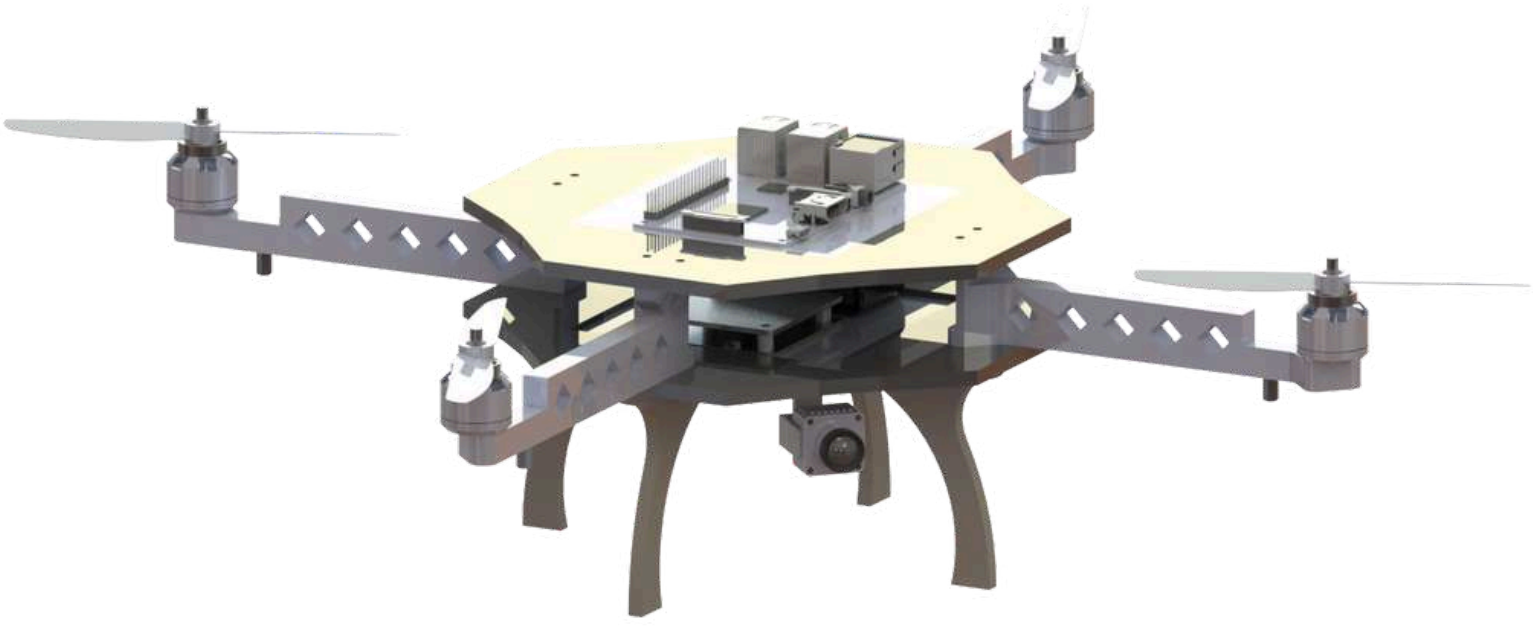
HUNZALA RAJPUT

ENGINEERING DESIGN PORTFOLIO



STEERING SYSTEM - FORMULA SAE

Designed and implemented steering system for University of Toronto Formula SAE Racing team

Design comprised of:

- three shaft steering system
- two universal-joints
- Stiletto steering rack to convert rotational input to linear motion

System can be operated:

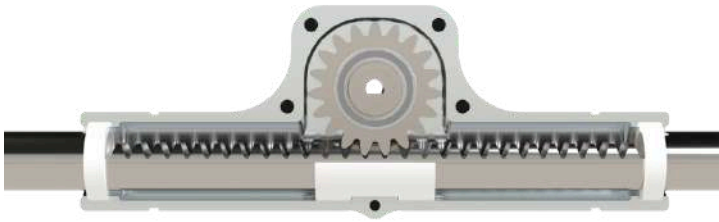
- manually by vehicle driver
- autonomously by robotic brushless DC (BLDC) motor

Detailed view of vertical bearing holder mounting

CUSTOM SAE RACK AND PINION

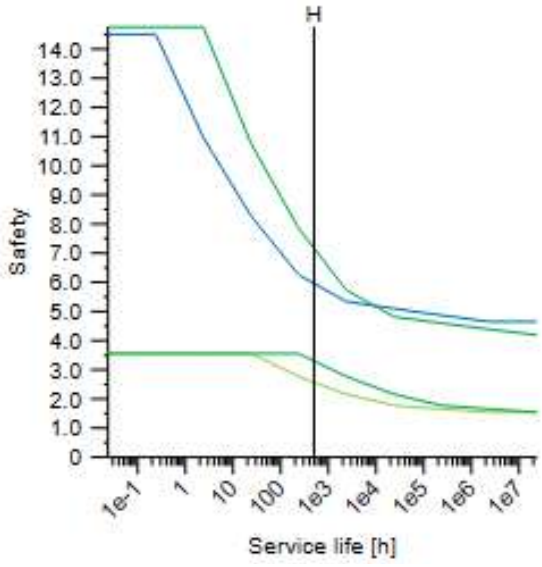
Designed first-ever custom SAE steering rack for University of Toronto Formula SAE Racing team using SolidWorks and Ansys

Detailed view of completed rack with a 6.4:1 gear ratio

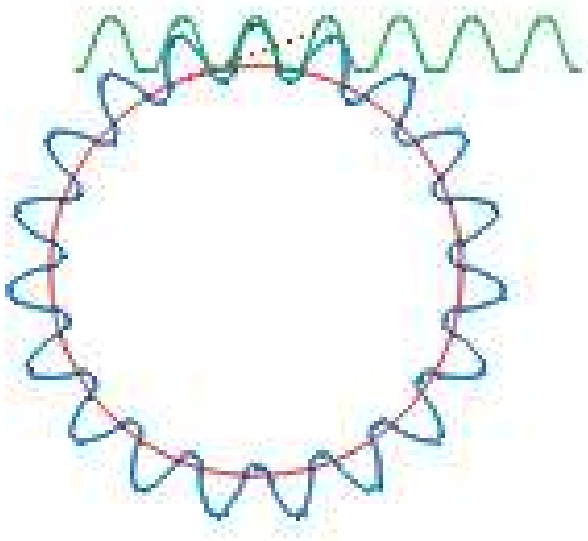


Dissected CAD view of rack and pinion

Conducted gear calculations and simulations using KissSoft



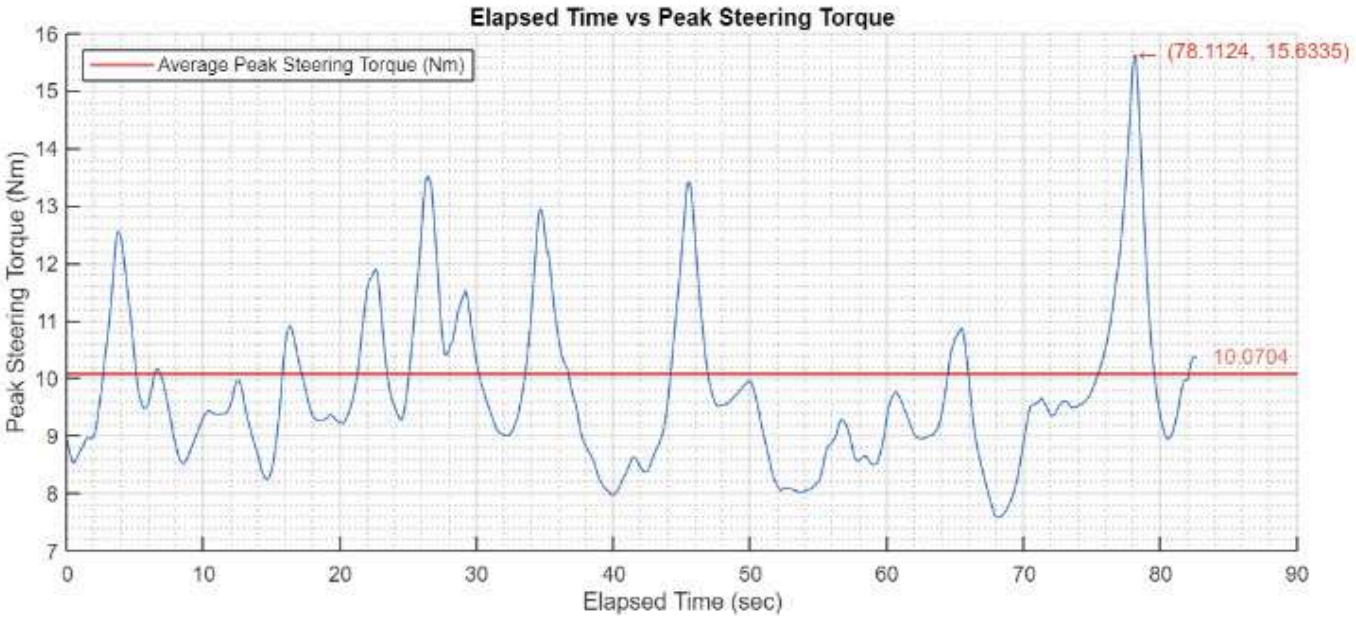
Graph depicting safety factor degradation against service life



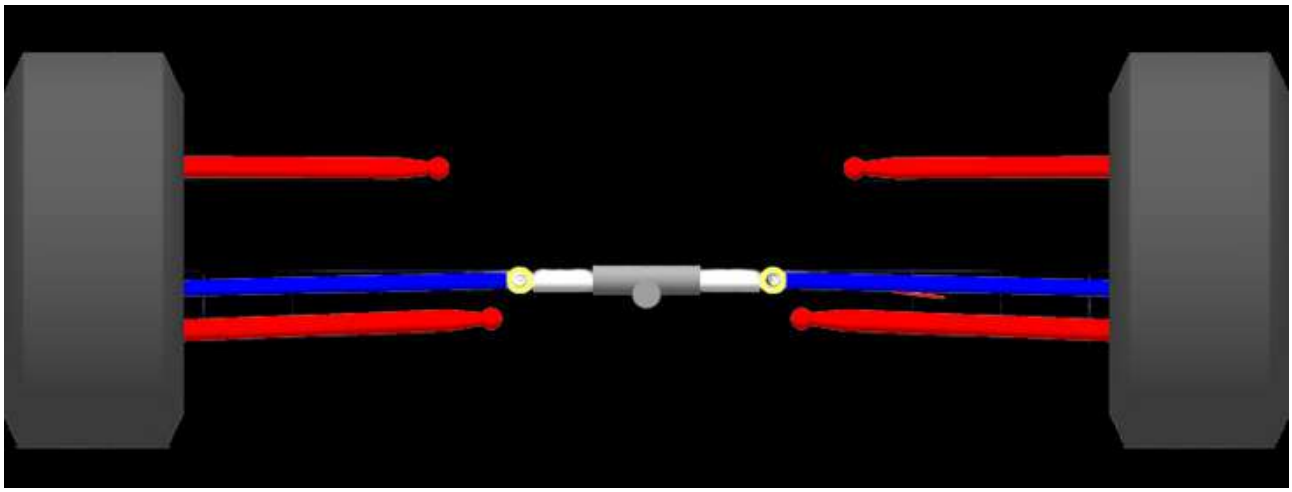
2D interactive view of 19-teeth pinion meshing with rack

STEERING TORQUE REDUCTION - FSAE

Redesigned suspension geometry to reduce steering torque by 64%



Steering torque telemetry of a vehicle using MATLAB



Suspension geometry in Susporg3D

AUTONOMOUS STEERING

Designed, bench tested and implemented first fully autonomous electro-mechanical steering system for University of Toronto Formula Racing team

System features

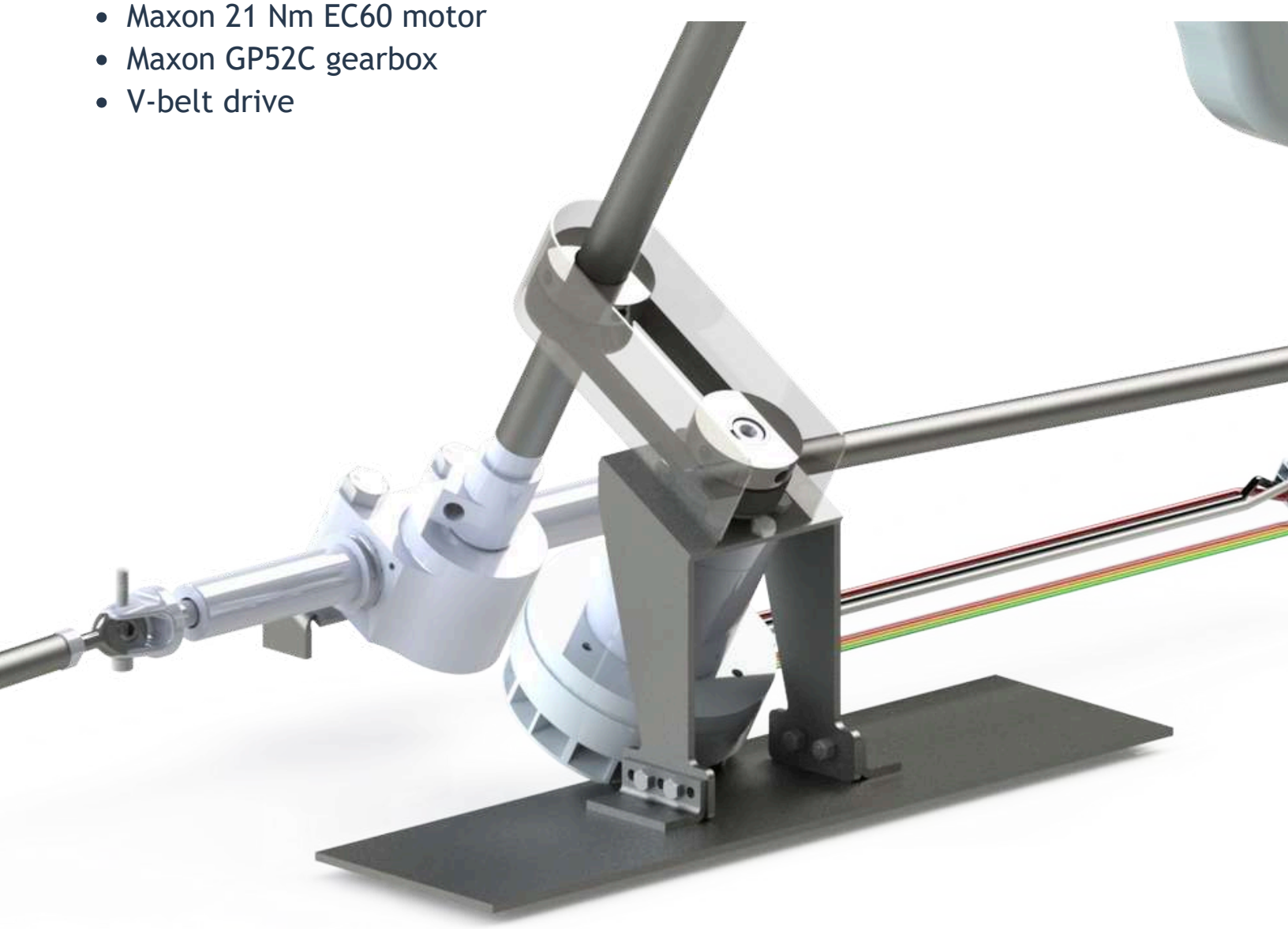
- 19 Nm AK10 robotic BLDC connected via chain-drive
- slider mounts allowing angle and lash adjustability
- belt shield for driver safety

STEER-BY-WIRE TESTING

Bench tested multiple electro-mechanical steer-by-wire systems

Iteration 1
Belt drive actuation of the steering shaft featuring:

- Maxon 21 Nm EC60 motor
- Maxon GP52C gearbox
- V-belt drive

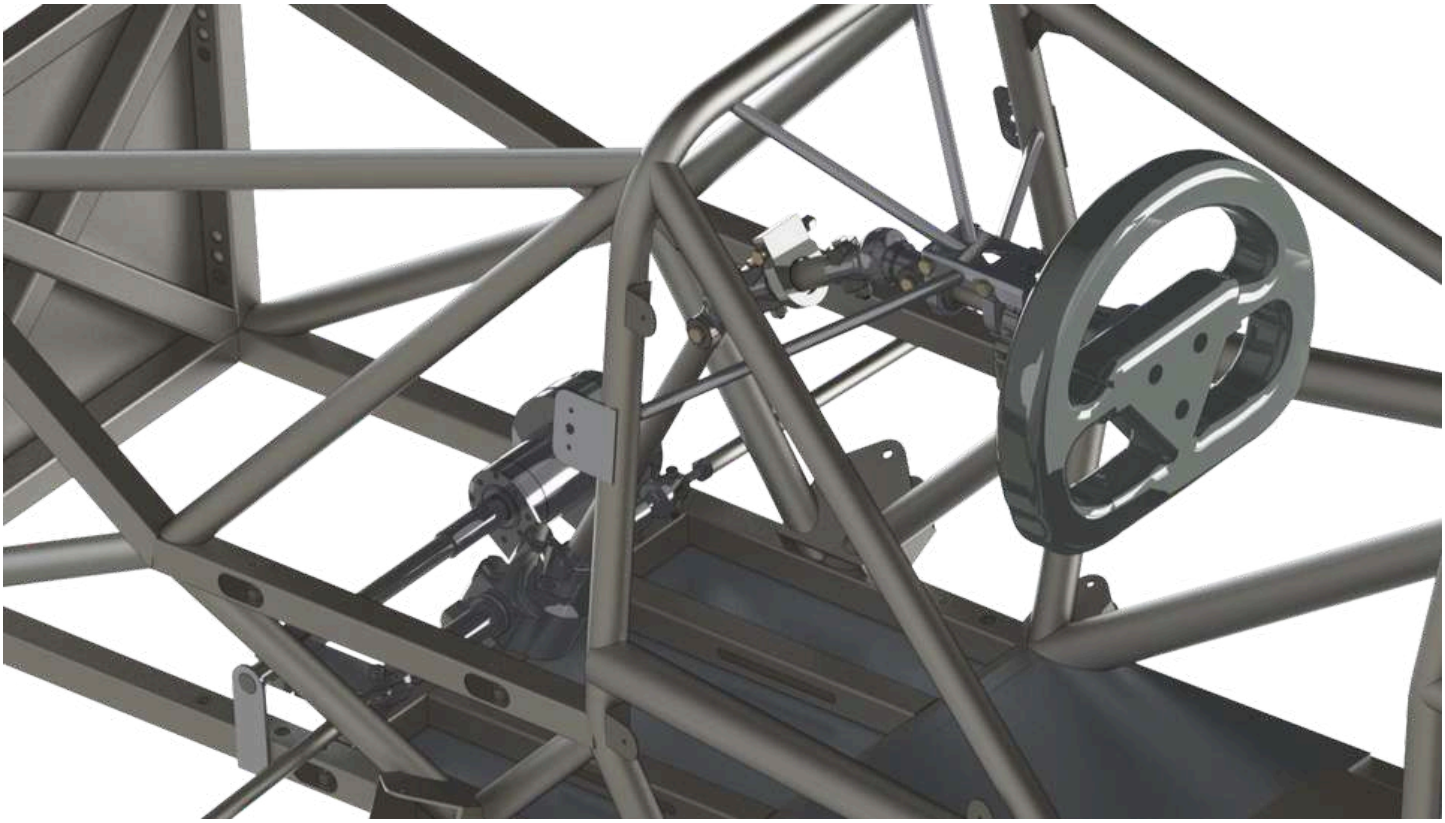


Iteration 2

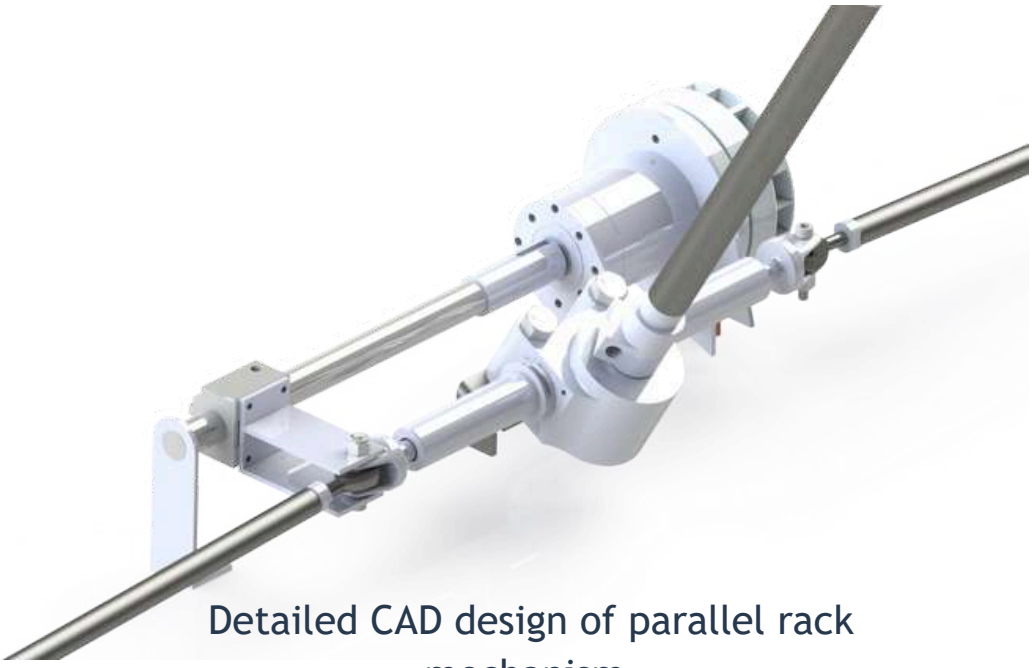
Parallel actuation of steering rack

Design features

- ball screw connected in parallel to steering rack end for turning wheels
- Maxon 21 Nm EC6- brushless DC motor (BLDC)
- Maxon GP52C gearbox



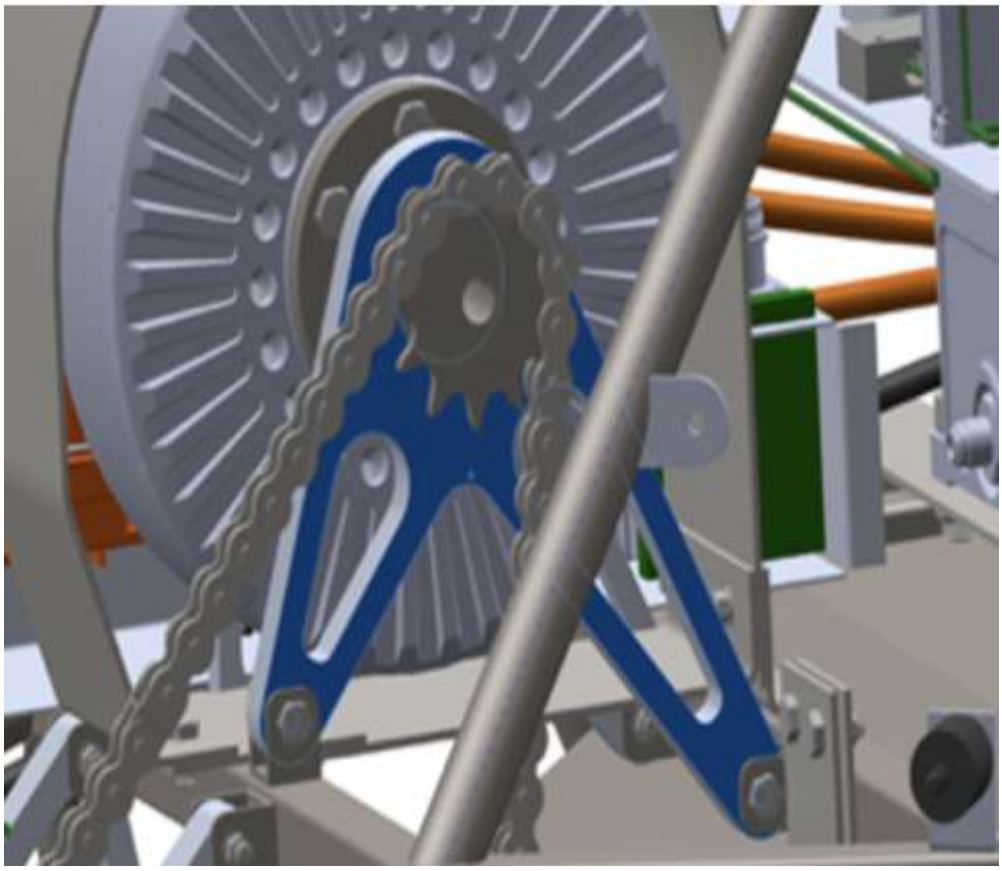
Rendering of parallel rack mechanism packaging in vehicle



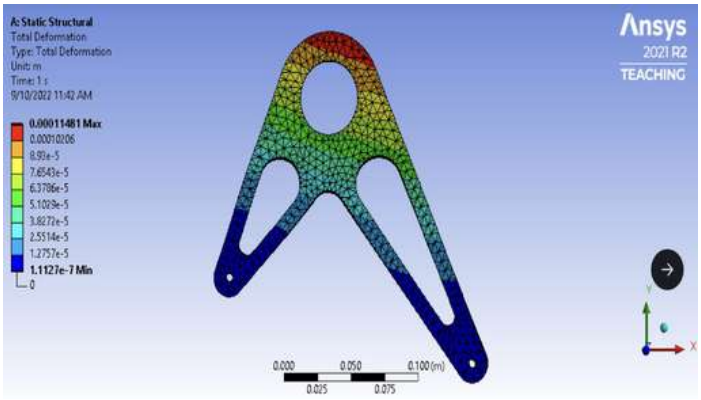
Detailed CAD design of parallel rack mechanism

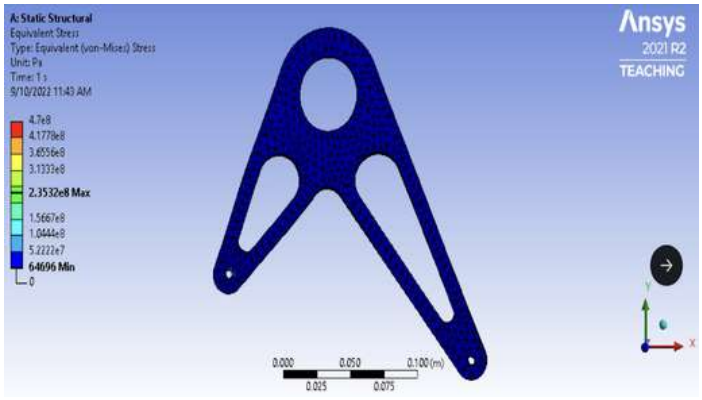
EMRAX MOTOR MOUNT - FSAE

Designed EMRAX motor mount using SolidWorks and analyzed in Ansys



Detailed CAD view of motor mount





Deformation and stress analysis of aluminum mount using Ansys

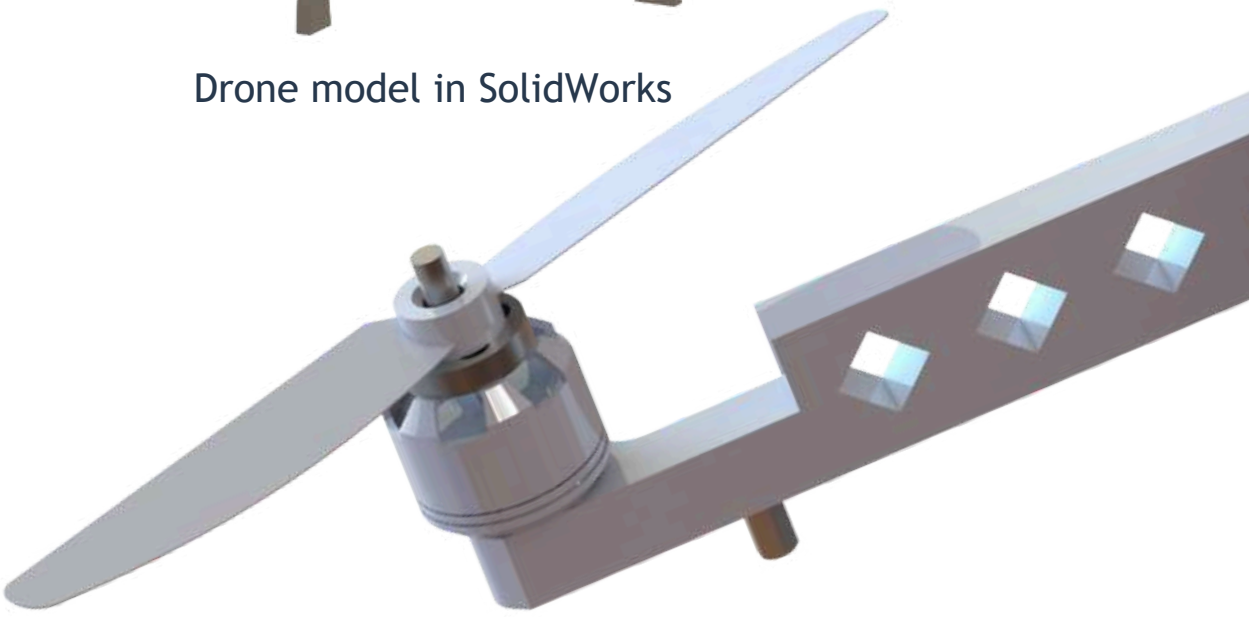
PACKAGE DELIVERY DRONE

Designed a package delivery quadcopter

Model features

- four mini-brushless motors
- flight controller
- camera

Drone model in SolidWorks



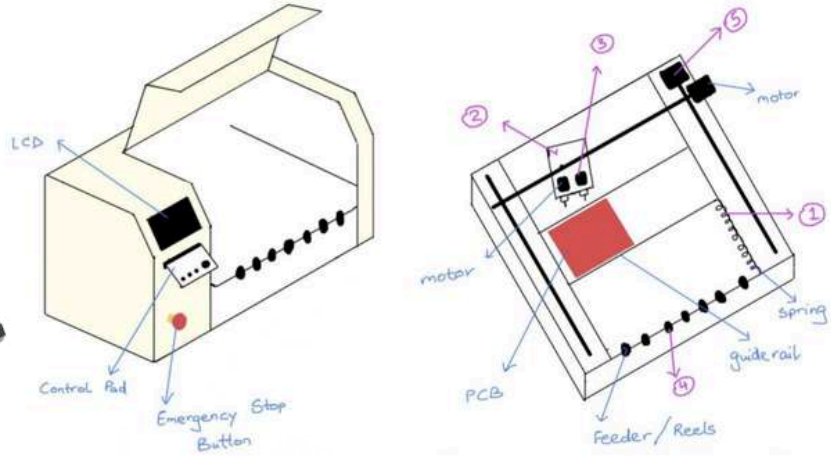
CAD view showcasing mini brushless motor

PICK & PLACE PCB MACHINE

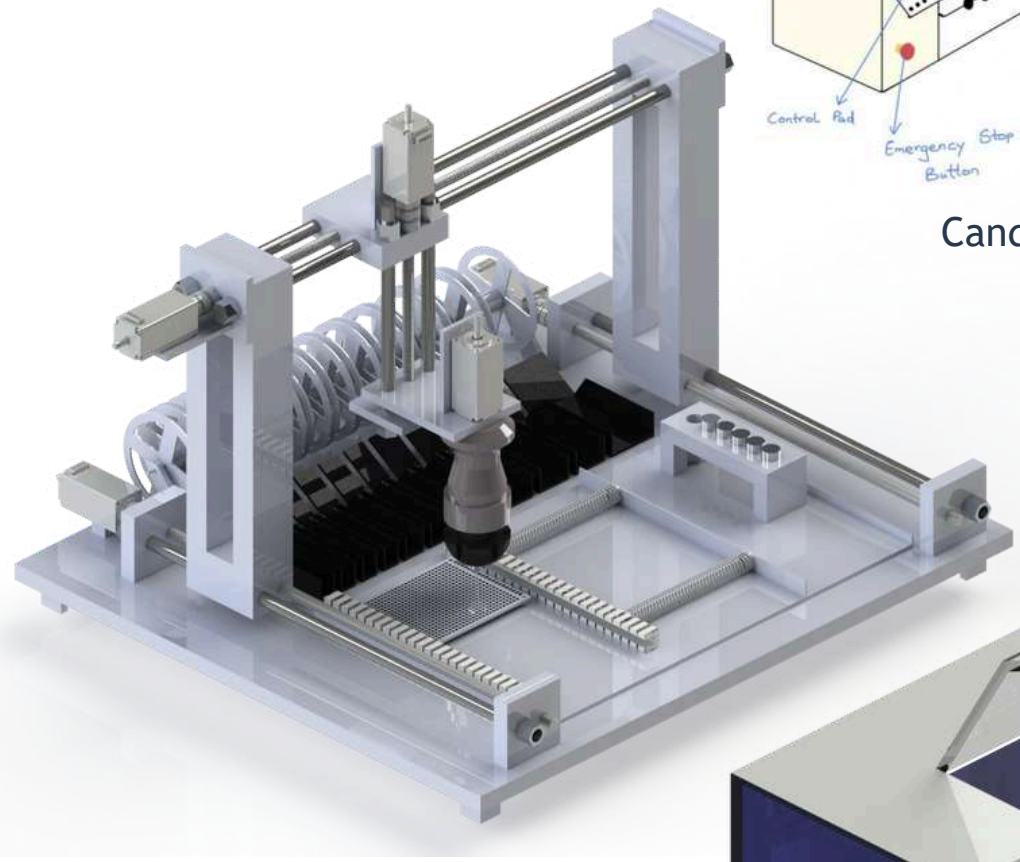
Designed 4-axis Printed Circuit Board (PCB) machine for educational setting

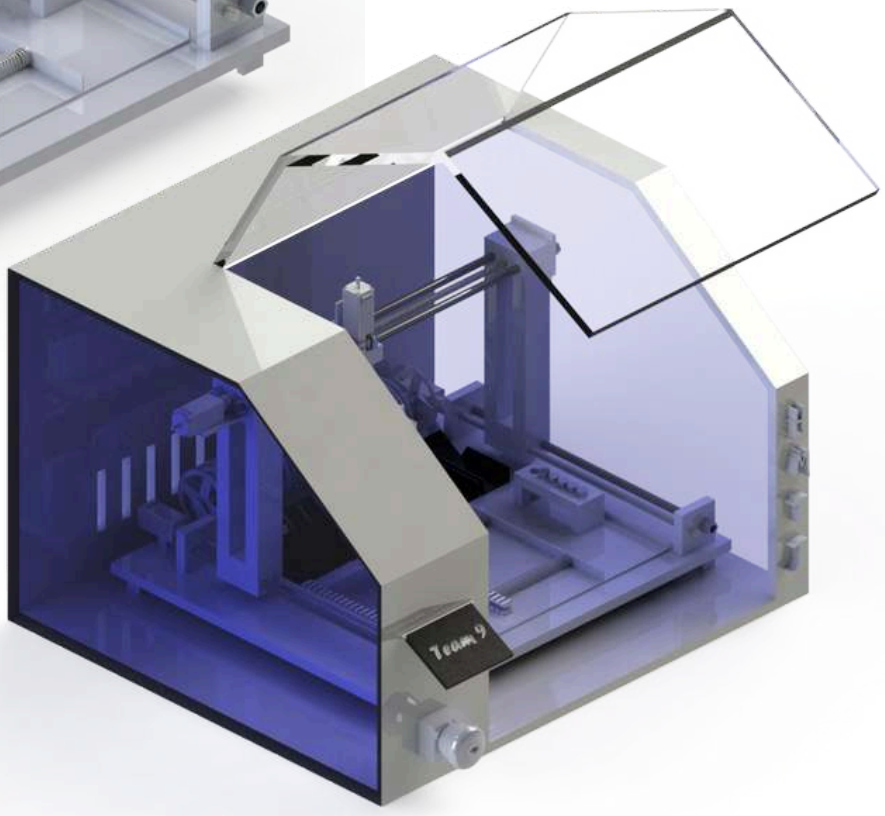
Design features

- vacuum pick up mechanism
- spring-loaded PCB holder
- heat dissipation mechanism



Candidate machine design





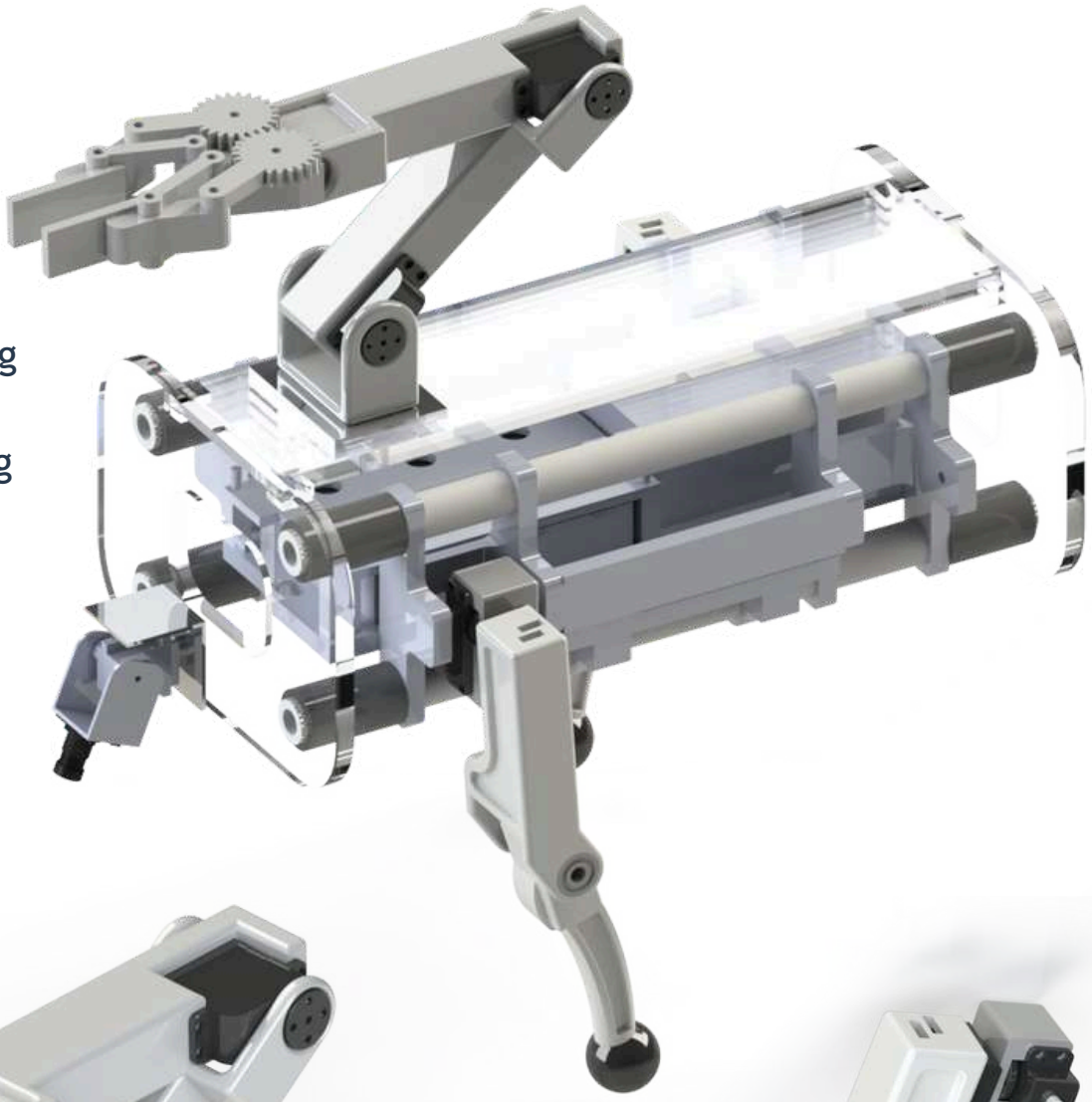
Detailed CAD design of pick & place PCB machine

ROBODOG

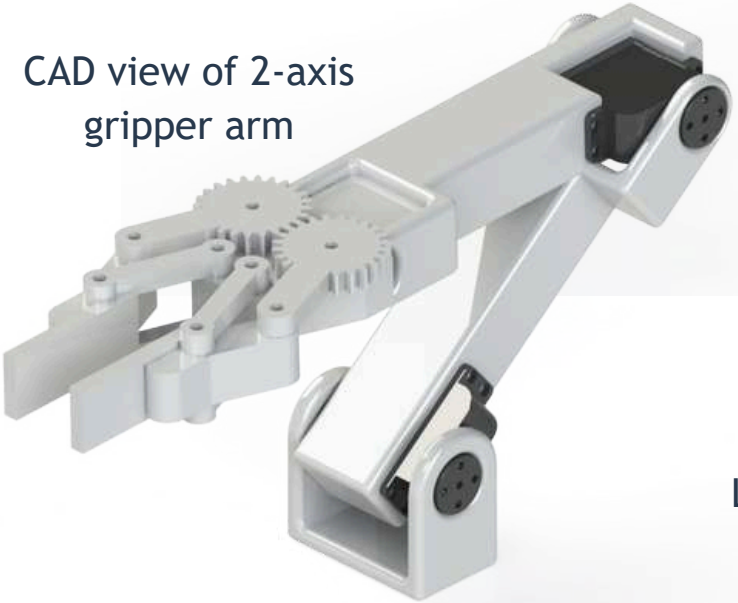
Designed a handyman Robot Dog responsible for assisting user in completing daily DIY projects

Model features

- four brushless DC motors (BLDC)
- two cameras
- gripper for holding tools
- LIDAR for mapping and navigation



CAD view of 2-axis gripper arm



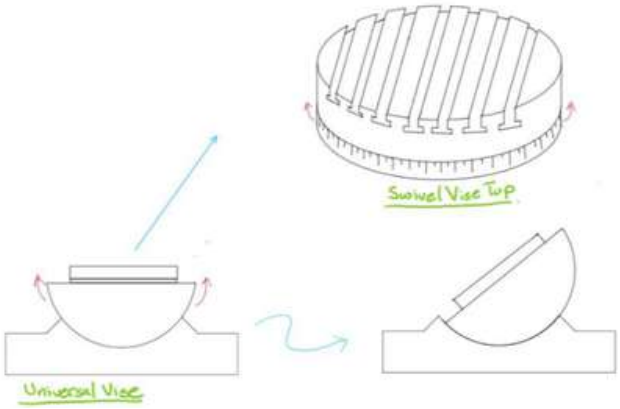
Leg actuated using a servo motor

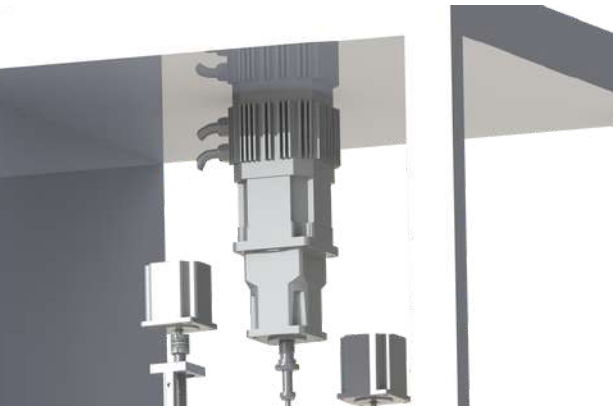
DESKTOP CNC MACHINE

Designed custom 4-axis Computer Numerical Control (CNC) machine using SolidWorks

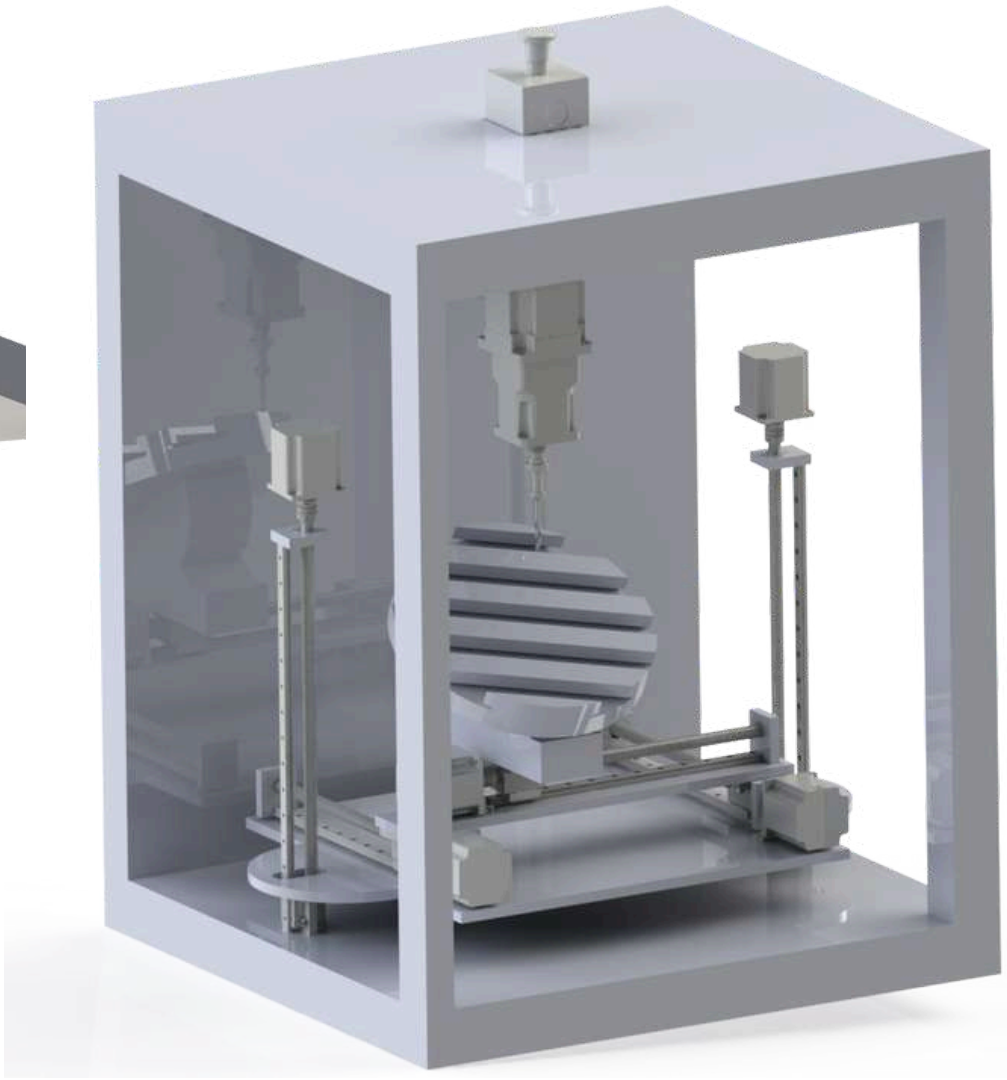
Design features

- 30,000 RPM Nema32 stepper motor for milling at different cutting speeds
- two Nema14 stepper motors for XYZ movement of work plate





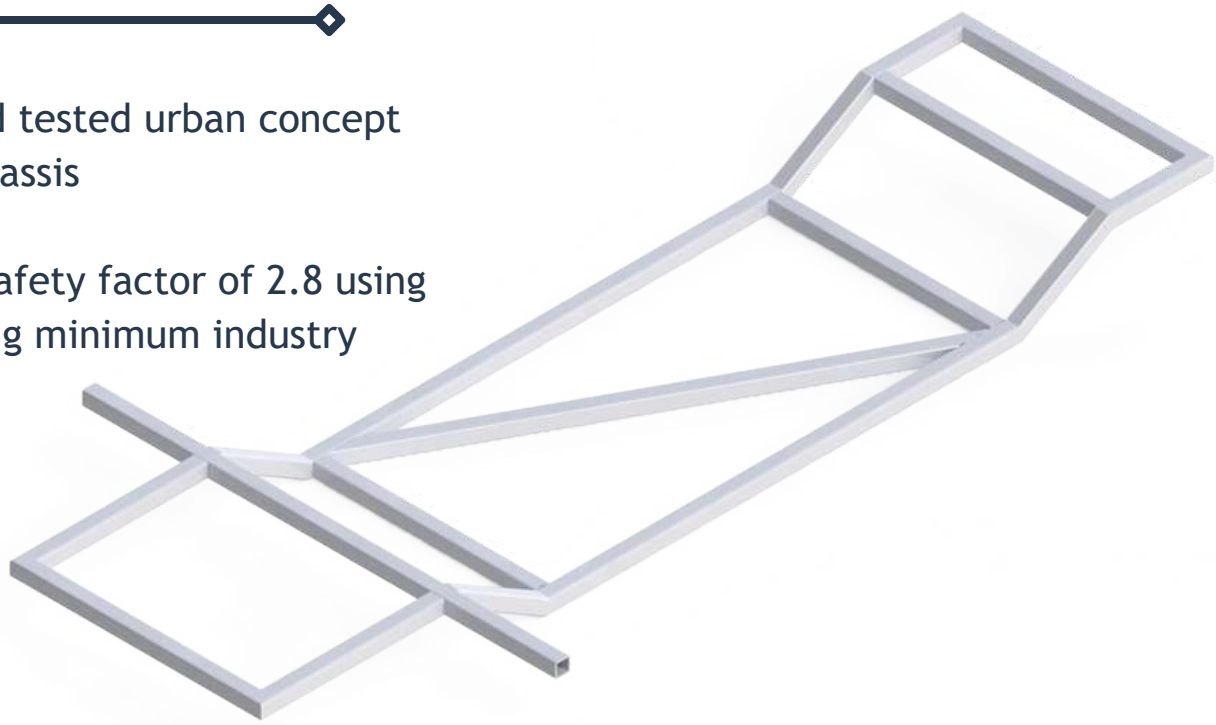
CAD view of Nema32 stepper motor

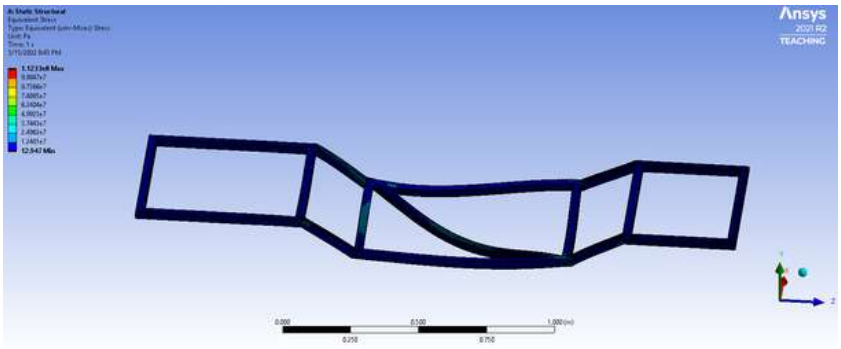


SUPERMILEAGE CHASSIS

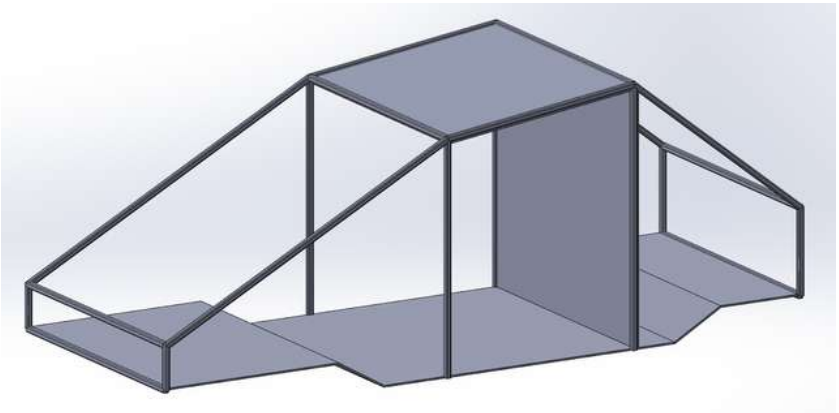
Designed and tested urban concept aluminum chassis

Achieved a safety factor of 2.8 using Ansys, passing minimum industry standards





Deformation and stress analysis of chassis using Ansys



Early candidate design of chassis in SolidWorks

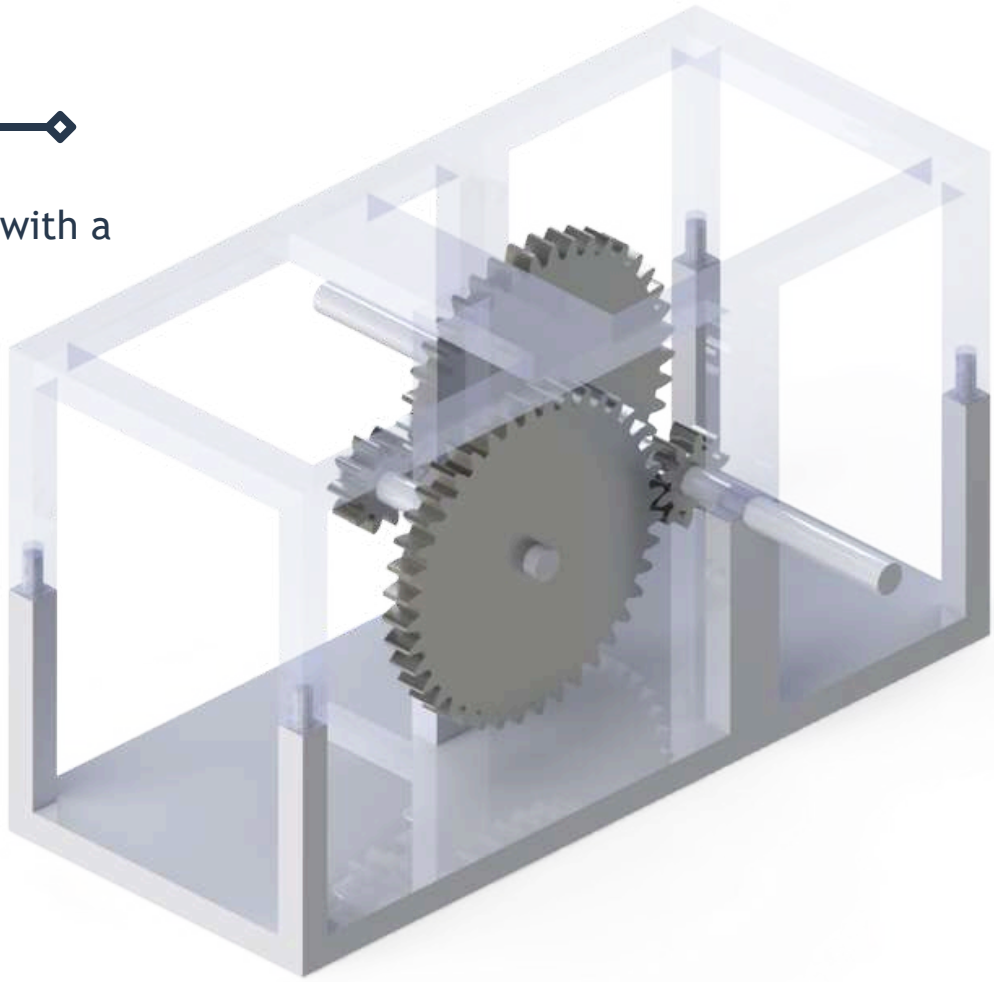
GEARBOX

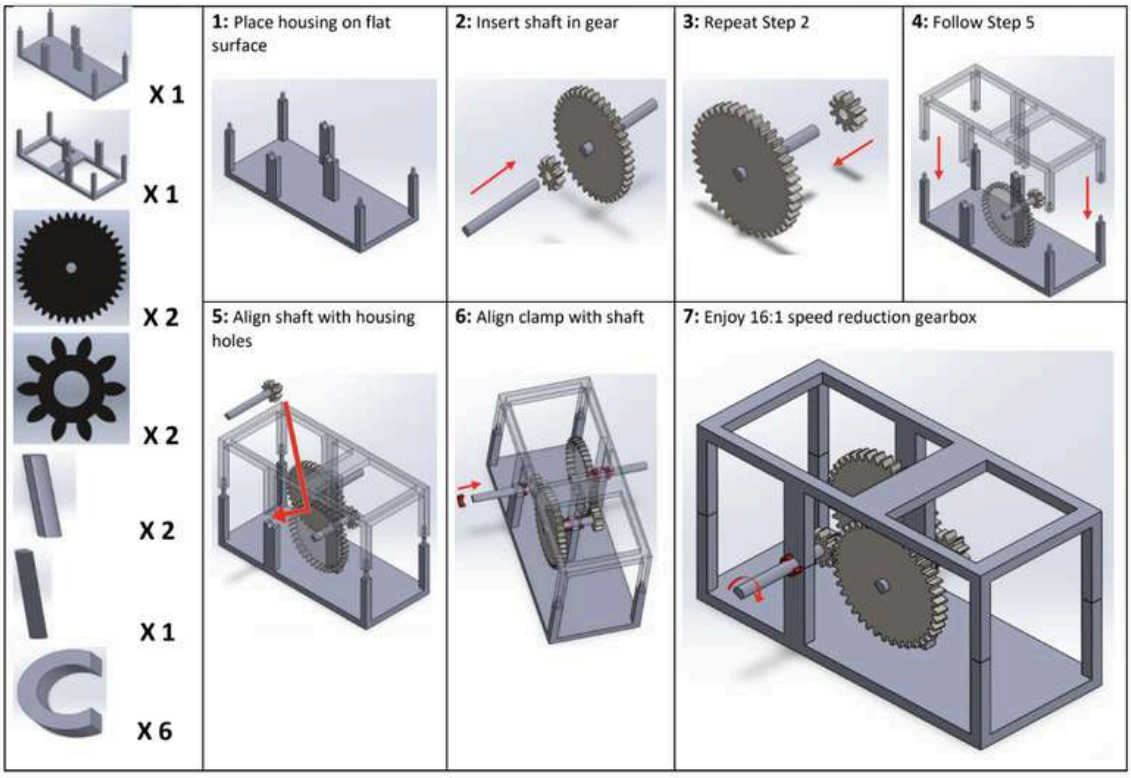
Designed a custom gearbox with a speed reduction of 16:1

The model was:

- optimized for 3D printing
- simulated under **accelerated life testing (ALT)**

The design withstood 400 RPM from a cordless drill, meeting minimum service life specifications





Gearbox assembly manual

MARINE GEAR ANALYSIS

Conducted fatigue life analysis of marines gears using Ansys

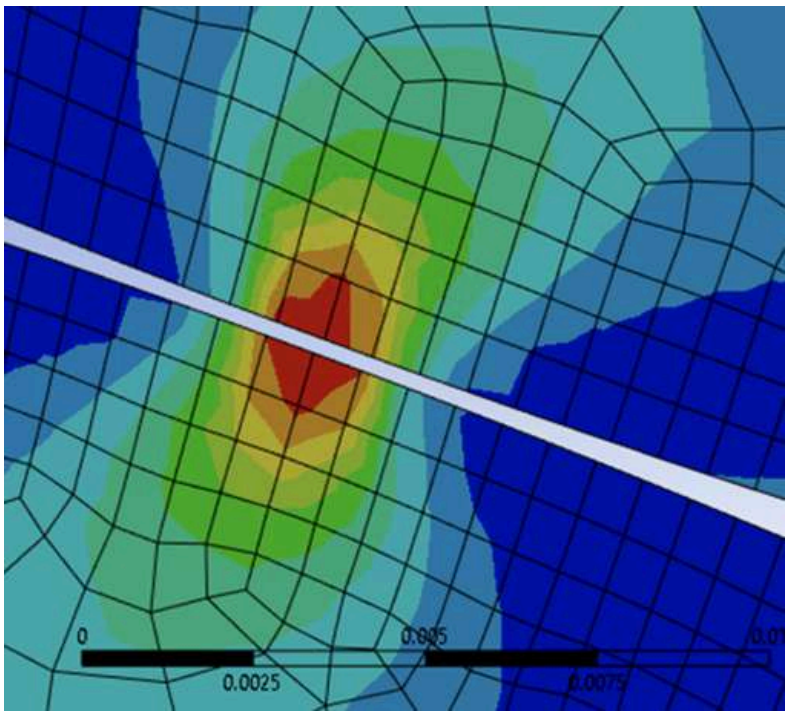
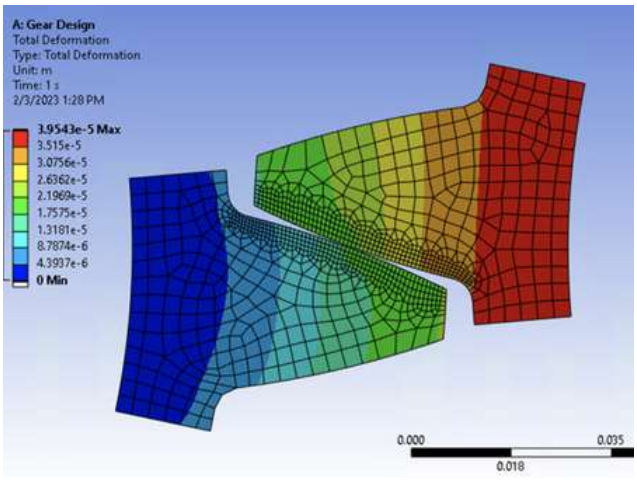
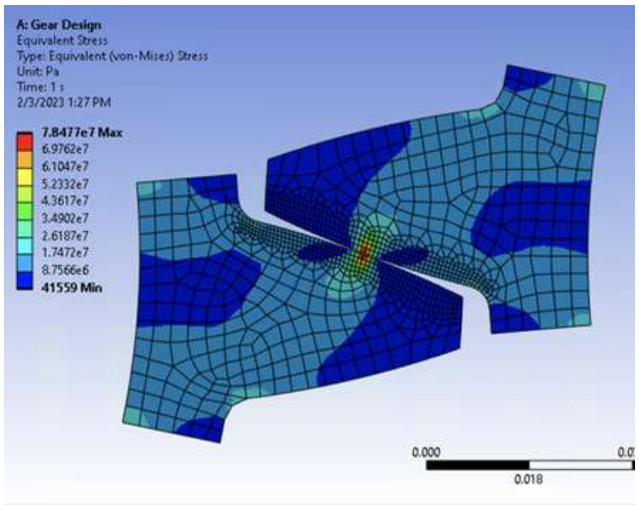


Figure shows stress concentration at point of tooth contact





Deformation and stress analysis of marine gears using Ansys