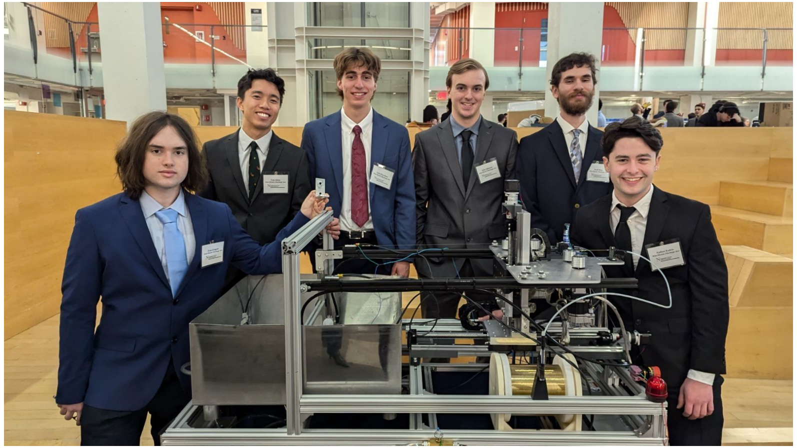
Nozzle Test

316 SS waterblock (my favorite part in the project)

3D printed prototype waterblock with nozzle, pulley, and fluid fitting

# What I learned

- On large projects, splitting up the system and doing subsystem testing is critical
- Test early and often
- There is always a way - even if it's me buying a 3D printer with personal funds and running it around the clock to make stand-ins for machined parts
- Good project management means communicating failures early and delegating work, even if I'd prefer to do it myself
- Any engineering assumption made will be tested and could cause failures

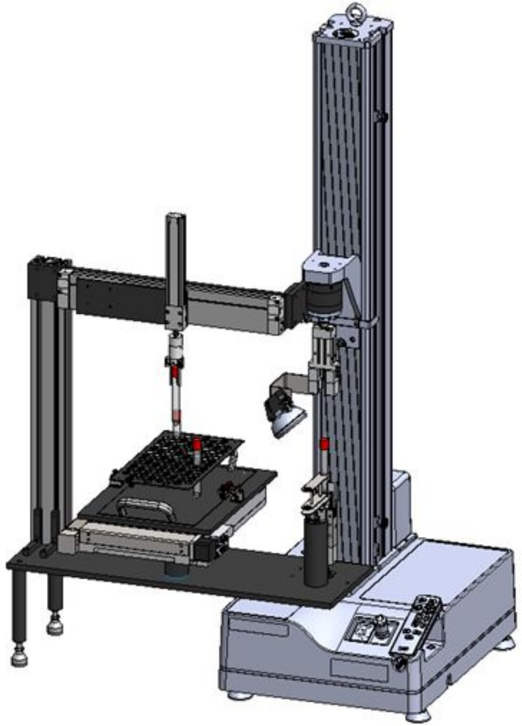


My capstone group after presenting our novel WEDM machine

# Automation System Mockup (Instron)

- Mockup of small automation system for customer quote
- Existing Instron & COTS parts used wherever possible
- 100 vial capacity while staying within small form factor
- Removable vial racks
- Pneumatic actuators used to reduce control complexity
- Vision system included to detect failures
- System functionality animated to demonstrate to customer

System Animation



Compact automation system assembly

# Thanks!

Please check out my website if you'd like to learn more about me or any of my projects!

## Contact Me

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