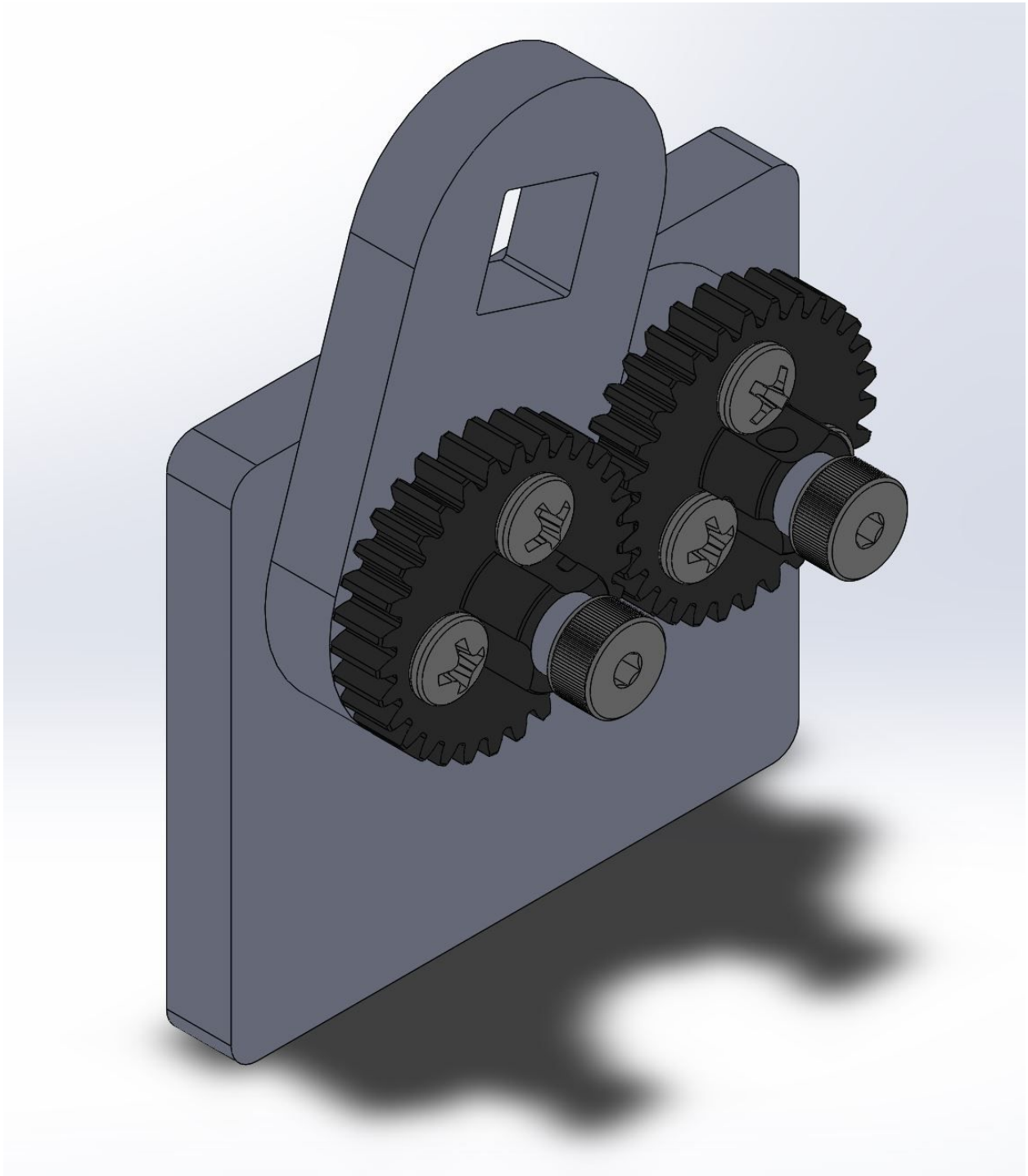
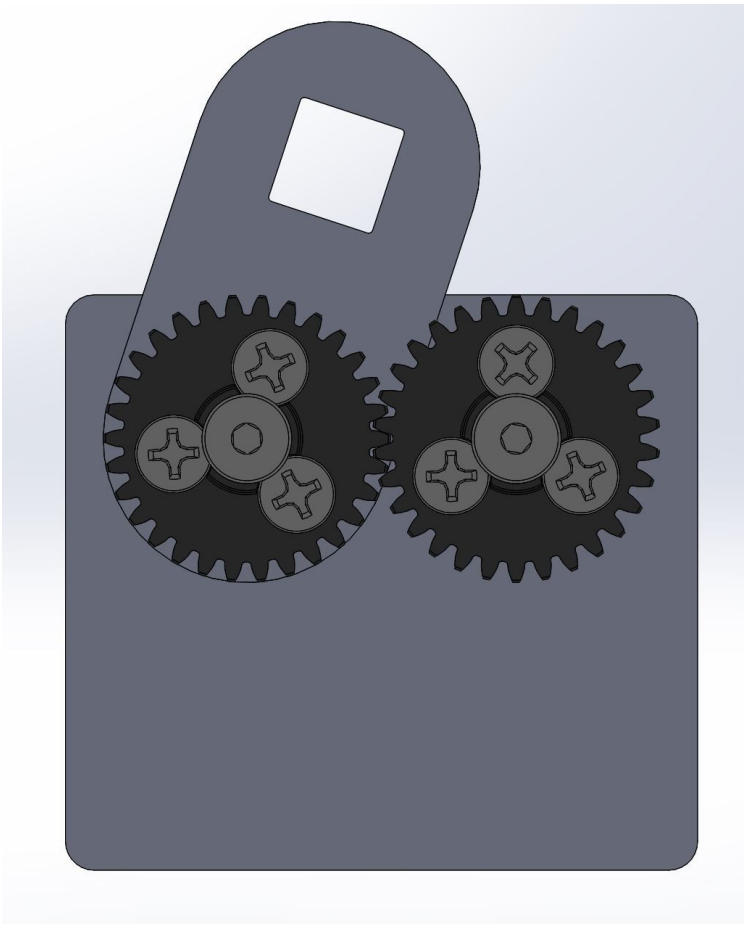
Miyuki Weldon
Hybrid Robotics Lab
Summer 2018 Project

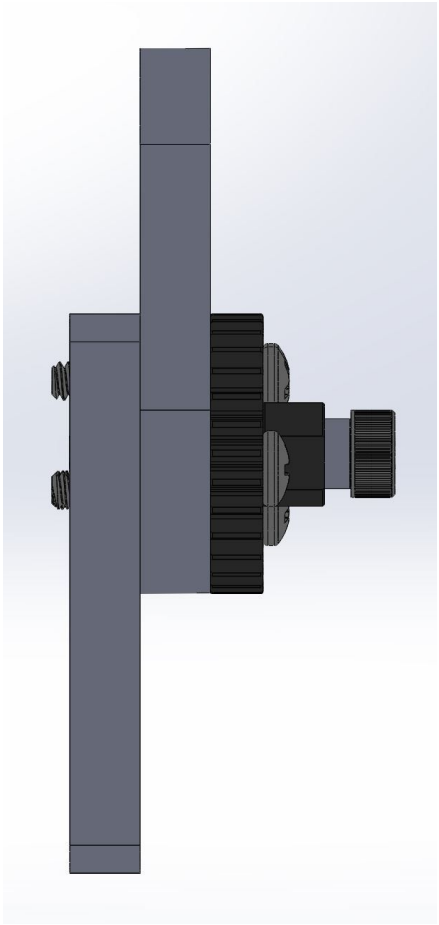
Gear Testing Results

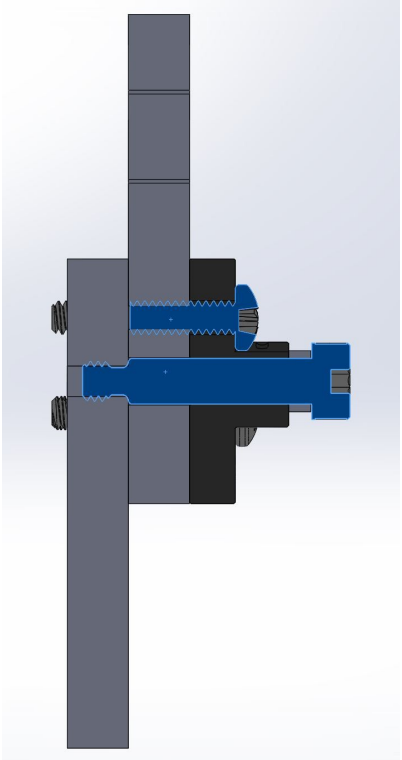
Setup:

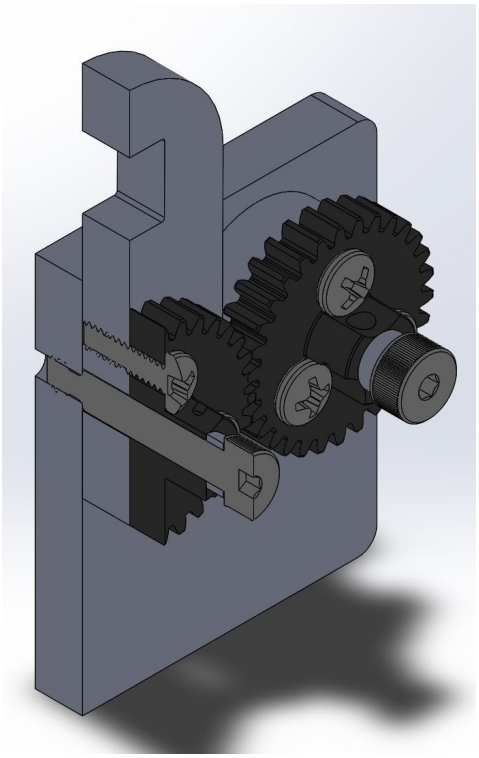
CAD:











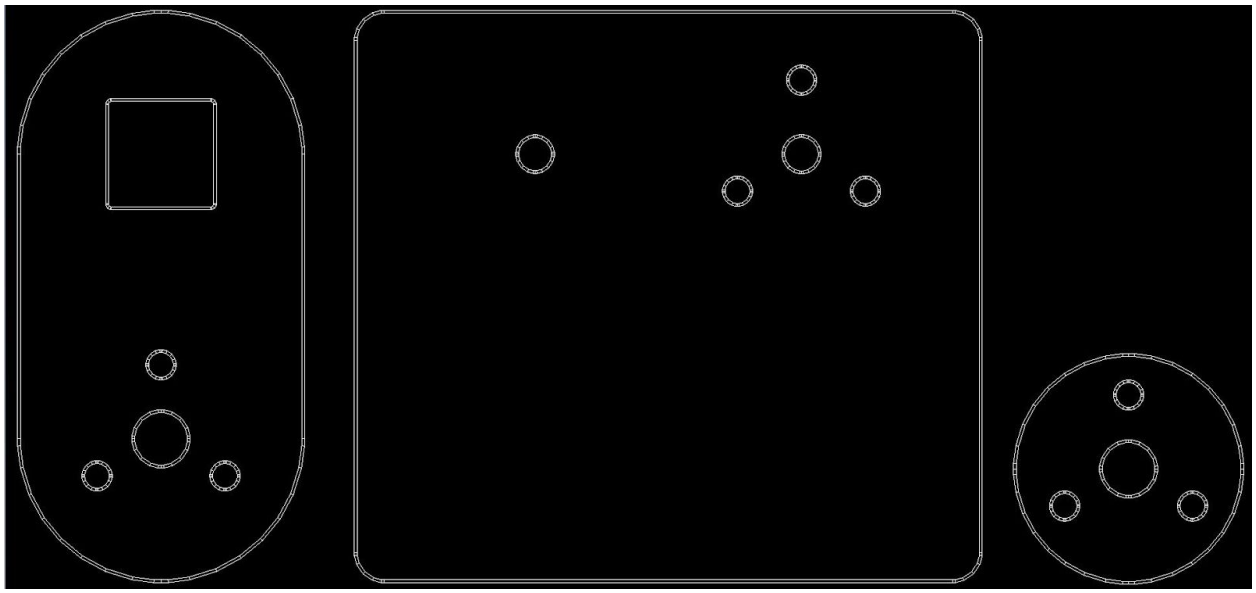
The section view to the far left shows cut faces of the screw and shoulder screw highlighted to show the threads because the gear holders have not been threaded yet.

BOM:

	Part	Quantity	Manufacturer
Gears	Onyx 30T 32 Pitch Gear	2	Manufactured Inhouse
	Stainless Steel 30T 32 Pitch Gear	2	SDP-SI
	Acetal 30T 32 Pitch Gear	2	SDP-SI
Motion Hardware	Shoulder Screw 3/16" Diameter 3/4" Long Shoulder, 8-32 Thread	2	McMaster
	Stainless Steel Screw 6-32 Thread, 3/4" Long	6	McMaster (3 are cut shorter inhouse)
Structural	Stationary Gear Holder	1	Waterjet inhouse with 1/4" aluminum
	Moving Gear Holder	1	
	Spacer	1	
Measuring Equipment	Torque Measuring Wrench	1	Amazon
	Wrench Adapters	1	Amazon

Waterjet Parts:

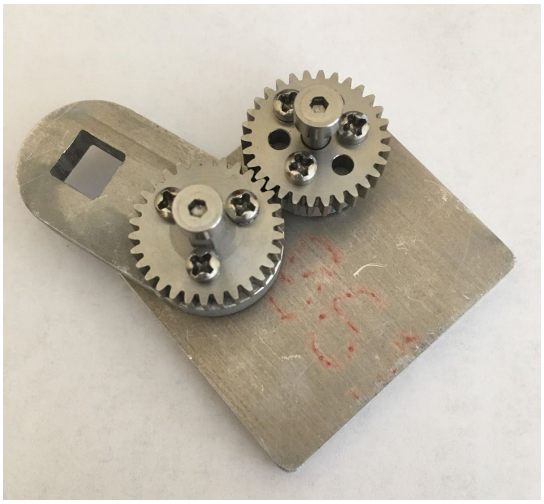
Moving Gear Holder Stationary Gear Holder Spacer

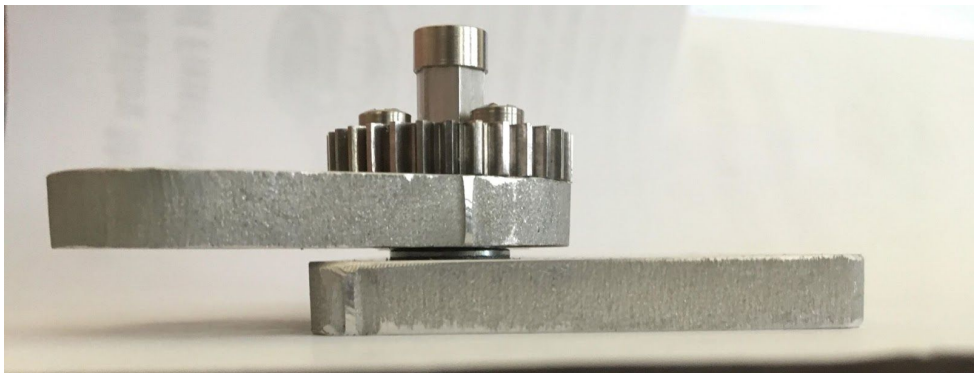


Machining:

- tapped and chamfered the 3 radial holes in the moving gear holder with 6-32 thread
- tapped and chamfered the 3 radial holes on the left side of the stationary gear holder with 6-32 thread
- tapped and chamfered the 2 center holes in the stationary gear holder with 8-32 thread
- drilled and chamfered the 3 radial holes in the spacer to .14” diameter because they were incorrectly cut to the tap drill size rather than through hole size for 6-32 size screw
- turned the gears (steel and acetal) on a lathe to remove the hub to make it easier to drill into
- milled a 3 hole pattern into the gears (steel and acetal) to be through holes for the 6-32 size screws (#28 drill)
    - one of the metal gears was centered incorrectly and had to have a second 3 hole patterned drilled into it so it has 6 holes
- turned the heads of the 6-32 screws on a lathe to decrease their diameter for easier assembly
- turned a standoff on the lathe to remove thread and adjust length to use as a spacer

Assembly:





A washer is used as a spacer under the stack up.

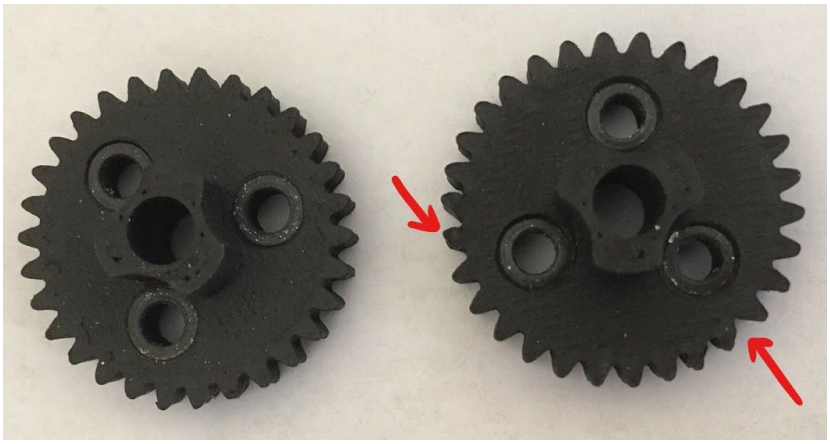
Testing:

3D Printed Onyx Gear:

Trial	Max Torque	Notes
1	5.6 N*m	Teeth deformed
2	N/A	Was not assembled properly and bent without reading a torque
3	5.8 N*m	Teeth deformed

Before

After



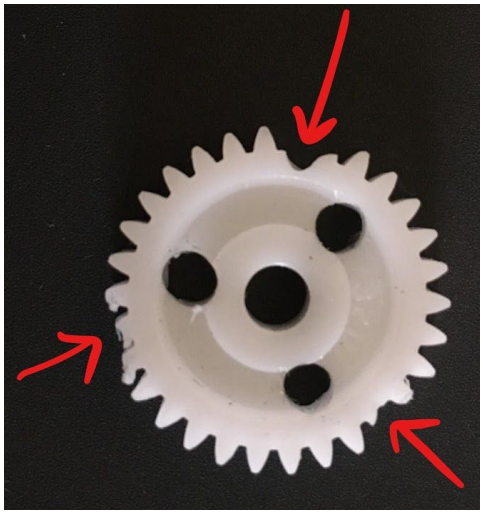
There are notable deformation in the teeth. The outer circles were created by the pressure of the heads of the screws when screwed in. This shows that the material can be deformed by something as little as hand tightening screws with a screwdriver.

Acetal Gear:

Trial	Max Torque	Notes
1	6.1 N*m	The first one wasn't assembled properly and had too much space between the gears
2	7.1 N*m	Teeth broke
3	7.9 N*m	Teeth broke

Before

After

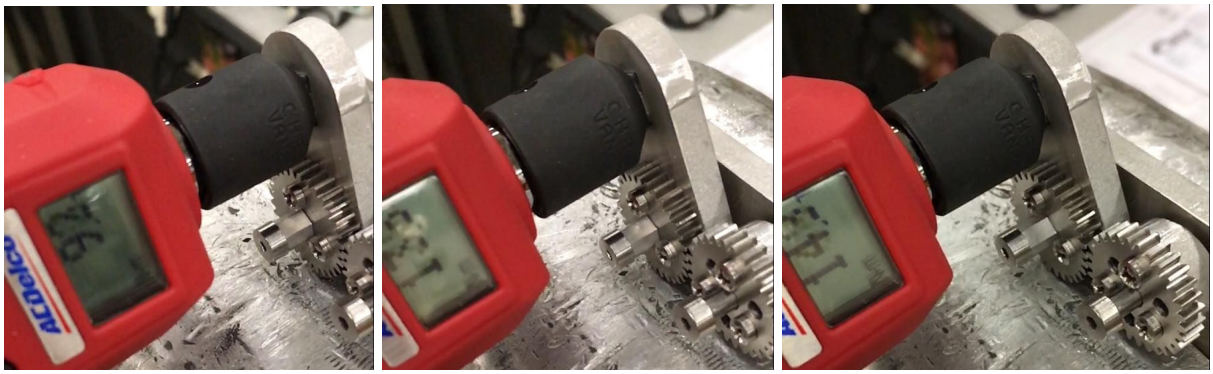


The acetal is more brittle than the 3D printed Onyx material causing the teeth to break rather than deform. The acetal gears can withstand greater torques than the 3D printed Onyx material.

Stainless Steel Gear:

Trial	Max Torque	Notes
1	9.2 N*m	Did not break
2	13.5 N*m	Did not break
3	14.3 N*m	Did not break

I ran each test applying more torque each time but the maximum torque the teeth can withstand before breaking is likely much larger than I can apply by hand. The maximum measured torque of the steel gears is more than twice that of the 3D printed gears and almost more than twice that of the acetal gear.



*All of the pictures of the torque wrench are screenshotted from slow motion captures of the gear testing