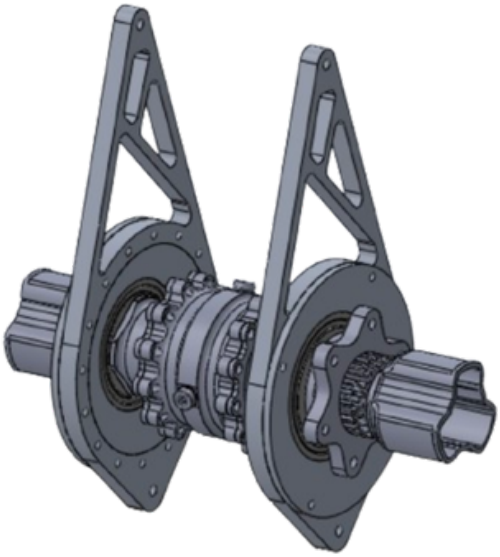
Drivetrain Full Project

Formula SAE | CAD | FEA | Manufacturing (CNC)

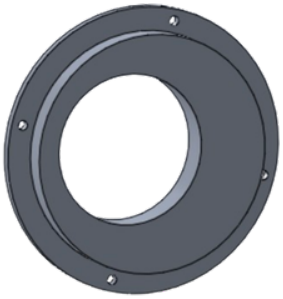


Situation:
For the new RR27 Vehicle, the drivetrain must be designed and manufactured. Historically, the drivetrain was unreliable, heavy, and had a very difficult chain adjustment mechanism

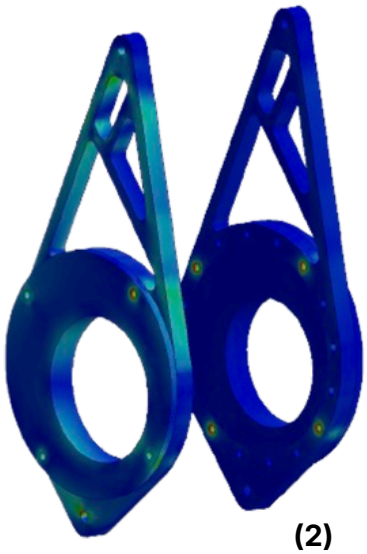
Task:
Create a Topologically Optimized Aluminum 6061 Drivetrain Frame, incorporating an eccentric disk for adjustability.

Action:

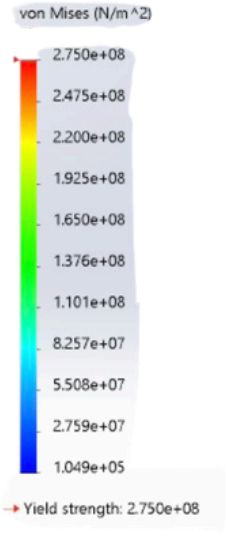
- **Designed** an **off-centered eccentric disk system**, allowing **a difference of 0.7in** between the **minimum** and **maximum** tightness position (1)
- **Designed** the frame, applying **FEA (>=2 FOS) and Buckling (>=10 BLF)**, I took off more than **75%** of its original weight (2)
- **Selected and ordered**: LS Differentials, 520 sprockets and chains
- Drew **engineering schematics** and sent the work off to the Manufacturing Team (currently in progress)

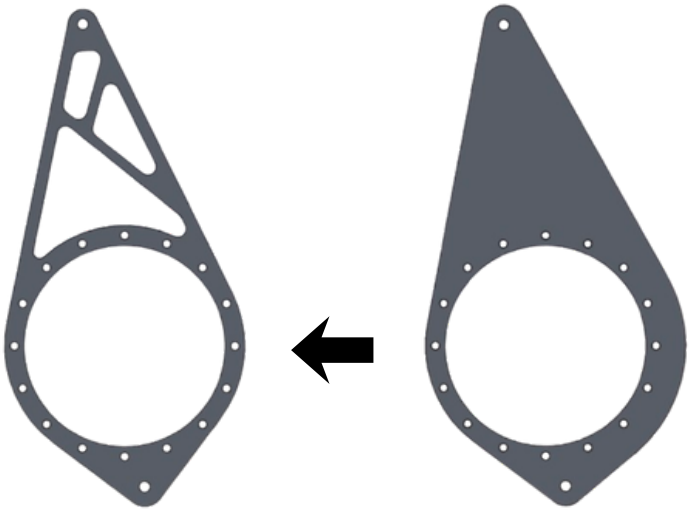


(1)



(2)





(2)

Result:

- Waiting on manufacturing currently
- Met the SoW so far
- V2 possibly in the future--based on team lead feedback and relaibility

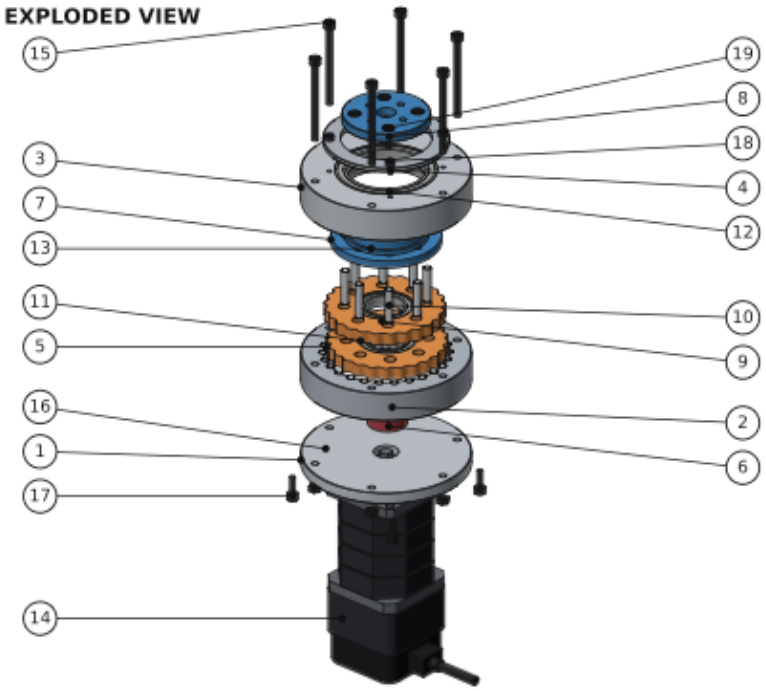
Cycloidial Gearbox

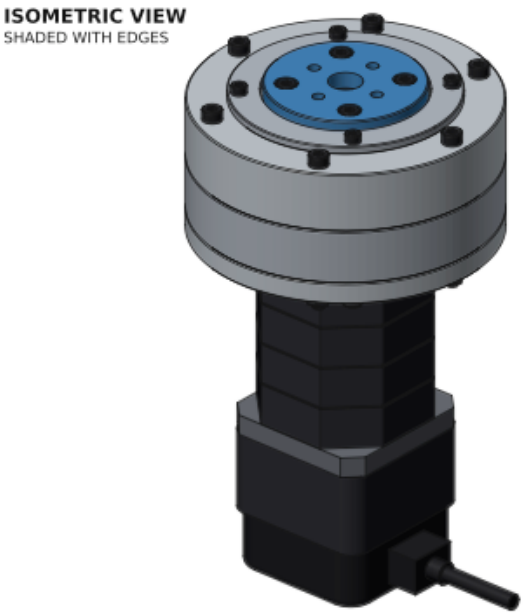
Solidworks | MATLAB

Situation:
A 6-axis, 0.6 m robot arm needs a compact, high-torque, low-backlash reducer at the shoulder joint, which carries the most load. A stepper motor alone can't supply that torque, and standard gear trains are too large and have too much backlash for precise positioning.

Task:
Design a 25:1 two-disc cycloidal reducer for the shoulder joint, paired with a closed-loop stepper motor and a power-off brake, and plan for it to be manufactured in the university machine shop.

Action:
- Sized the shoulder joint from a mass model of the arm: 16 N·m working and 25 N·m peak torque
- Selected a NEMA 23 closed-loop stepper and bearings (608, 61805)
- Generated the cycloidal disc profile from kinematic equations in **MATLAB**, with checks for undercut, contact stress and pin clearance over a full input revolution (15 µm minimum gap)
- Designed a two-disc layout (discs offset 180° to balance the eccentric loads) with 26 ring pins, 8 output pins, an eccentric input shaft and an output flange





Result:
- Full design and CAD complete, with zero interference across all 49 parts
- Waiting on the drivetrain to be manufactured and designed so I can better understand the whole process, then I'll create a drawing and manufacture it out of 6061 Aluminum and PETG
- Next: build the prototype, then measure backlash, torque capacity and efficiency against the test plan

Reactor Gasket Thermal Analysis

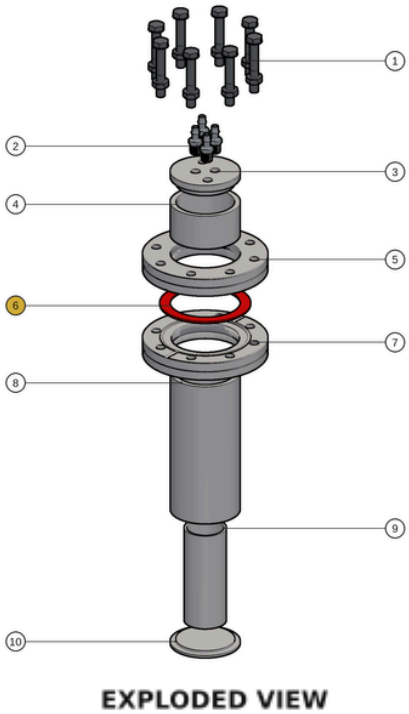
Fusion 360 | Ansys

Situation:
A molten-salt (FFC) reactor reduces alumina to aluminum in $CaCl_2$ held at 950 °C for 24 h. The redesign swaps the threaded lid for a bolted ConFlat flange pair with a silver-plated copper gasket, which is the route to a vacuum-tight vessel suitable for the Moon. No one had studied the new joint thermally, and a hand estimate showed the uncooled gasket could pass its 450 °C limit.

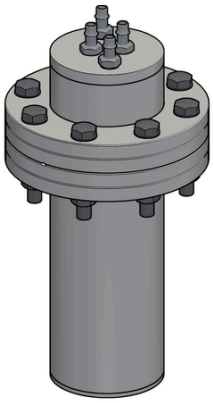
Task:
Build a thermal model of the full reactor and furnace to check that the melt stays molten (above 800 °C), the Cu gasket (in red, in exploded view) stays under 450 °C (250 °C target), and the top fittings and silicone lines stay under 200 °C. Then size the lightest water-cooling coil that meets those limits.

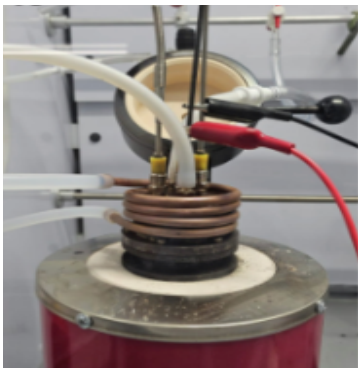
Action:

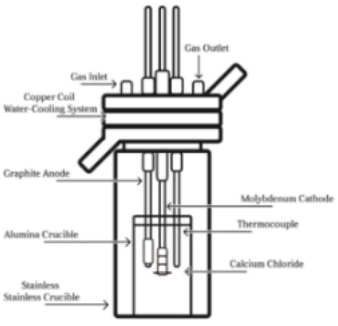
- Built a 20-body model from the STEP assembly in ANSYS, adding the furnace, insulation, $CaCl_2$ melt and electrodes
- Entered temperature-dependent material data, and modelled melting with an enthalpy curve to capture $CaCl_2$'s 257 kJ/kg latent heat at 772 °C
- Set up 24 contact regions with thermal contact conductances (knife-edge in Cu, bolted flange land, NPT threads, welds)
- Modelled two surface-to-surface radiation enclosures (furnace chamber and retort interior), plus convection and radiation to the room



EXPLODED VIEW


ISOMETRIC VIEW





Result:

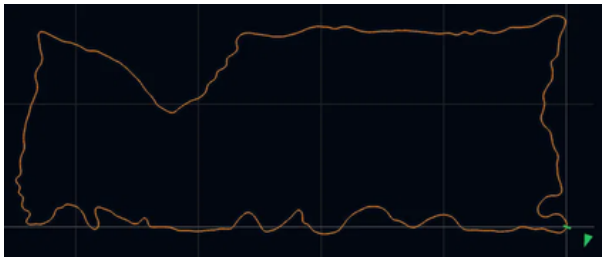
- Calibrated baseline: **gasket 432 °C, lid 371 °C, heater 702 W** at a **981 °C heater** setpoint.
- The uncooled gasket passes the reaches **410 °C, 40 °C** below the **450 °C** (2 FOS, Gasket melts at 900 °C), top fittings and silicon lines both stayed well below 130 °C.
- Next: look into possible preventative cooling-coil options, run a °C 52 h transient study, then pass the temperatures to a bolt-preload structural check.

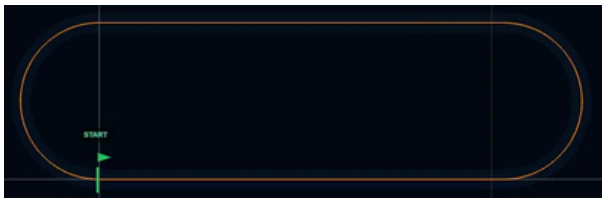
Track Time Simulation

Formula SAE | MATLAB | Applied Racing Dynamics

Situation:
Historically, shifting mechanisms were all mechanical and not pneumatic. Additionally, a new engine was bought for the RR27 car with new gear ratios, different acceleration, top speed, and overall vehicle dimensions/weights

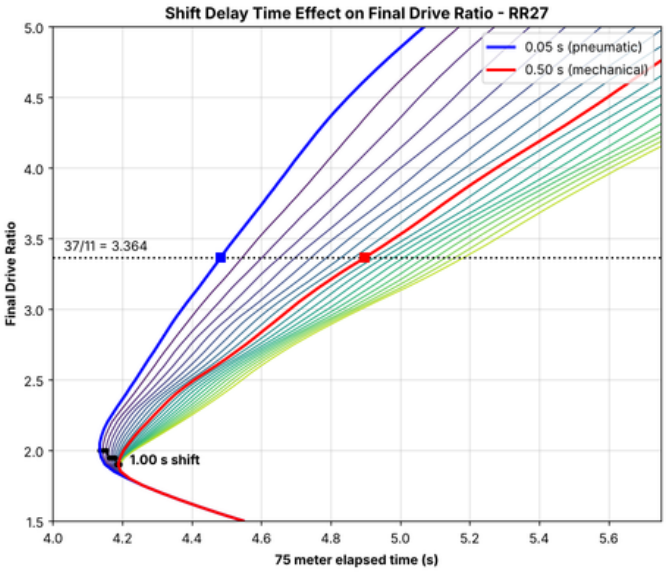
Task:
Simulate track times using **MATLAB** and **ARD** to create a shift-time upgrade feasability report as well as finding the best Final Drive ratio at both shift times.



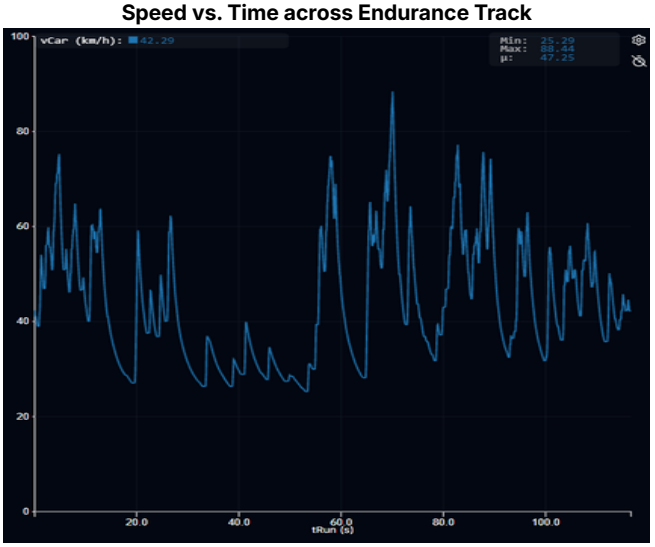


Action:

- Gathered **vehicle data** across all teams over the summer and helped create an **accurate model** of our **new vehicle.**
- **Recreated** both of Formula SAE Michigan's endurance track and acceleration track using MATLAB (.csv output)
- **Coded** a track time vs. 75m (acceleration track) elapsed time @ 0.5s ST and 0.05s ST on MATLAB
- Verified results with Applied Racing Dynamics



Speed vs. Time across Endurance Track



Result:

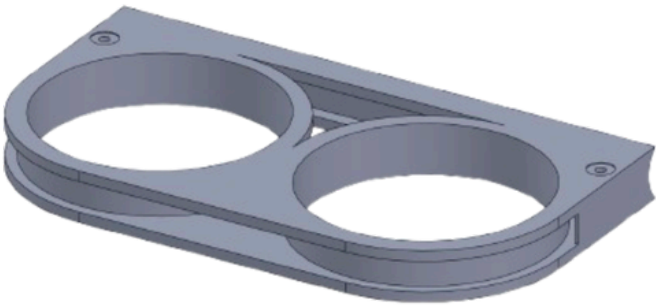
- A gain of about 10% in the accel. race, which is huge.
  - However, the endurance track is worth much more points cares more about reliability than speed.
  - If a pneumatic shifting option is selected, it should not be specifically for the accel. race
- A ratio of 37/11 was selected, any final drive sprocket larger than 37 teeth would not fit with the current package, an 11 tooth sprocket is the lowest 520 sprocket available.
  - Increasing the amount of teeth in 11 tooth sprocket is a possible option to be explored in the future

Catchcan Mounts

Solidworks

Situation, Task, Action:
A quick, easy, and light mounting system was needed for us to attend the 2026 Ferrari Fest and give the RR25 its final farewell.

Result:
- Measured catchcans, frame dimensions, and everything else using calipers
- 3D printed it using PETG





RPi Housing and Cooling

Solidworks

Situation, Task, Action:
Designed and 3D printed a housing for a Raspberry Pi that is intended to be used as a smart-home server manager.

Result:
- 3D printed it using PETG on a Creality Ender 3 V3 SE
- Ordered fans that connect to the raspberry pi for cooling







About Me

Personal:
My resume and portfolio says pretty much everything about me professionally, but heres a quick summary about me:

I'm a very active and social person. I like any form of exercise (soccer, basketball, weightlifting, tennis, basically anything that can be done in a group). I'm a hardcore UFC fan and a casual soccer (Real Madrid only) fan.

I love travelling, animals, and nature. I've been to Switzerland, Germany, Austria, Italy, Slovakia, the Netherlands, Qatar, Oman, Saudia Arabia, UAE, Mexico (Cancun), a bunch of other countries.

I'm interested in any form of technology, whether that is semiconductors, robotics, or something as 'boring' as HVAC systems--I care more about the engineering and design aspect MUCH more than the specific technology.



my first (and only) attempt at a backflip in Cancun



chichen itza (a seven wonder of the world)



me next to a very angry buck



juvenile red tailed hawk



nightview when me and my friends went camping