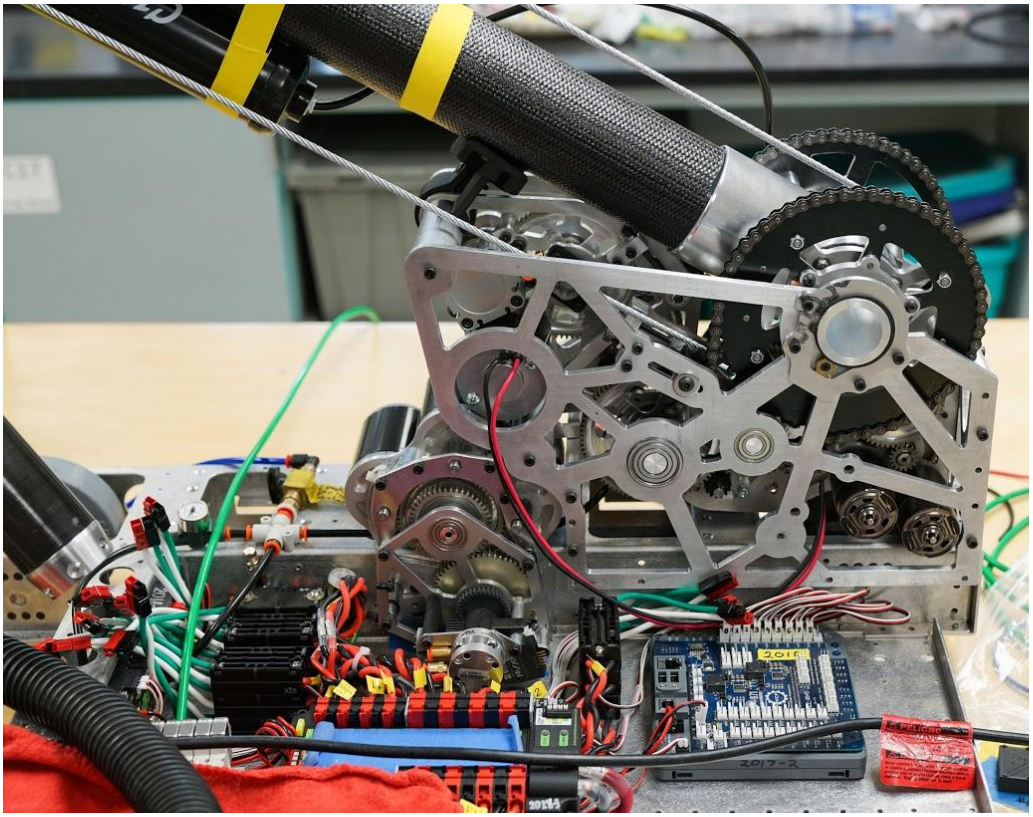
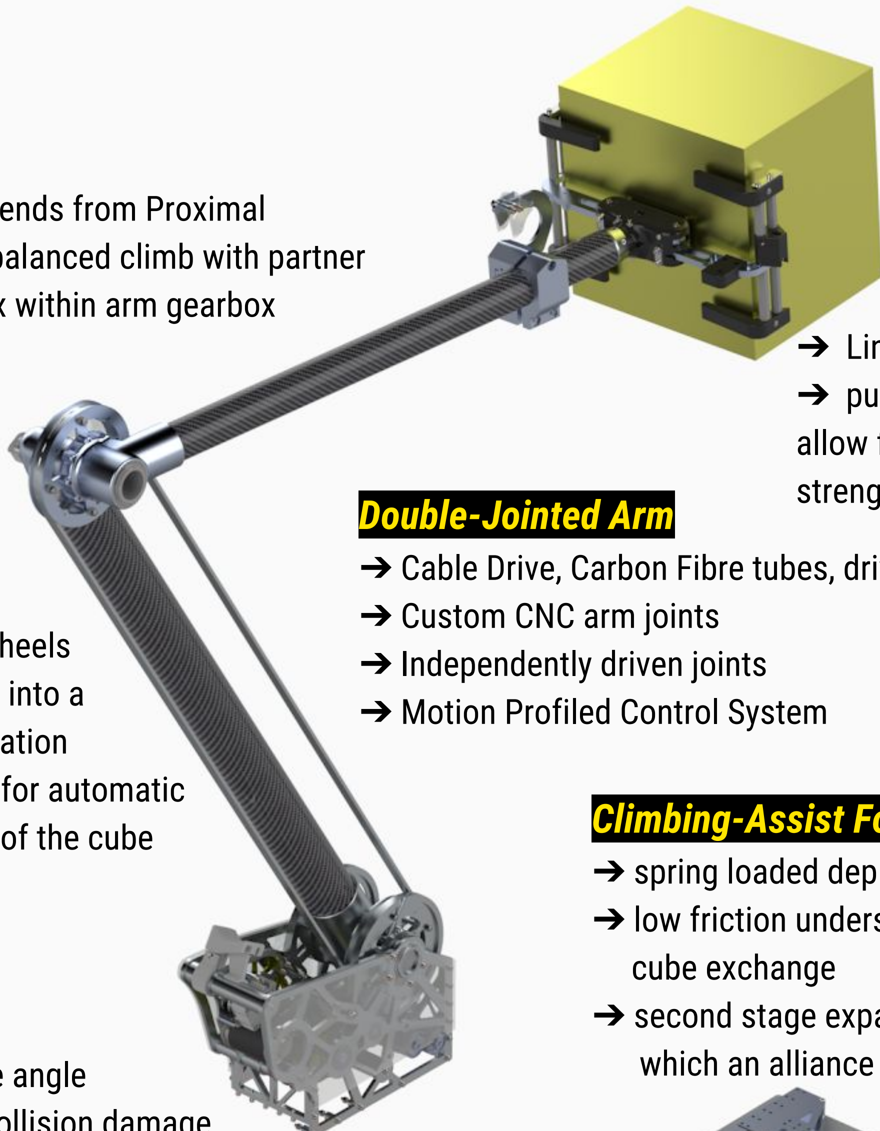
SPARTAN ROBOTICS

FRC 971



Technical Documentation 2018

971 Robot Overview



Climber
- ➔ Hook deploy
- ➔ Winch cable extends from Proximal Tube allowing balanced climb with partner
- ➔ Climber gearbox within arm gearbox

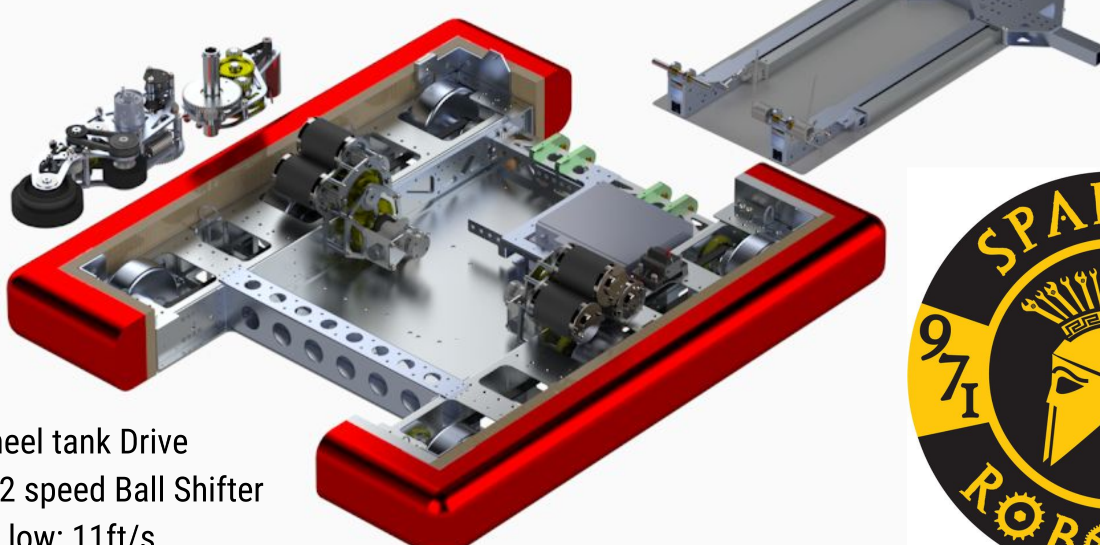
Claw
- ➔ Linear pneumatic action
- ➔ pulleys minimize profile and allow for increased grasping strength

Double-Jointed Arm
- ➔ Cable Drive, Carbon Fibre tubes, driven by 3 mini CIMs.
- ➔ Custom CNC arm joints
- ➔ Independently driven joints
- ➔ Motion Profiled Control System

Intake
- ➔ 4” Webbed Fairlane Wheels
- ➔ Geometry forces cube into a predictable 45º orientation
- ➔ Optical sensors allow for automatic orientation correction of the cube

Climbing-Assist Fork
- ➔ spring loaded deployment mechanism
- ➔ low friction underside to allow for efficient cube exchange
- ➔ second stage expansion enlarges the area which an alliance member has to drive on

Series Elastic
- ➔ Continuously variable angle
- ➔ Elasticity mitigates collision damage

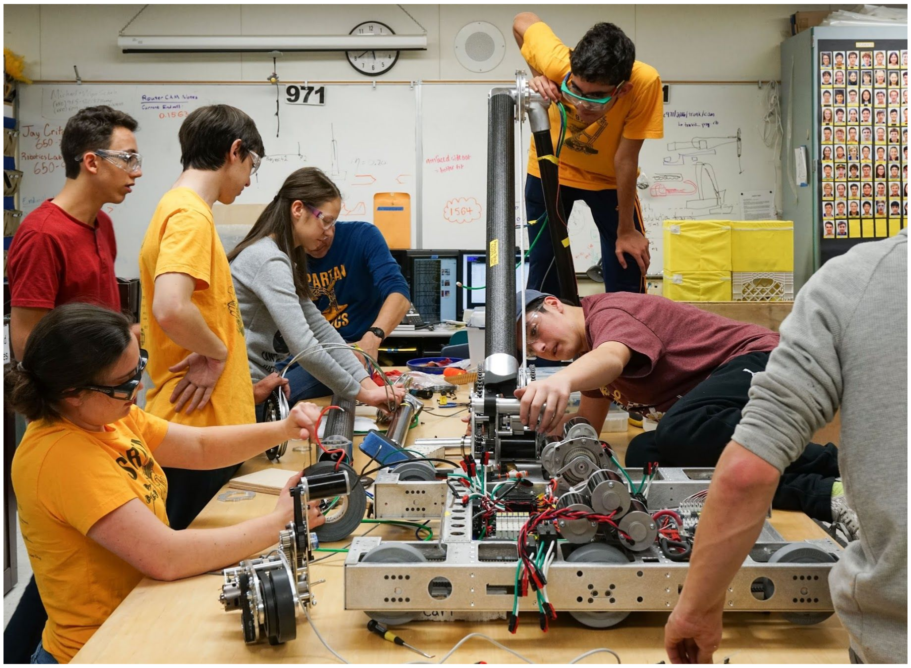


Drivetrain
- ➔ 6 Colson wheel tank Drive
- ➔ Belt Driven, 2 speed Ball Shifter
- ➔ High: 17ft/s low: 11ft/s

971 ON DESIGN

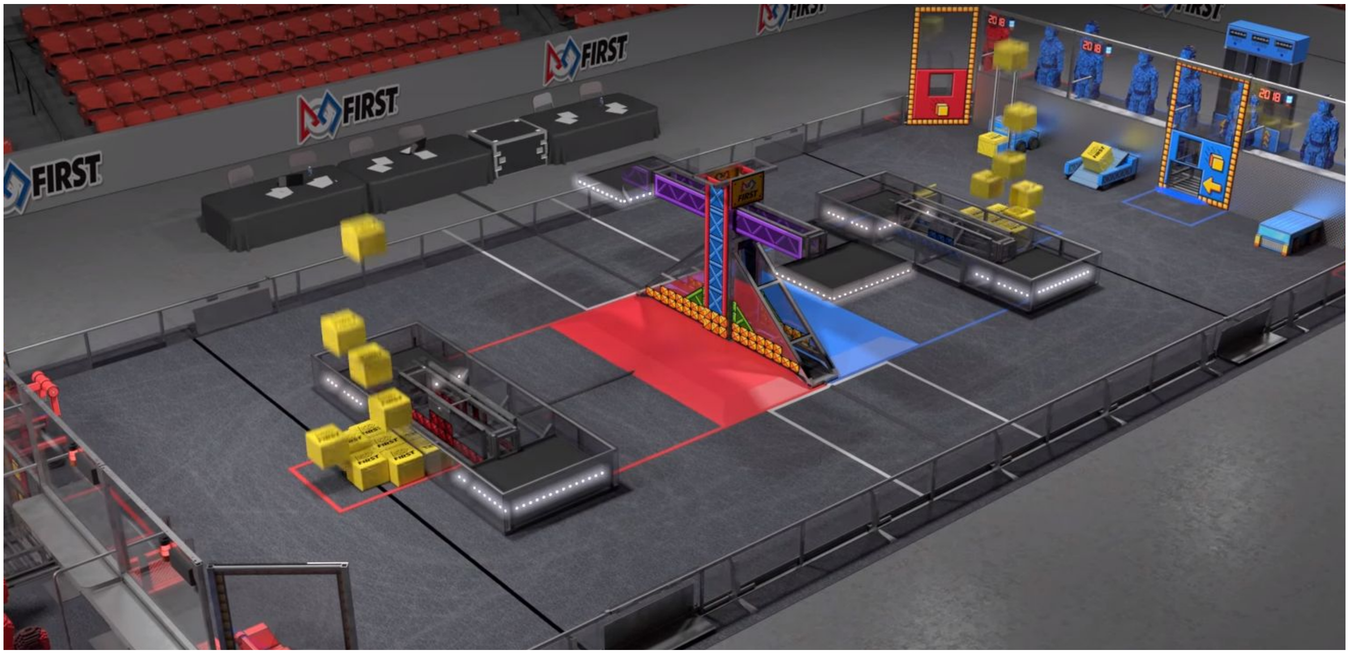
On Spartan Robotics, we believe that engineering is the process of optimizing a solution to perform its task as efficiently as the laws of physics allow. Our goal is the develop the highest quality robot possible and relentlessly chase perfection.

Design Process



1. Identify necessary functions.
2. Determine assemblies and allocate the necessary functions.
    - Prototype subassemblies.
    - Use CAD to determine geometry and prototype to confirm feasible geometry.
3. Use CAD to design the robot and produce drawings for manufacturing.
4. Integrate subsystems with code. Use state feedback control to make the robot run at peak performance reliably and consistently.

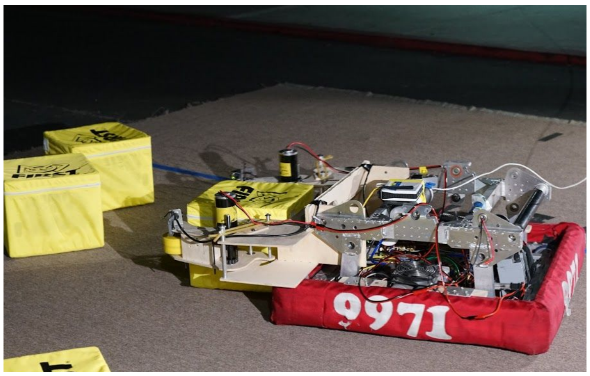
Robot Function Objectives



- Place Cubes on the Scale with a degree of accuracy amenable to stacking multiple layers, as quickly as possible, while facing towards or away from the scale.
- Intake Cubes off the ground from a variety of angles and lateral displacements without requiring driver/manipulator input.
  - “Touch it, own it.”
- Be able to place cubes on the switch and the exchange with them fore or aft of us.
- Maneuverable and light drivetrain to avoid defense.
- Hang quickly and consistently at the end of the match, with the ability to carry another robot with us.

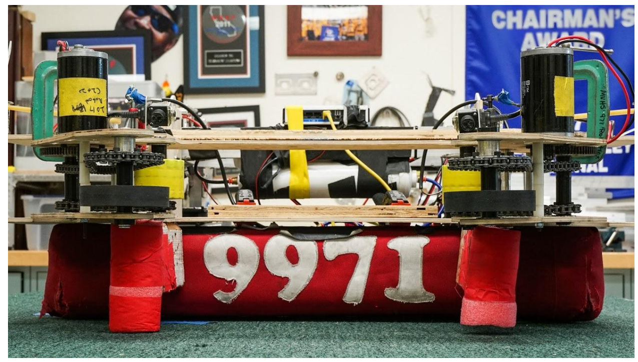
Prototyping

Intake



Iteration 1

- Noticed box, would be forced to 45º, added optical sensors to detect when it was in that orientation and reverse one side of the intake

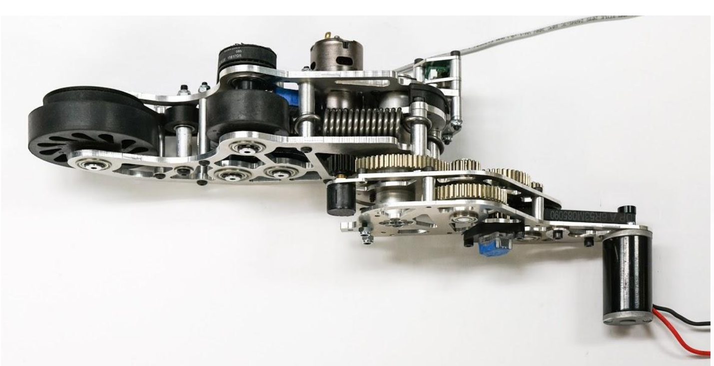


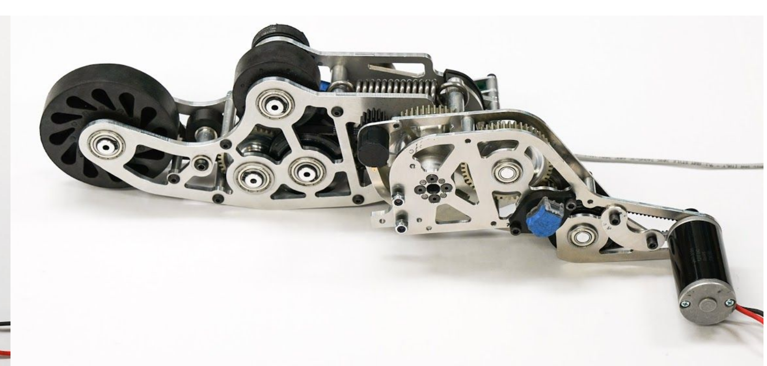
Iteration 2

- Softer, Thinner Webbed Fairlane Wheels allow for greater friction against box, tuning intake geometry and tension to allow for intake boxes from all states.

Final Iteration + Series Elastic:

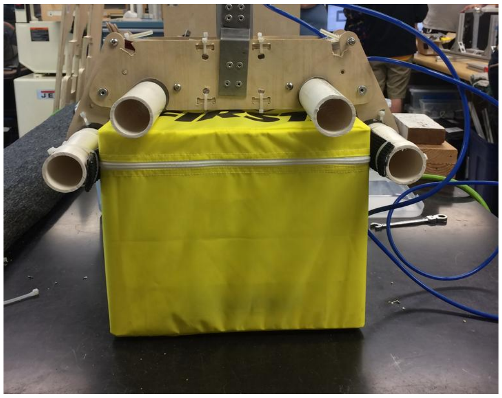
After determining out geometry and that actively varying our intake angle would be beneficial towards our goals iit became obvious we would need to actuate the intakes, and we welcomed the notion of a motor in series with our elastic as both a means to more effectively damp oscillations we observed in prototyping and give us greater control authority over this subsystem.





Prototyping

Claw



Iteration 1

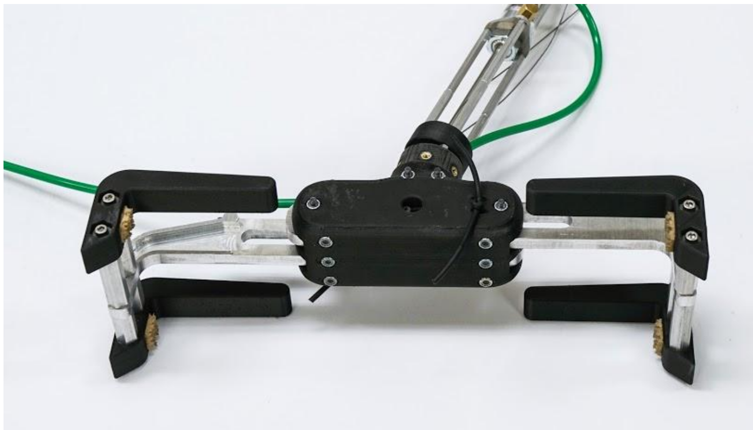
- Hinged pvc actuated with pneumatics
- Worked very well, with next iteration attempted or reduce weight and allow for the cube to be placed from any claw orientation

Iteration 2

- Linear Actuation was determined to be similar to hinged, and could be made far lighter.
- Carbon fiber 3d printed components, milled aluminum structural elements
- Pulley System allows for lower size and rotational inertia

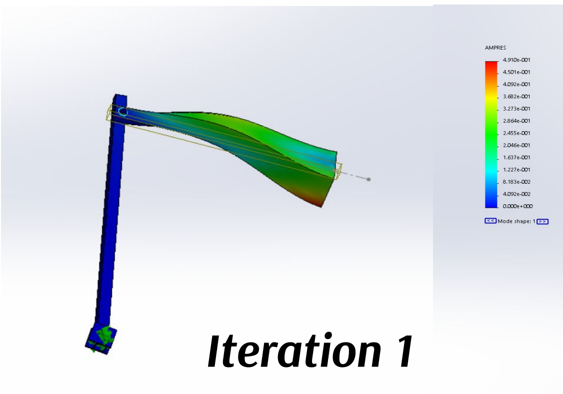
Final Iteration + Tuning

After realizing, much to our chagrin, that the wider claw caught on the zipper cover on the power cubes we made the decision to sacrifice a small amount of control while reducing both weight and the jamming behavior by shortening the claws considerably.



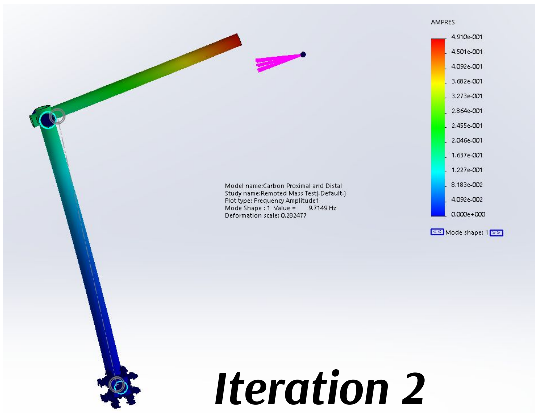
Prototyping

Arm



Iteration 1

- Light square aluminum tubing
- Structurally unsound



Iteration 2

- 3in carbon fibre proximal tube, 2 in distal tube
- Much stiffer(Natural frequency ~ 10 Hz)
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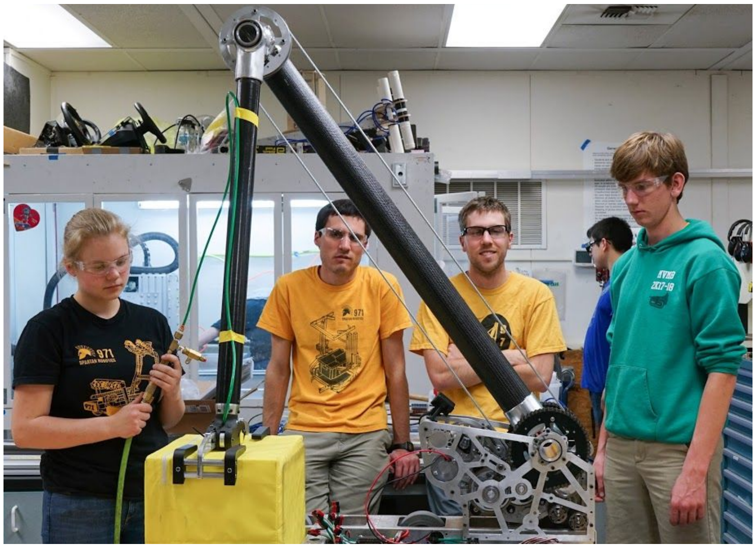
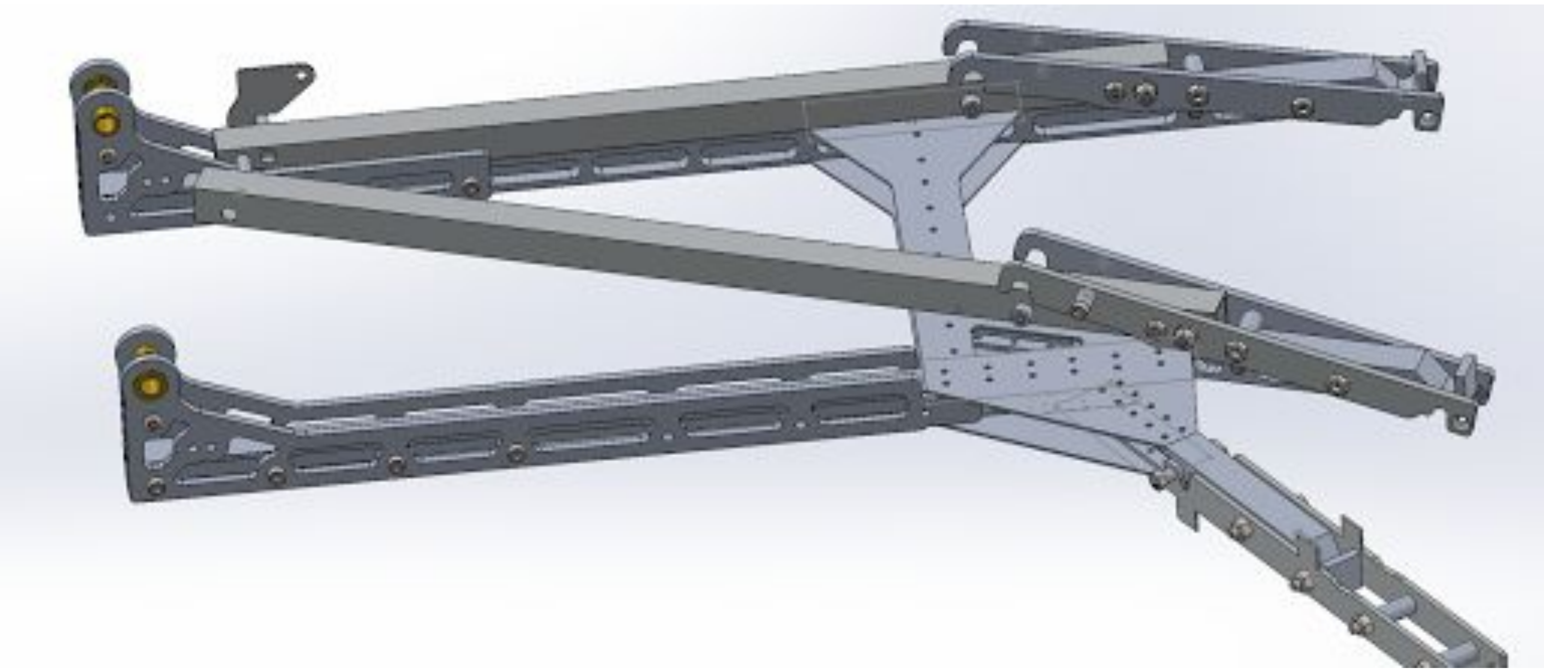
Final Iteration + Tuning



Prototyping

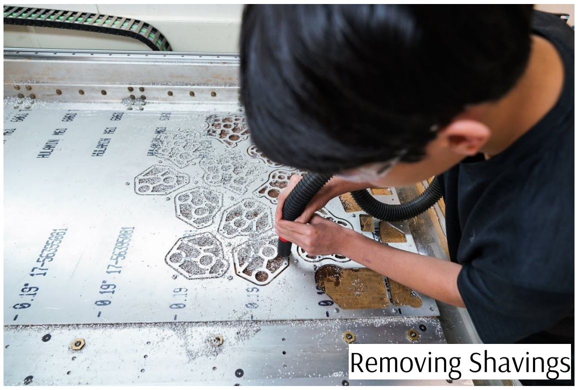
Lift

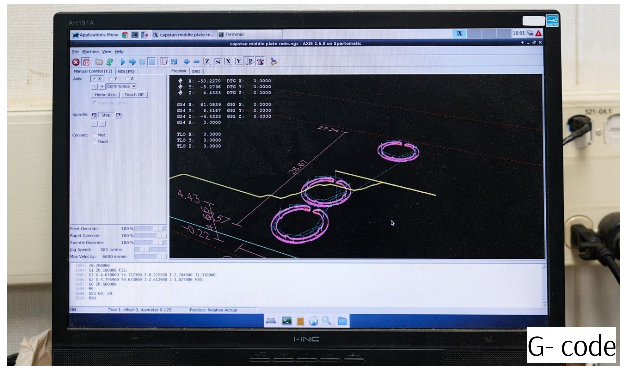
Load Test at 38 lbs



In-House Manufacturing

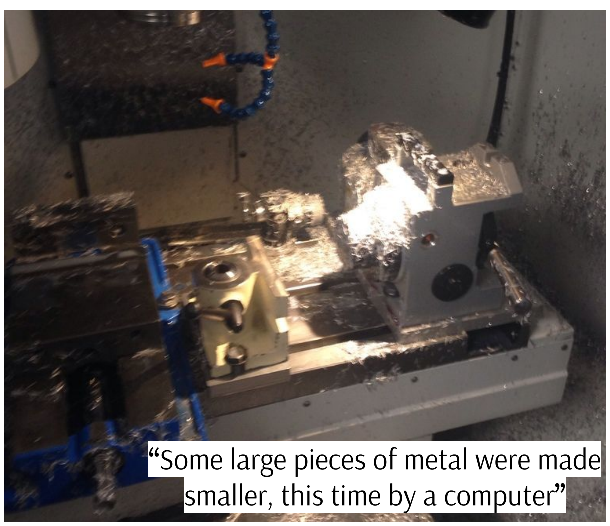
CNC Router


Removing Shavings


G- code

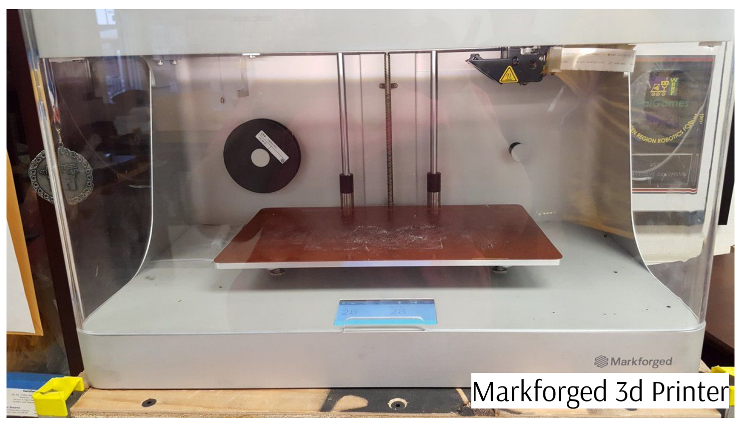
Mill

“Some large pieces of metal were made smaller”


“Some large pieces of metal were made smaller, this time by a computer”

3D Printer


Finished 3d printed part



Markforged 3d Printer