DRIVETRAIN

technical

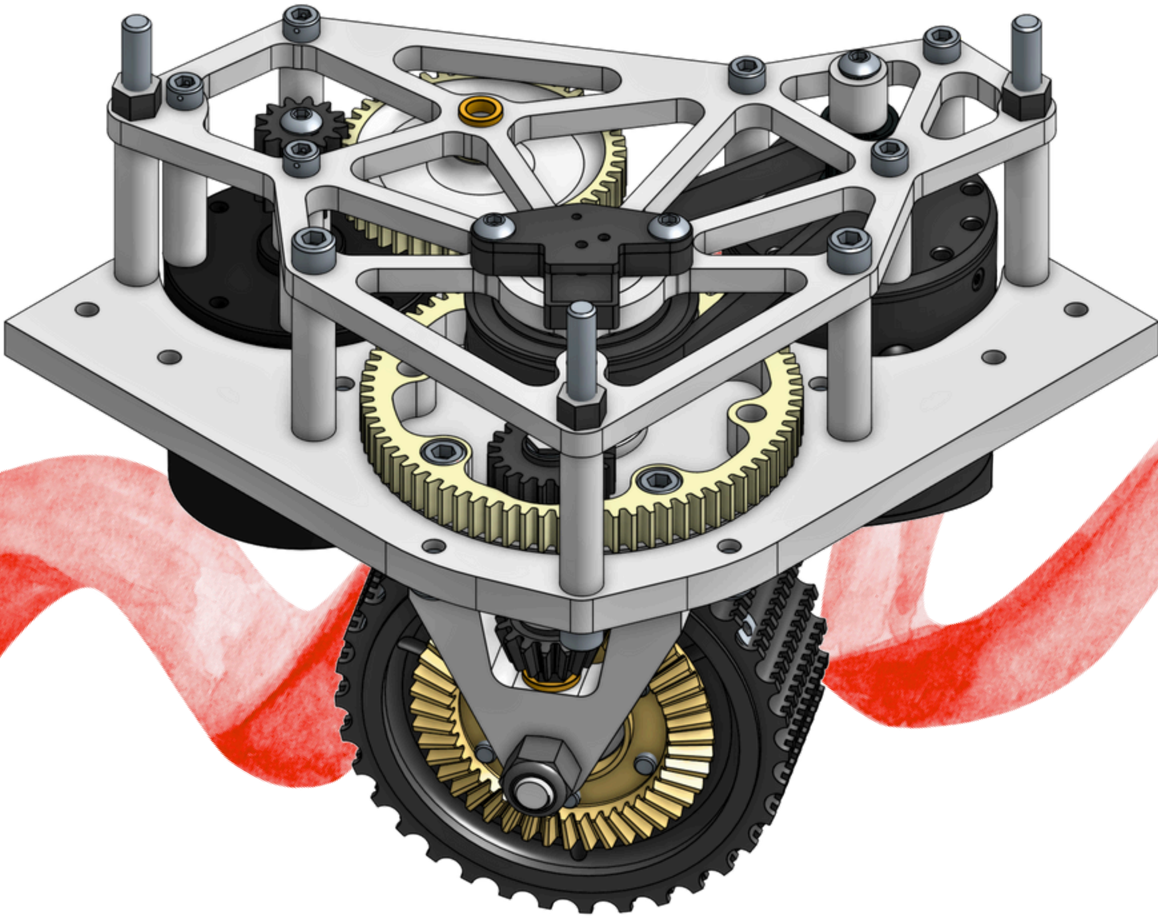
documentation.

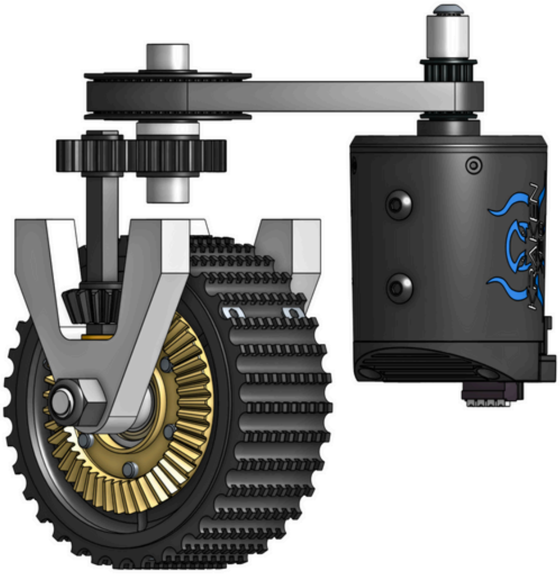
GRT 2025

gunn robotics team #192

Andromeda

- series iv -





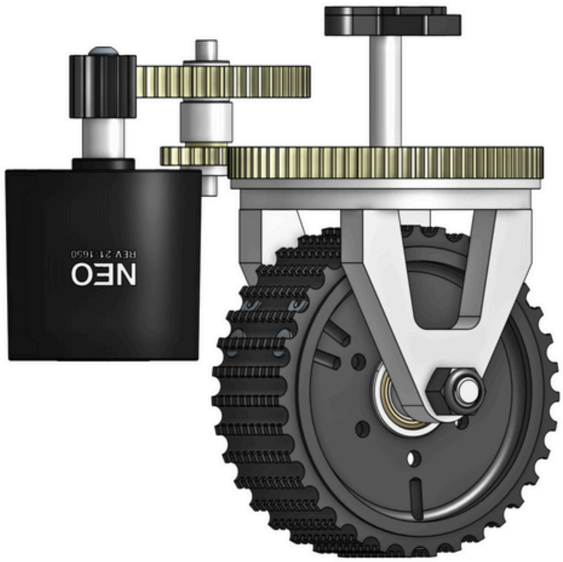
Drive Gearing
Kraken X60 (7.09 Nm)
Gear Ratio *6.92*
[48/16, 20/26, 45/15]

Max Accel 55 m/s²
Max Velocity 4.6 m/s

* theoretical acceleration
limited by tread, carpet, etc

Steer Gearing
NEO V1.1 (2.6 Nm)
Gear Ratio *12.69*
[48/14, 74/20]

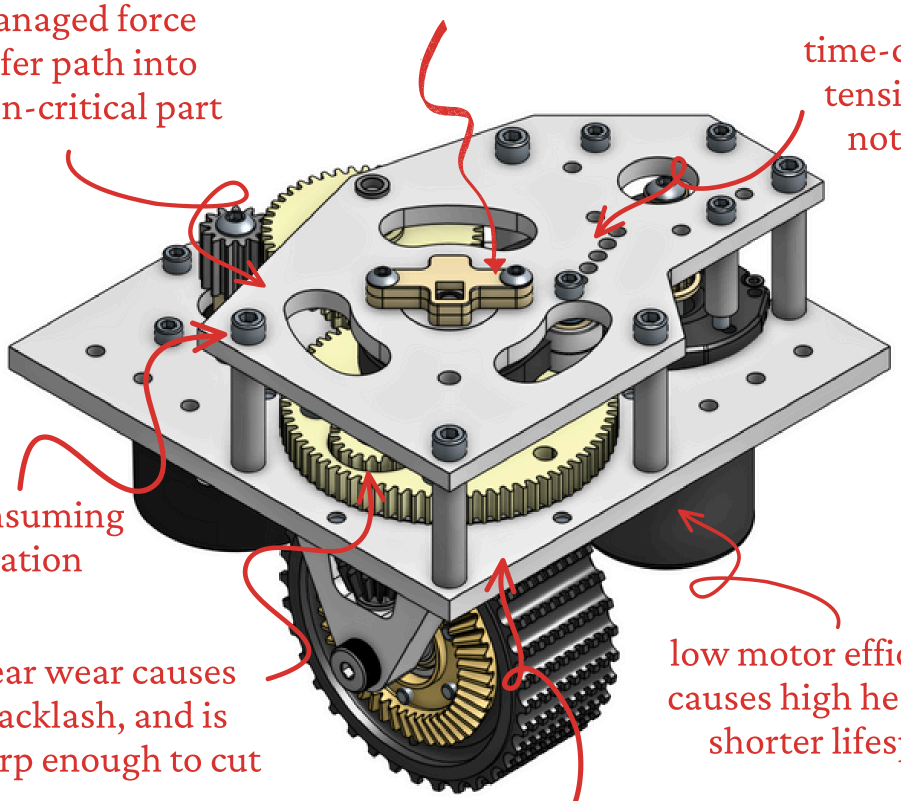
Steer Encoder
HELIUM Canandmag
0.022° Resolution

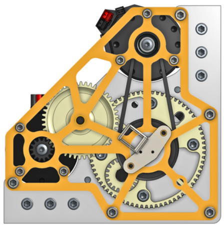
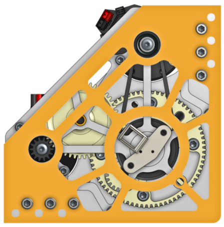
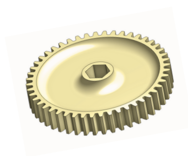
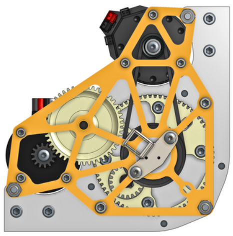
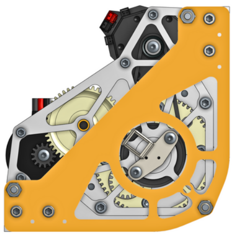
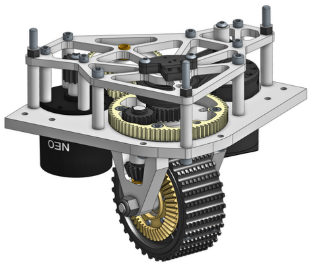
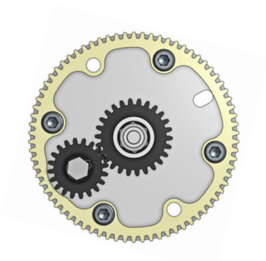


Review ↗

analysis of previous years' performance
iterations on new design concepts

identifying problems
(2024 module “hermes”)



Series 1	  • both motors mounted to top plate for **weight saving** • **switch motor** to Kraken X60 after analysis of prior season • designed to facilitate **swappable drive gear ratio**
Series 2	  • motor/encoder plate offset 0.050" to **clear force transfer path** • start **pocketing gears** for weight saving 
Series 3	   • plates redesigned for **increased integrity** • middle plate offset • **rigid pre-loaded columns** introduced for corner strength
Series 4	  • further central steer **gear pocketing** • **roll pins** used as centering features • **steel gears** at crucial drive powertrains

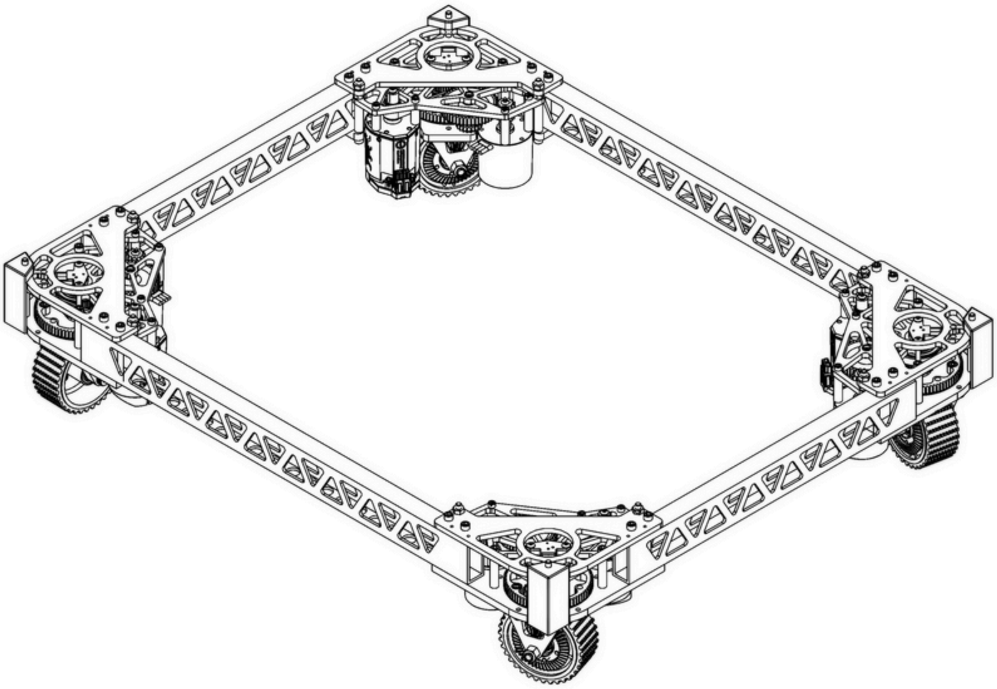
Design Goals for 2025

- use more **powerful motor and powertrain** for the drive system
- use **quantitative analysis** (finite element analysis) to minimize weight while maintaining structural integrity and safe **force transfer paths**
- simplify of design to facilitate **efficiency in fabrication**
- develop a more accurate **diametric magnet mounting** method
- facilitate **swappable drive gear ratio** to respond to game needs

competition drivebase

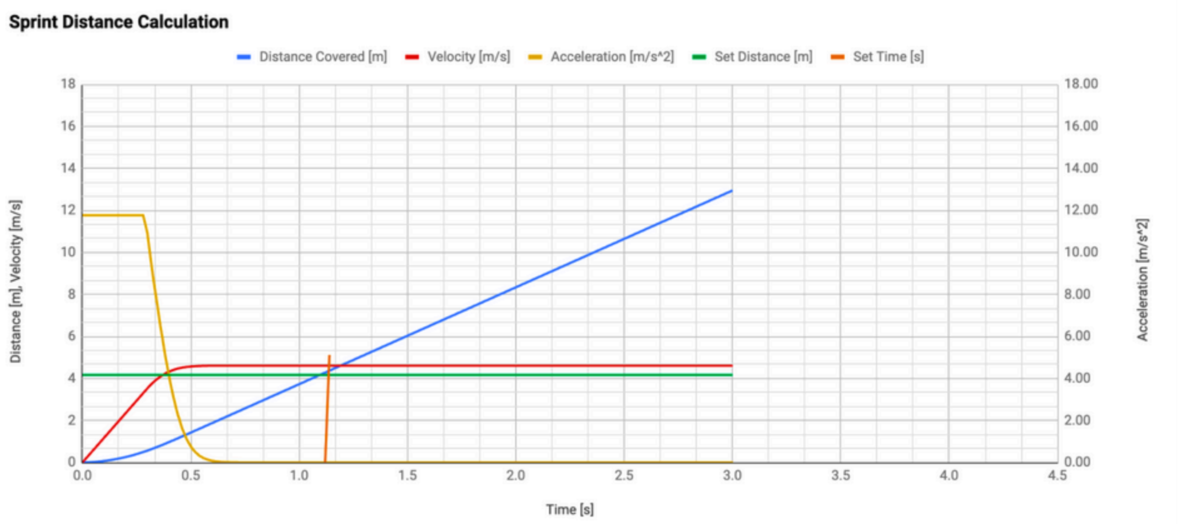
andromeda series 4

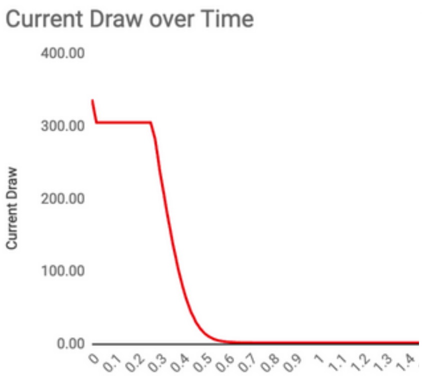
chassis 27" x 33"



Design ↗

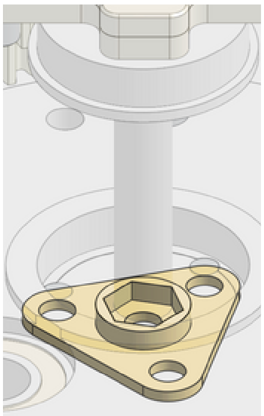
resolving known issues, identifying goals
cad, simulate, analyze, and reimagine



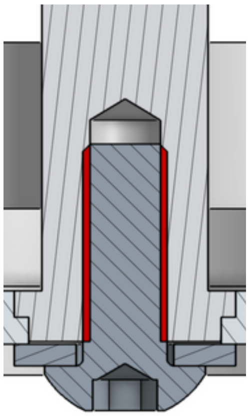


- To optimize current draw and time-to-objective, we simulated several different gear ratios.
- We selected an **overall 6.923 gear reduction on the drive motor**, capable of reaching from the coral station to the reef in 1.10 seconds.
- Prioritizing **powerful acceleration** over speed is effective given the short score cycle distance.
- A **lower current draw** allows more flexibility in running both the swerve and mechanisms.

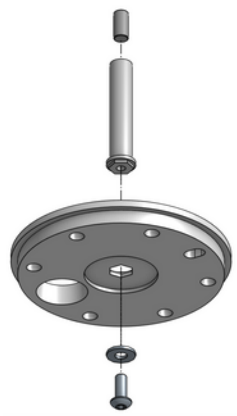
- This year, our encoder mount is **fully metal**, rather than having a plastic mounting part.
- A hex broach **precisely locates** the encoder relative to the gear hub.
- The axle is flanged and bolted into place.
- This resolves a major flaw from last year.



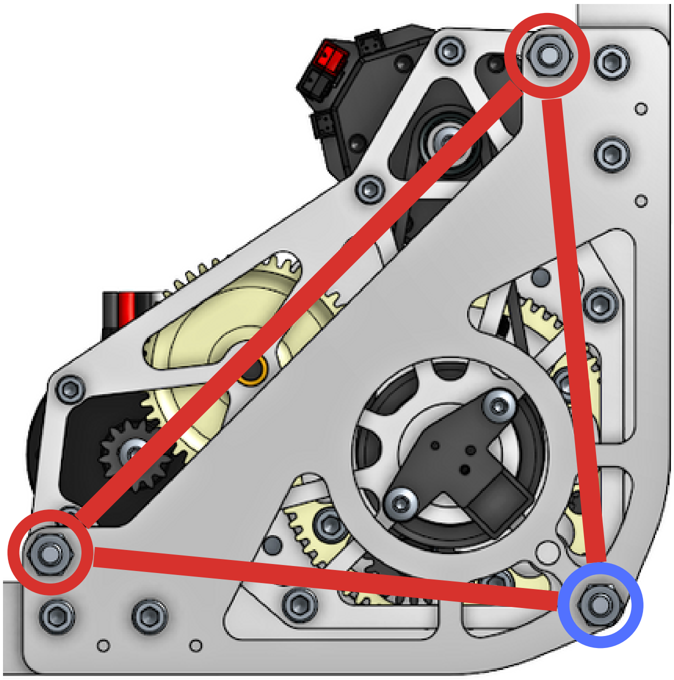
Previous Design



Axial Locating

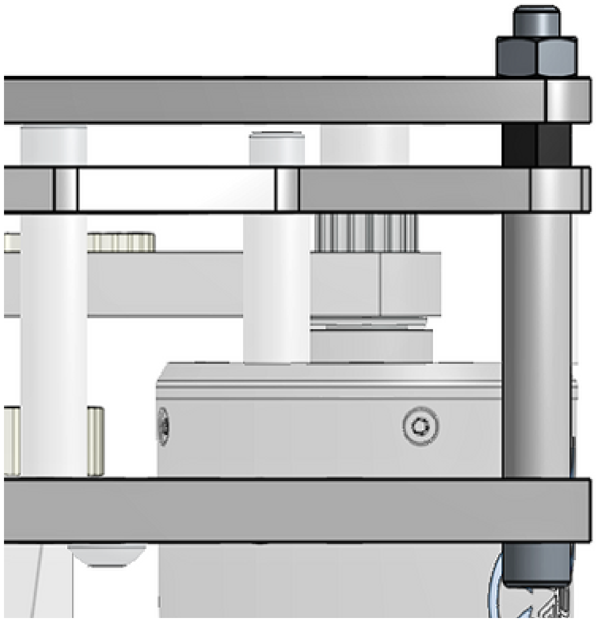


Encoder Assembly

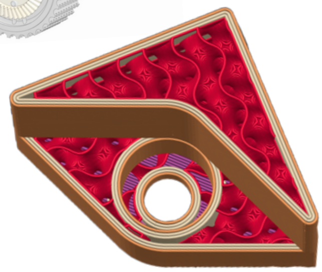


- The three standoff columns holding the swerve module together are spread out and arranged in a triangular shape.
- The **triangular shape of the top gusset** allows for maximum integrity retention with amazing weight savings.
- This year saw the **crucial addition of a corner bolt** running through the entire module (blue). Last year, the bolt was used as a spacer below the top plate. It is replaced by a custom part (below).

- This year's design includes fully supported **rigid columns** clamping down on the three module corners.
- Bolts provide compression force, while precision manufactured standoffs maintain spacing.
- This preload applied to the fastener gives the column **more strength and rigidity**, and lessens the risk of bolts shearing in corner collisions.
- The added spacer nut also comes with the benefit of making modules **easier to disassemble and repair**.

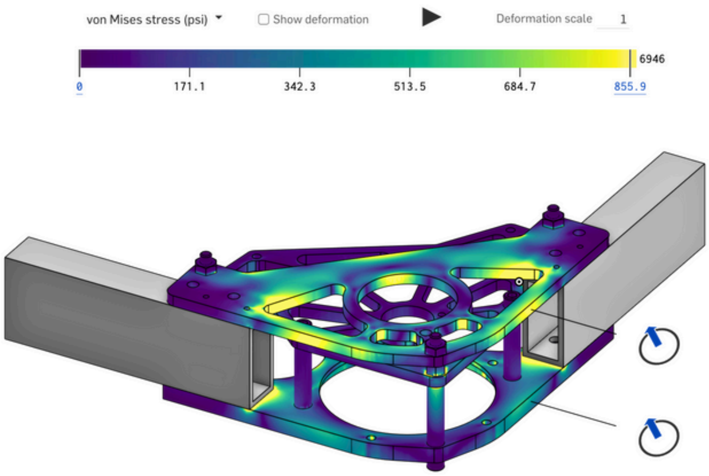


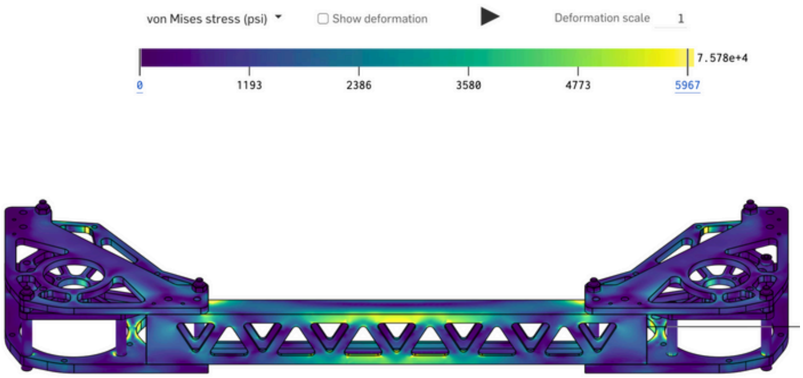
- To optimize the weight chassis weight saving from material loss, we used Finite Element Analysis (FEA) **software to simulate various impact forces**.
- Aluminum 6061 has a yield strength of 40,000psi (deform) and a tensile strength of 45,000psi (fracture).
- The collision forces are **simulated higher than forces experienced in FRC**, and neglect bumper dampening.
- Impacts to the chassis corner will be further mitigated by a new crumple bumper, which is 3D-printed with a gyroid infill and intended to sustain minor compression.



Simulation of a **direct 4000N corner collision** shows the high stress points experiences less than 900psi of stress.

The **stress is absorbed** by the triangular top plate, as intended. The **middle plate is clear**.

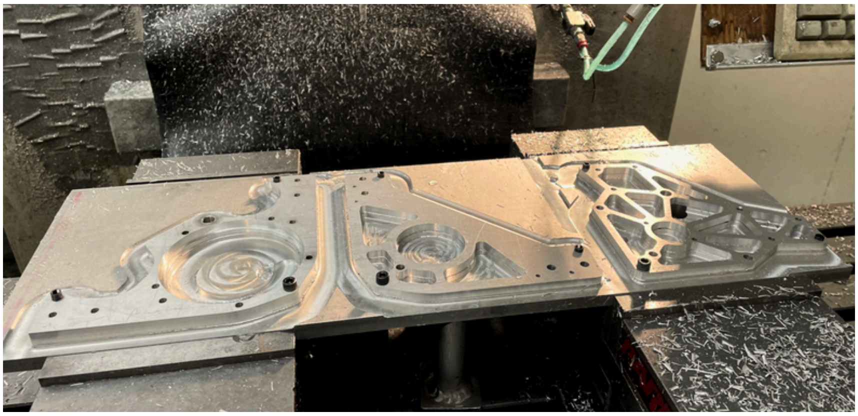


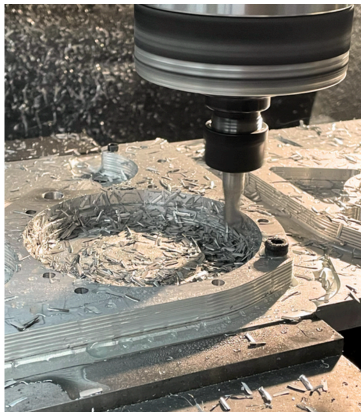


Heavy triangular pocketing of chassis was determined feasible. The maximum stress point experiences less than 6000psi under a **2600N side impact**.

Build ↗

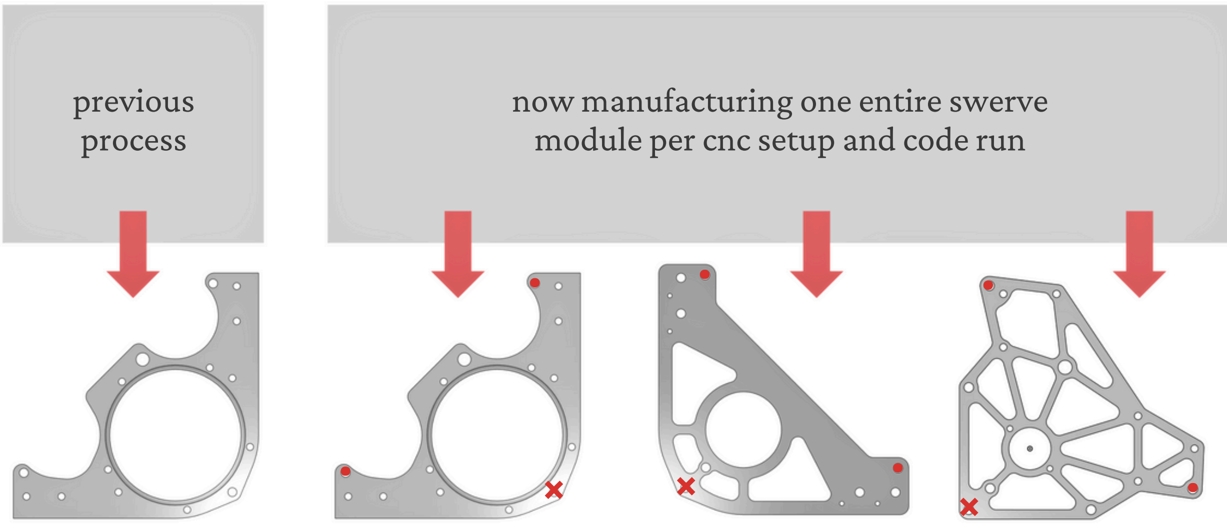
machining with precision and efficiency
new tools, techniques, and processes

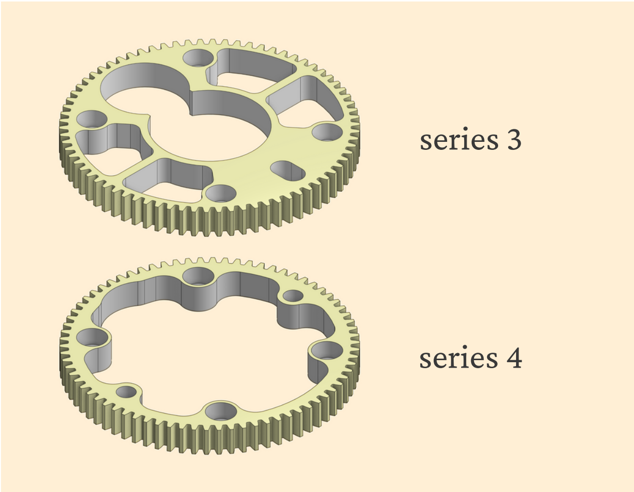


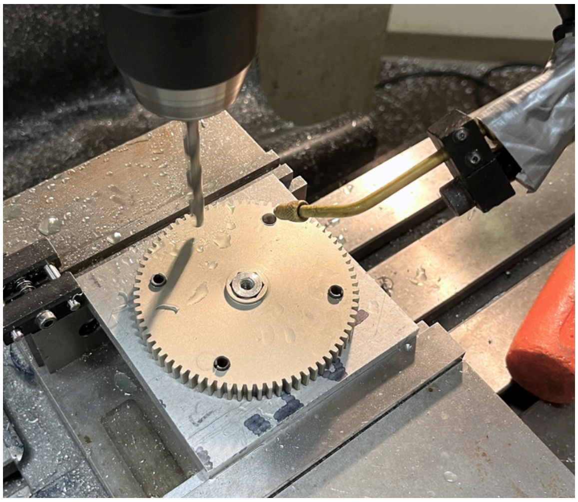


- To maximize efficiency and minimize build time per module, we mounted three plates to one fixture. Our team's CNC subgroup could manufacture plates for one entire module in one machine setup, saving lots of valuable time.
- This "parts needed per module" instead of "total quantity per part" manufacturing process also **streamlined our module fabrication and assembly**.
- We could begin assembling, testing, and wearing in full modules while parts for the next module were still in fabrication or assembly.

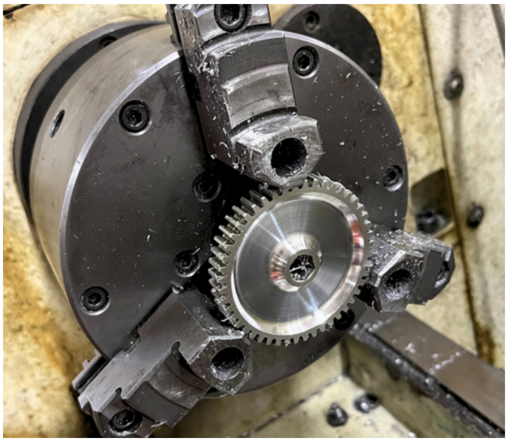
- While clamps hold the metal stock in place, an initial toolpath drills the ∅0.257" holes on all three plates. To replace clamps, nuts and bolts hold the stock down.
- This year, we also began using roll pins. These can be pressed flush with the stock surface, giving them an even smaller mounting footprint than bolts or clamps.
- Roll pins prevent the stock from rotating and sliding over the fixture.



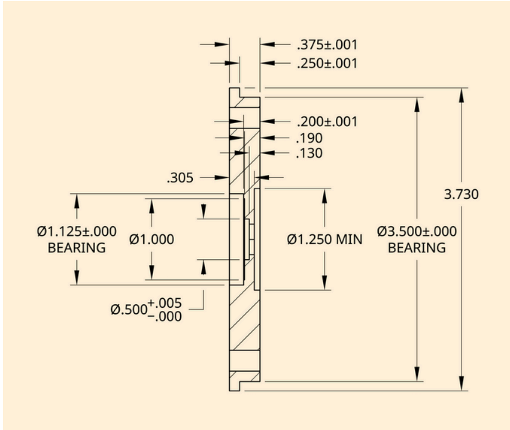




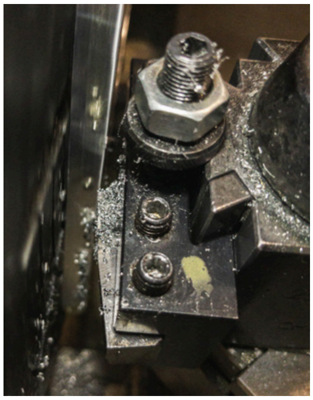
- The main CNC steer gear was originally minimally pocketed, retaining material in the center circular geometry for the purpose of centering, as bolts have some play.
- Using **roll pins as locating features**, a much larger contour can be removed.
- This also removed the corresponding centering nub on other parts, greatly **reducing complexity and increasing machining efficiency** across the modules.



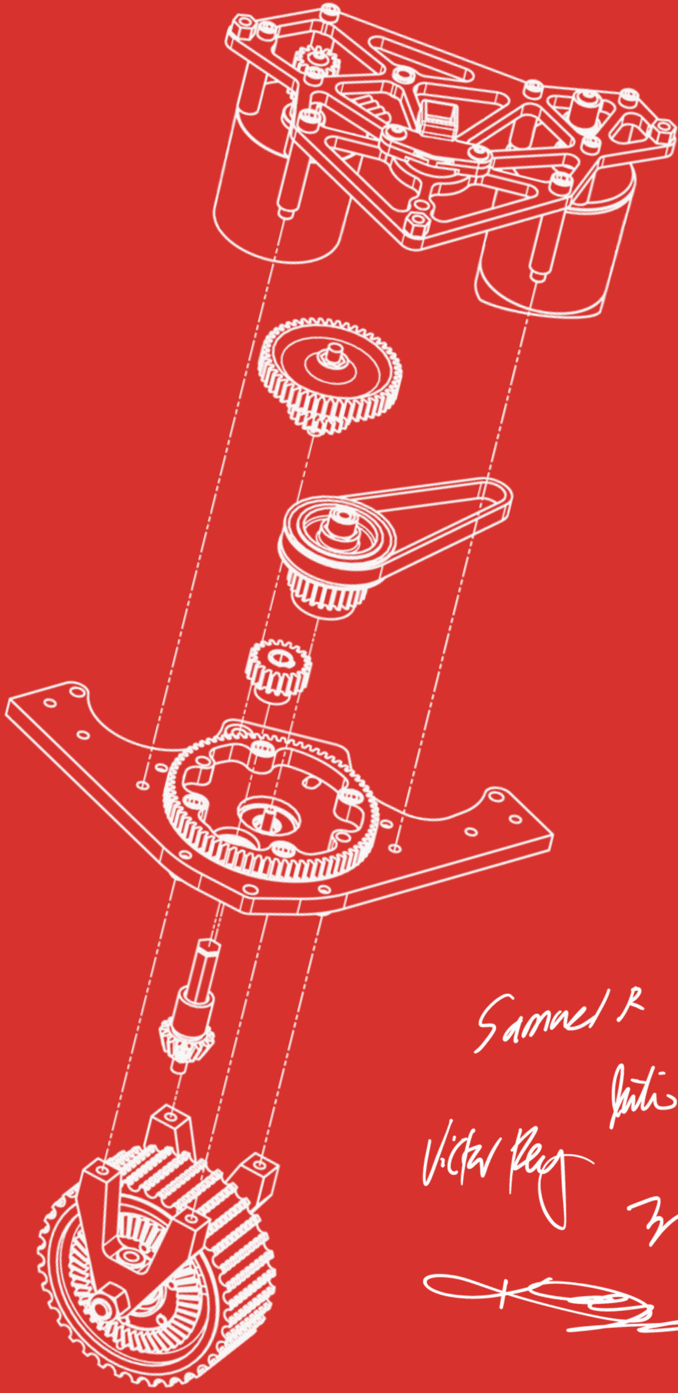
- We identified that a large steering gear under negligible force was needlessly bulky.
- Retailers are beginning to offer pocketed options for gears, but **we do it in-house**.
- Material is removed until a 0.090" web remains connecting the shaft to the teeth.
- Students learned to **grind and sharpen high speed steel (HSS) lathe tools**.
- We ground our own trepanning tool and used it to nearly **halve the gear's weight**.
- Previously, GRT bored out large holes. This is a waste of time and material. From our efforts to cut weight, we now have a tool with a range of many useful applications.



- Standard FRC vendors provide gears up to 3/8" thick, which could not accommodate the features we needed on the gear. We thickened the gear with a "gear hub."
- We first mill the stock. A hole is drilled near the stock center and broached. The part is then **centered about the broach**, ensuring other features are concentric.
- The remaining mounting holes and a bore are made relative to the hex broach.
- The part is mounted to a **GRT-welded fixture**, then adjusted about the axis and face using a **dial indicator**. The remaining features and the contour are manually lathed.
- This year, we also learned to precisely **adjust the center and square of the chuck**.



- Our bottom gusset is 0.350" thick, a balance between weight and strength.
- The nearest stock size we have is 0.375", which also comes to us ~0.011" oversized.
- Originally, we flycut the stock, which was slow and resulted in an uneven surface.
- Like many **new machining skills this year**, this **efficient and effective method** was adopted after curious team members found and cleaned an old fixture mount from storage, and researched how to use the lathe's spindle nose interface.
- Another essential non-curriculum feature students self-learned was the autofeed.



Samuel R