Electric Scooter Drive Chain

Goals:

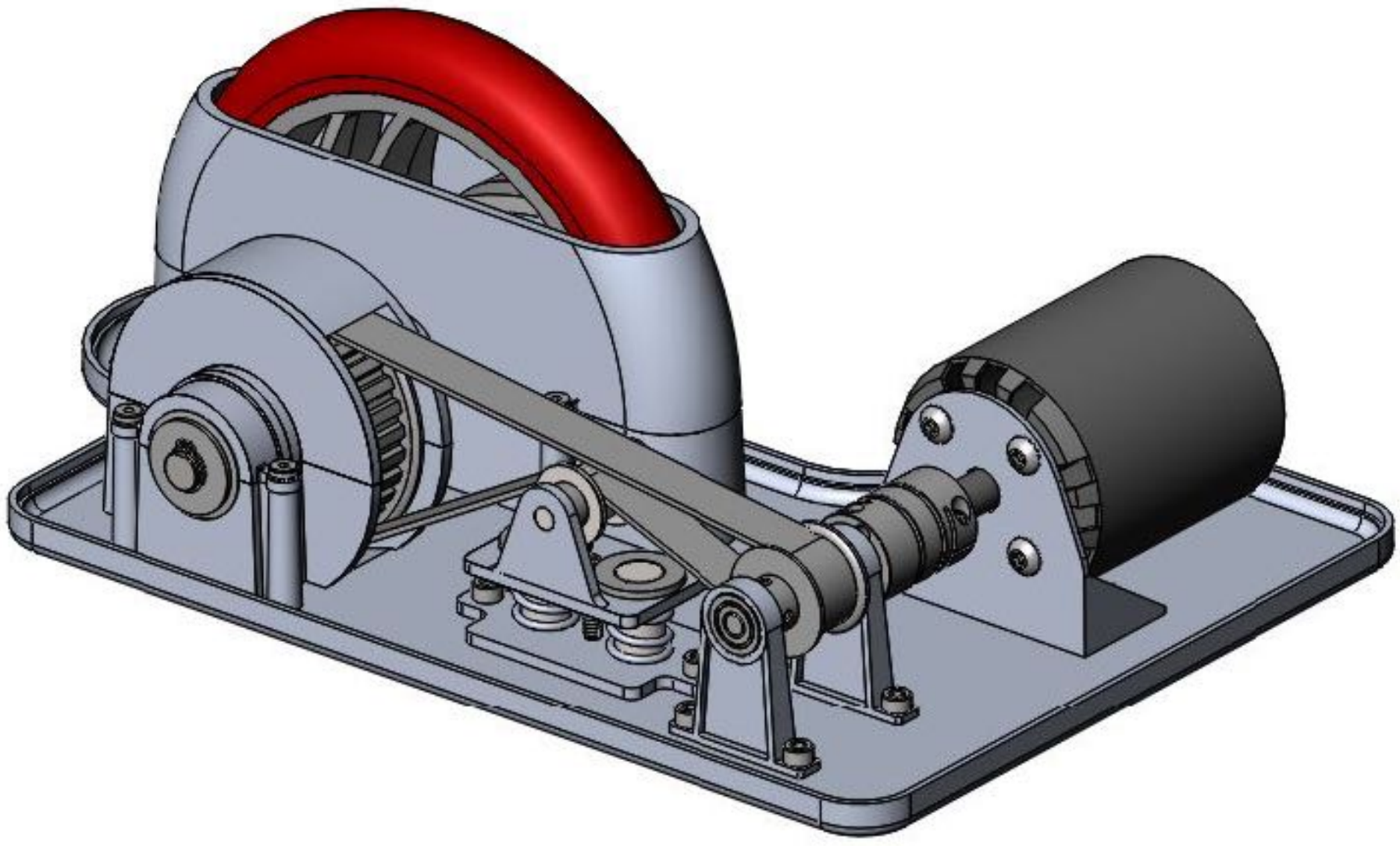
Design an electric scooter for kids.

Max rider weight 85lbs

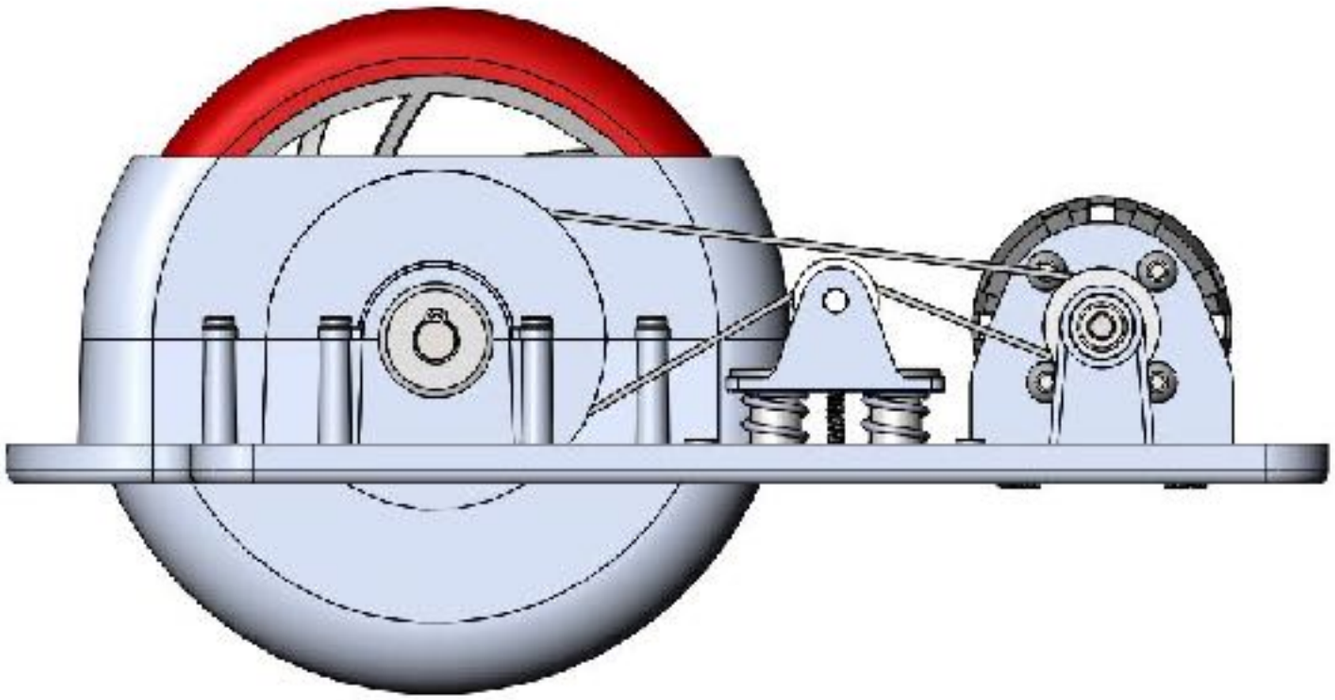
Top speed 15mph

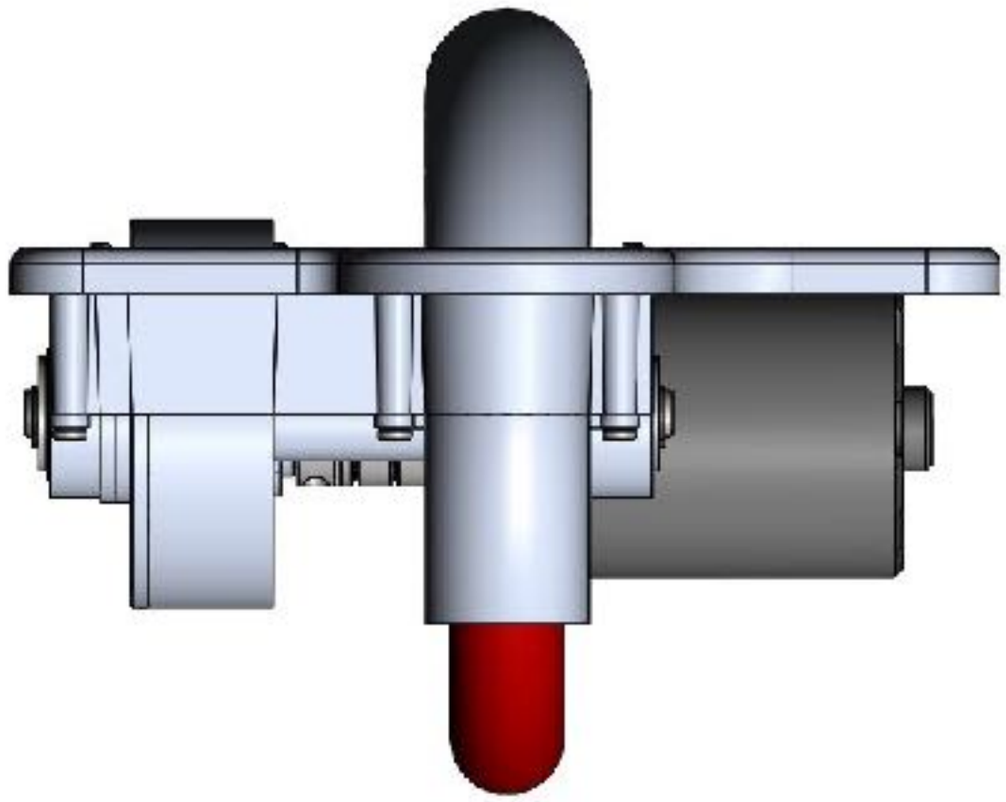
Power supply maximum output 42V

Hub Assembly



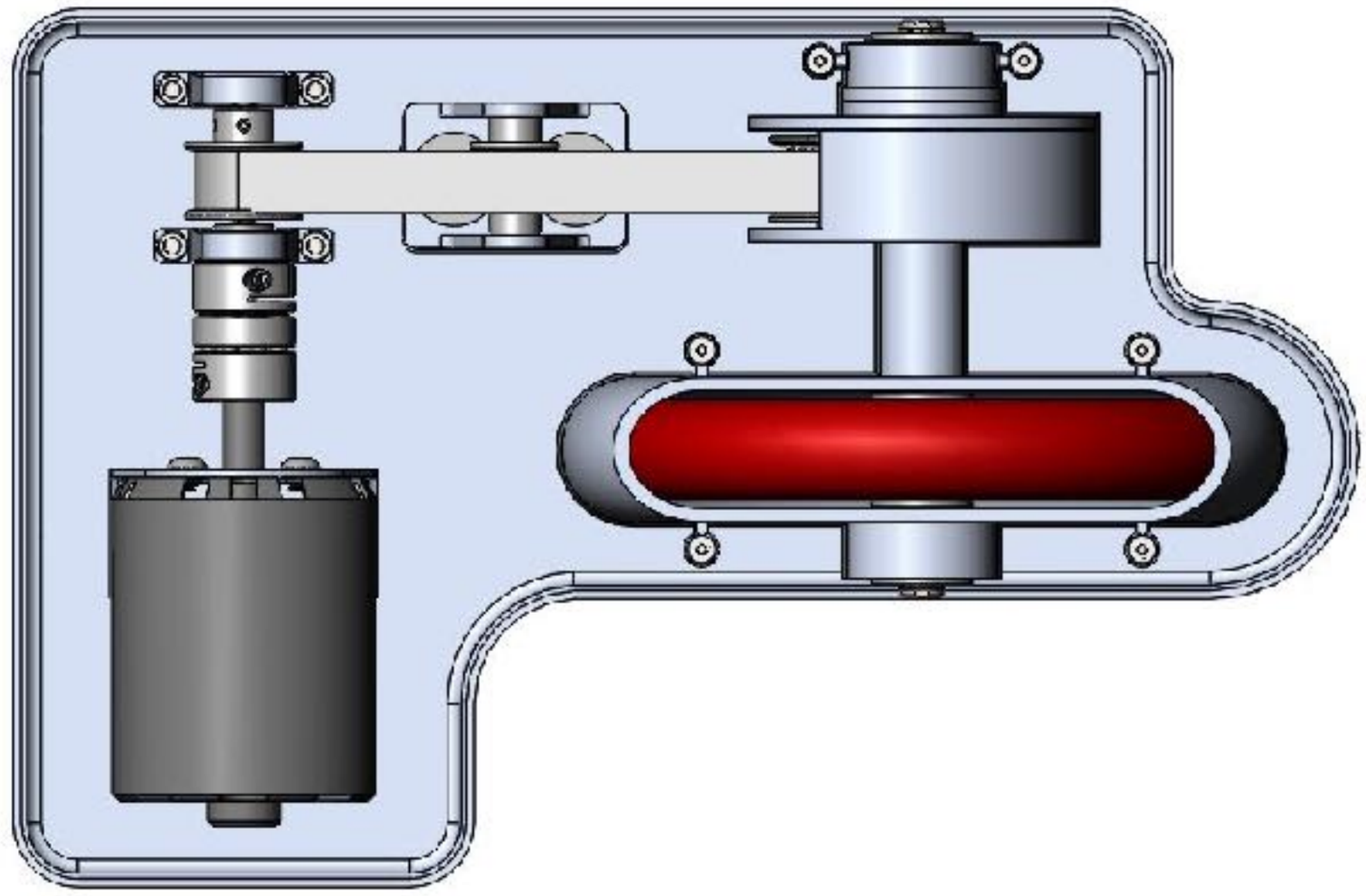
Hub Assembly

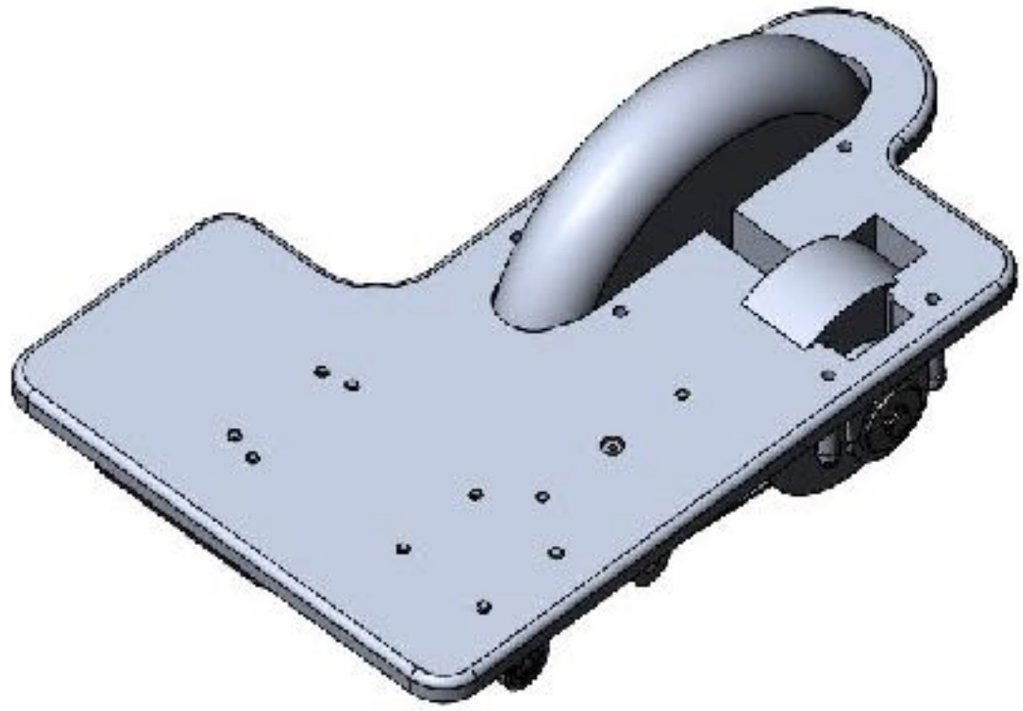




\Preload of belt drive +- .125”
\Drive mechanism (entirety of assembly above) intended to be assembled first as preload must be adjusted on underside of bottom plate, prior to being fixed to the scooter underside

Hub Assembly





\Uniform wall thickness in all cast parts, undersides of raised components hollow
\Thickness of .010 on all cast parts

Hub Assembly

Part Name	Part Num	Material	Quantity	In pack	Order	Price	Notes	URL
belt	7959K25	Neoprene with Fiberglass, Nylon Coated	2	1	2	$3.18	per foot	https://www.mcmaster.com/7959k25
18-8 Stainless Steel Socket Head Screw	92196A143	18-8 Stainless Steel	10	50	1	$9.80		https://www.mcmaster.com/92196a143

Drive Sub-Assembly

Motor: Brushless DC 270KV
Lipo: 3S-8S
Max torque: 4Nm

Goal run at 2Nm. Assume scooter that can support 170lb (twice the design ask, e.g. two kids ride the scooter together) with a safety factor of 2; ~340lb.

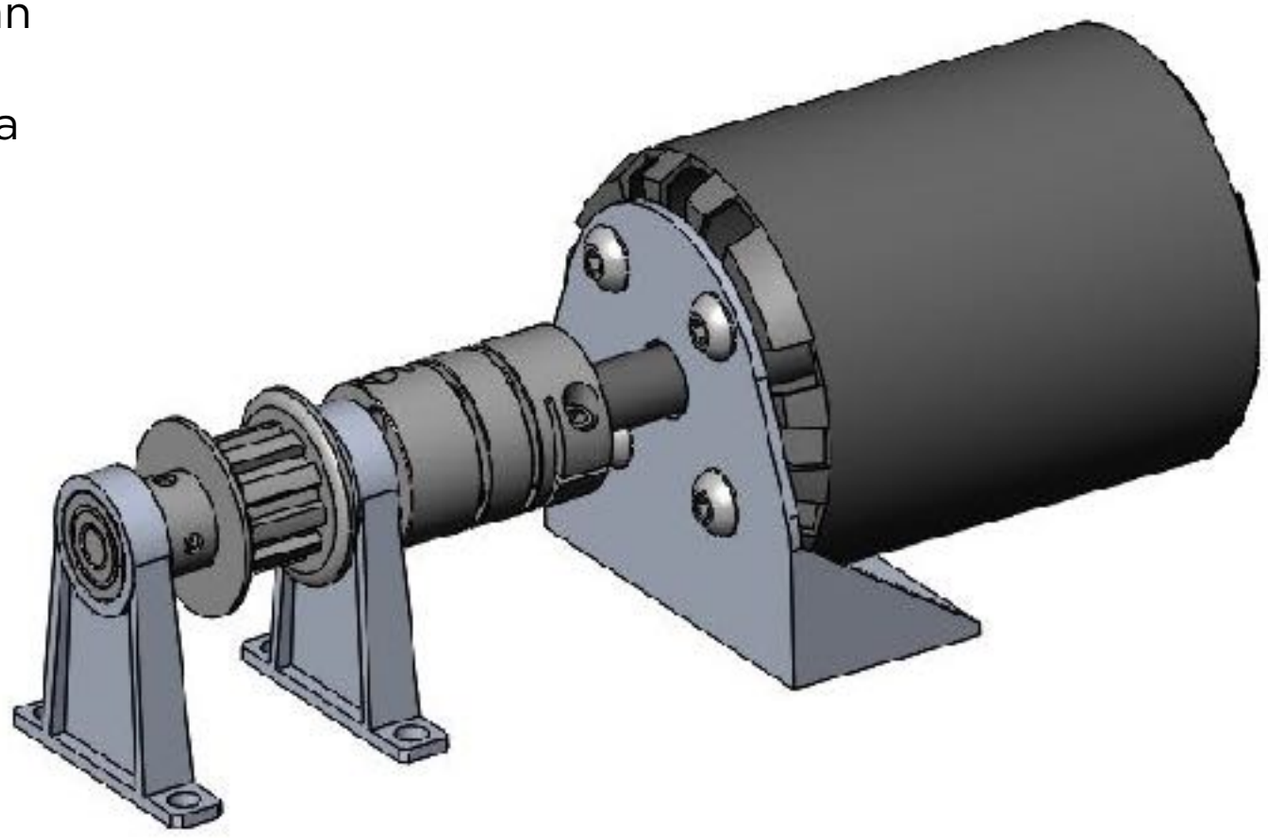
vf=v0+at where v0=0
15mph = v0 + a*10sec
a = 5400 mi/h^2 = 0.6706m/s^2
85lb = 38.56kg | 340lb = 154.24kg
F=ma
F=25.858336N | 103.43N
R = 2.5in = .0635 m
F*r = T
T = 1.641Nm | 6.56Nm

1:3.2 gear ratio, 10 : 32 teeth

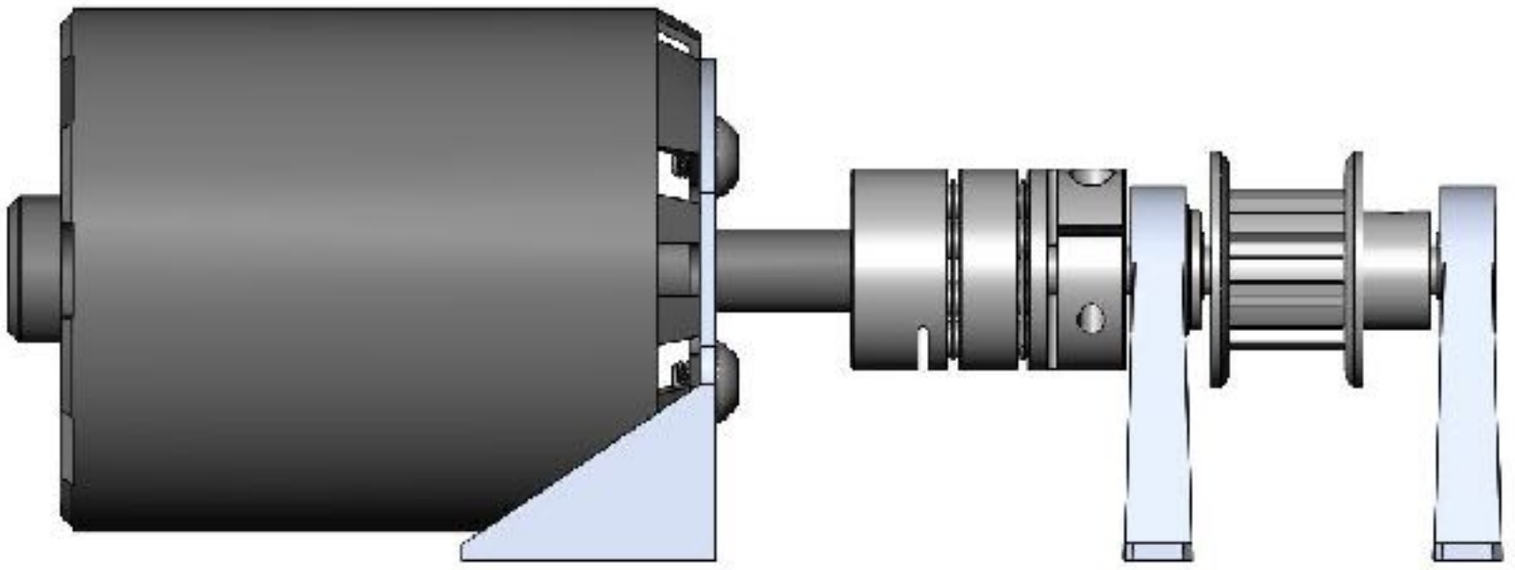
15MPH/60min*5280ft/mile *
12in/ft /(2*pi*5in /2) = 1008RPM

1008RPM * 3.2 = 3225.6RPM

Ideal motor voltage:
3225.6RPM/270KV = 11.94V

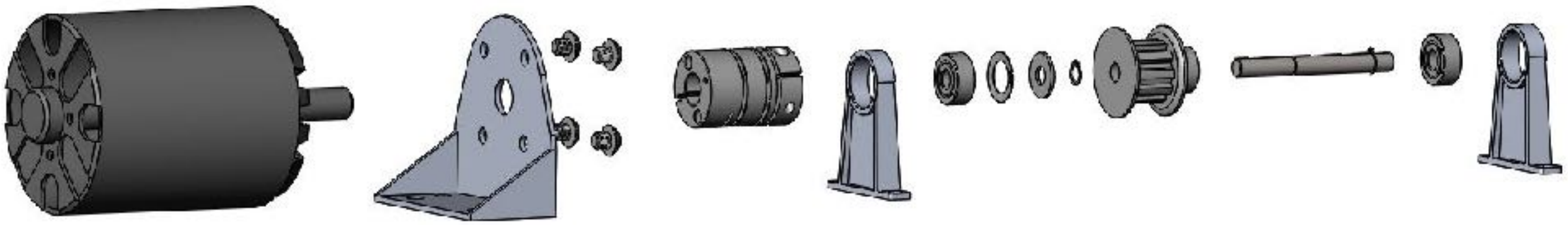


Drive Sub-Assembly



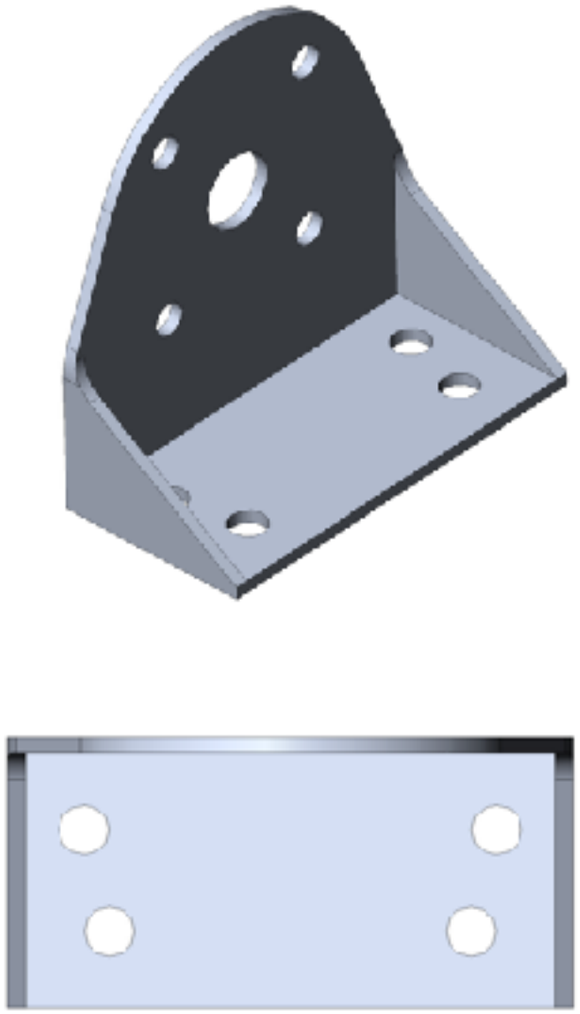
\8mm motor shaft to 3/16” imperial shaft, conversion via flexible shaft coupler
\3/16” Dshaft for set screws on timing belt pulley
\XL belt drive throughout assembly

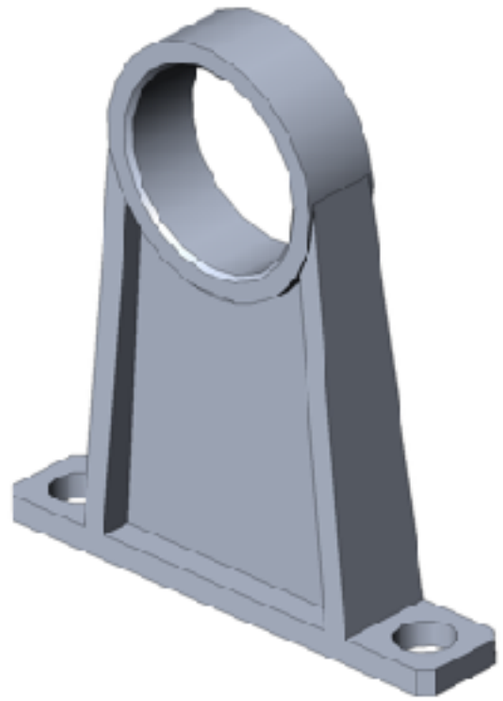
Drive Sub-Assembly



\For drive assembly casting individual mounting components uses significantly less material and is easier to machine that one large component. Challenging to create a single cast part and post machine proper holes for mounting motor and shaft due to tight clearances for tooling.
\Aluminum die casting for all components, selected for strength to weight ratio and low cost
\External retaining rings on dive assembly to prevent shaft movement, preload with belleville washer

Drive Sub-Assembly





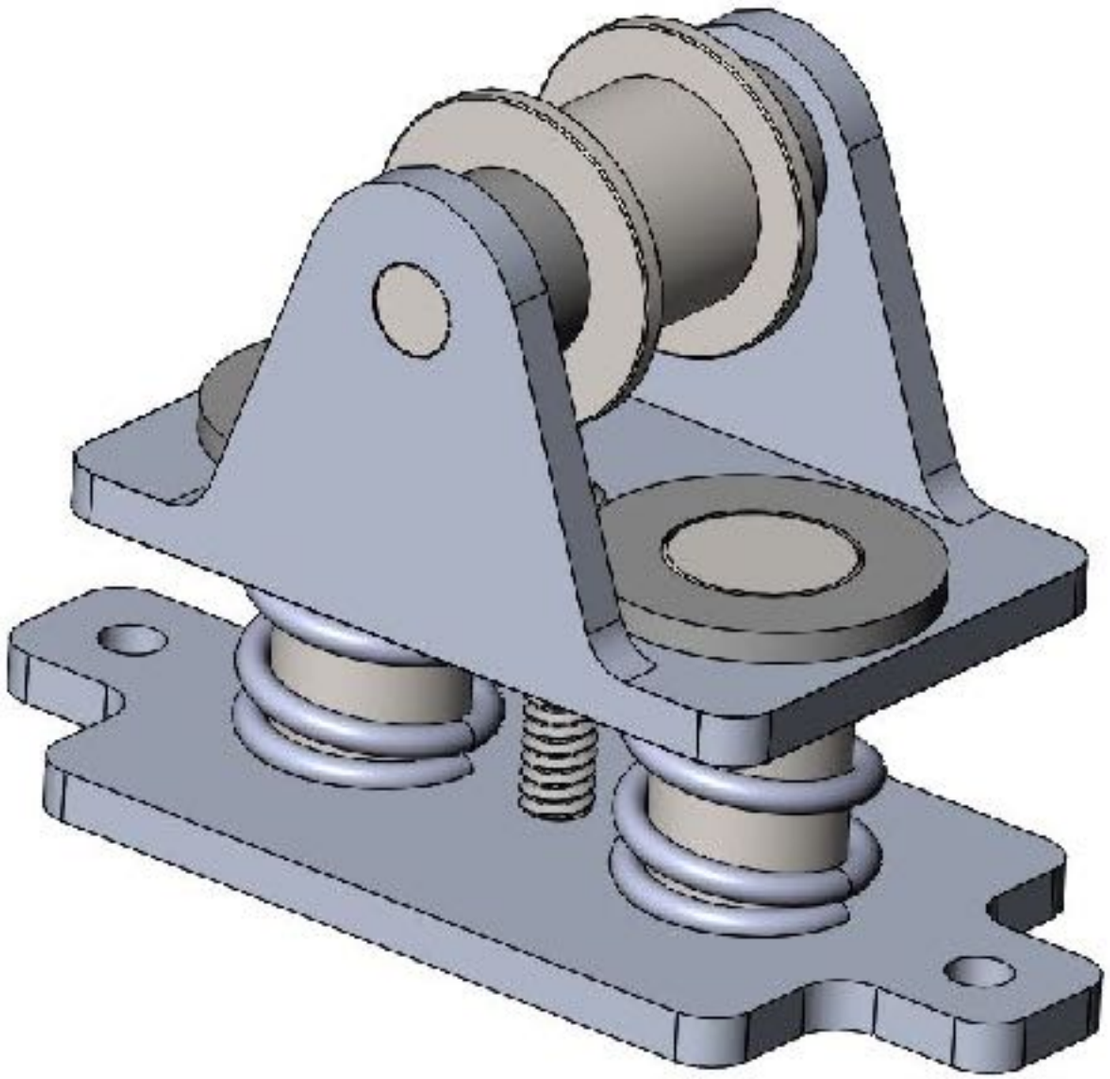
\Poka-yoke motor bracket to ensure directionality

\Uniform wall thickness on bearing supports, gussets for additional support, draft on all surfaces, symmetrical to minimize error during assembly
\Shielded bearings press-fit

Drive Sub-Assembly

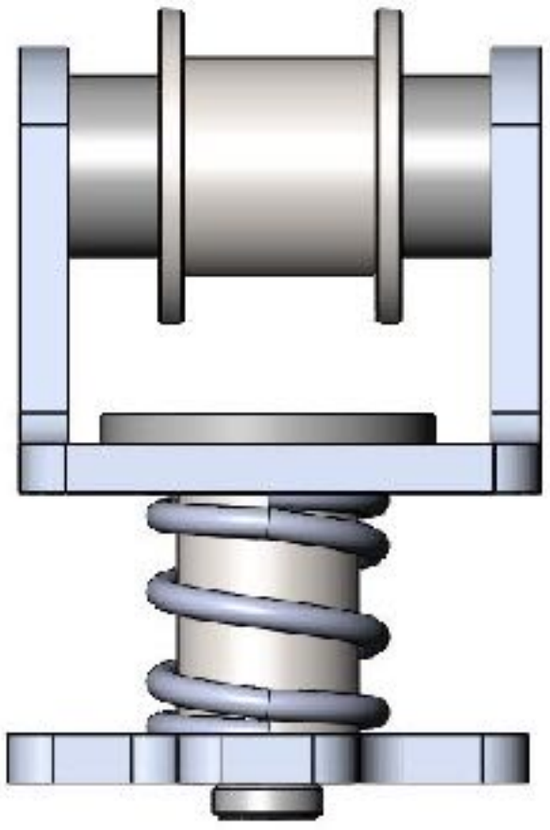
Part Name	Part Num	Material	Quantity	In pack	Order	Price	Notes	URL
BLDC motor			1	1	1	$49.00	8mm shaft	https://flipsky.net/products/flipsky-electric-skateboard-
bearing_fixture		diecast aluminum 6061, post machined	2					
motor_mount		diecast aluminum 6061	1					
shaft_316		304 SS	1				3/16" shaft	
Corrosion-Resistant Timing Belt Pulley	1277N41	anodized aluminum	1	1	1	$8.87	3/16in shaft, 3/8in belt, 10 teeth	https://www.mcmaster.com/1277n41
Servomotor Precision Flexible Shaft Coupling	2764K117	2017 Aluminum and 304 Stainless Steel	1	1	1	$61.67	8mm to 3/16in shaft	https://www.mcmaster.com/2764k117
Shielded, Trade No. R3-2Z, for 3/16" Shaft Diameter	60355K42	steel	2	1	2	$6.81	3/16 shaft bearings	https://www.mcmaster.com/60355k42
External Retaining Ring	97633A120	1060-1090 Spring Steel	2	100	1	$8.13	3/16 shaft, pack of 100	https://www.mcmaster.com/97633a120
Belleville Disc Springs	94065K26	High-Carbon Steel	1	10	1	$2.75	3/16 shaft, pack of 10 - R3, ht = .02	https://www.mcmaster.com/94065k26
Button Head Hex Drive Screws	92095A476	Passivated 18-8 Stainless Steel	4	100	1	$7.80	motor screws, pack 100	https://www.mcmaster.com/92095a476
Grade 8 Steel Washer	98180A190	Zinc-Aluminum Coated Steel	1	10	1	$6.71	.19"ID, pack of 10	https://www.mcmaster.com/98180a190

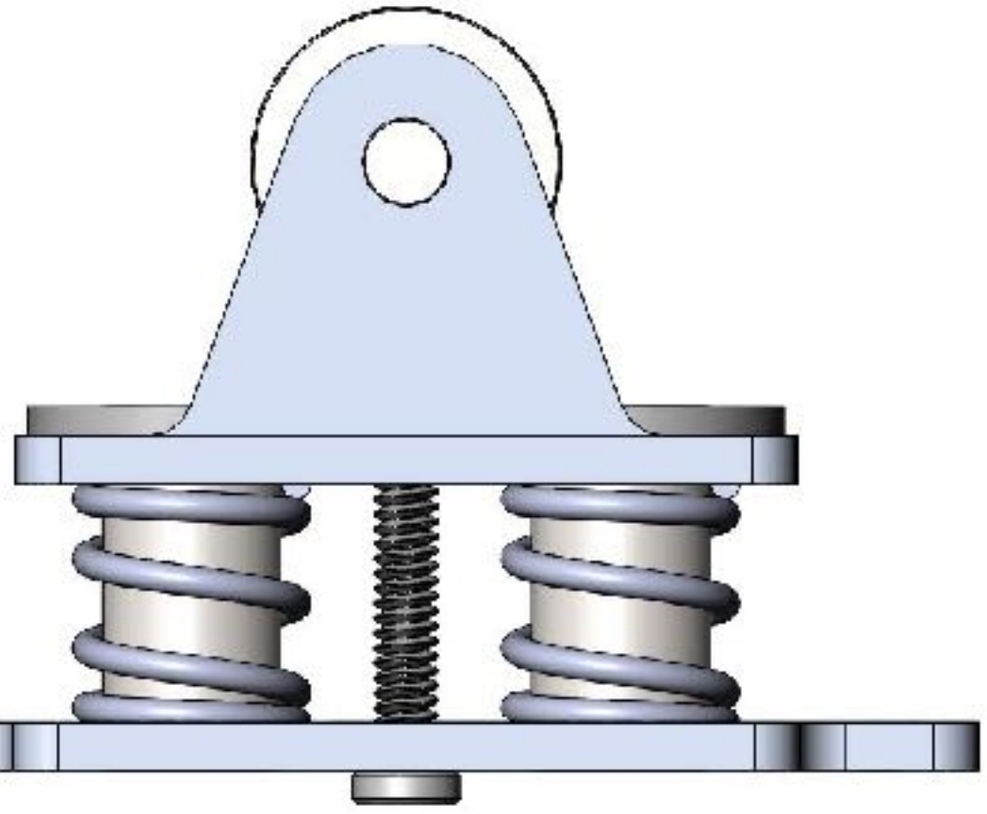
Belt Preload Sub-Assembly



\Belt preload via adjustable third pulley. Flat profile comes in contact with rear side of XL timing belt.
\Two springs with accompanying shafts constrains the systems preventing rotational motion, linear motion facilitated by flanged bushing.
\Compression is applied through hex screw which can be accessed on the top side of the scooter.

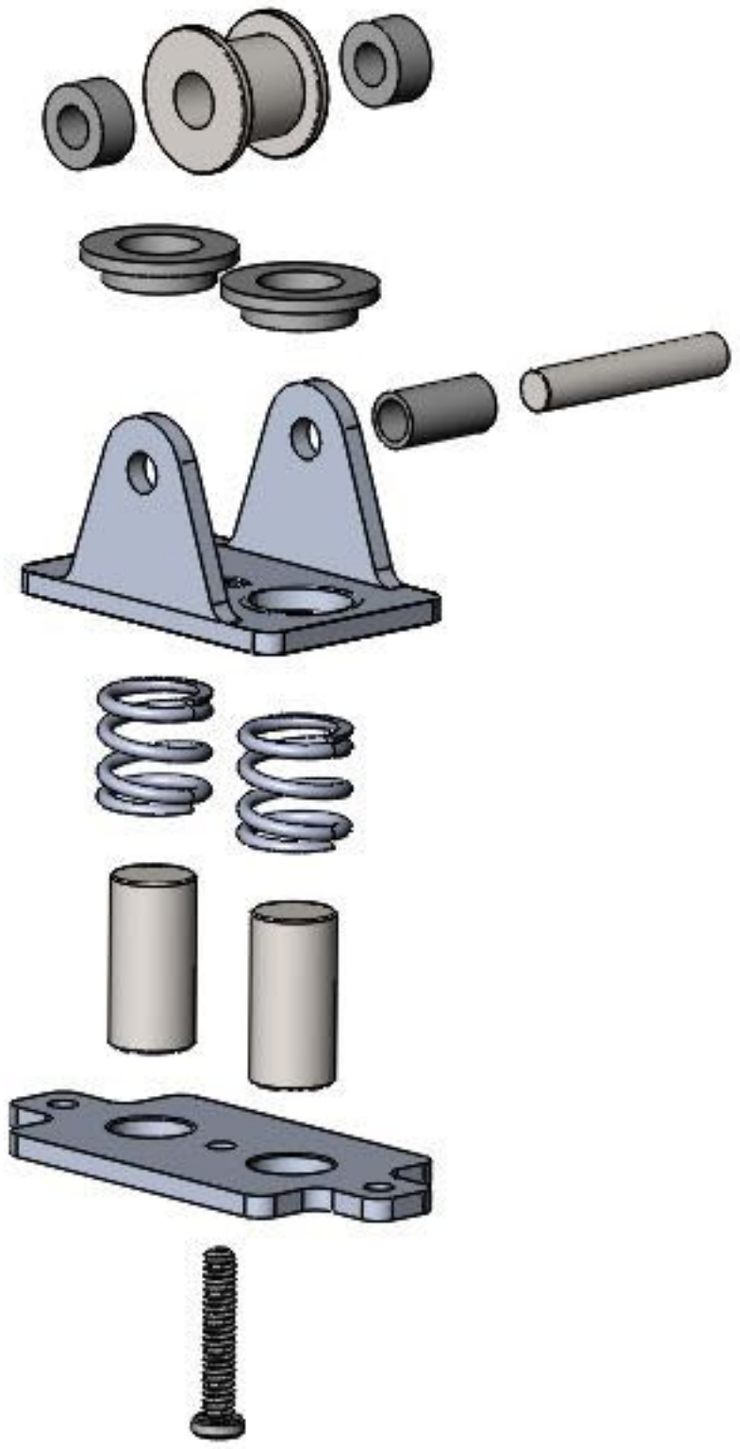
Belt Preload Sub-Assembly





\Flat face pulley press fit onto bushing creating ‘frictionless’ spin on the center shaft.
\One flange of pulley holder designed for press-fit of shaft, adjacent side slip-fit. Two aluminum spacers on either side of pulley rub on center brushing only, thus centering pulley while maintaining reduced friction environment

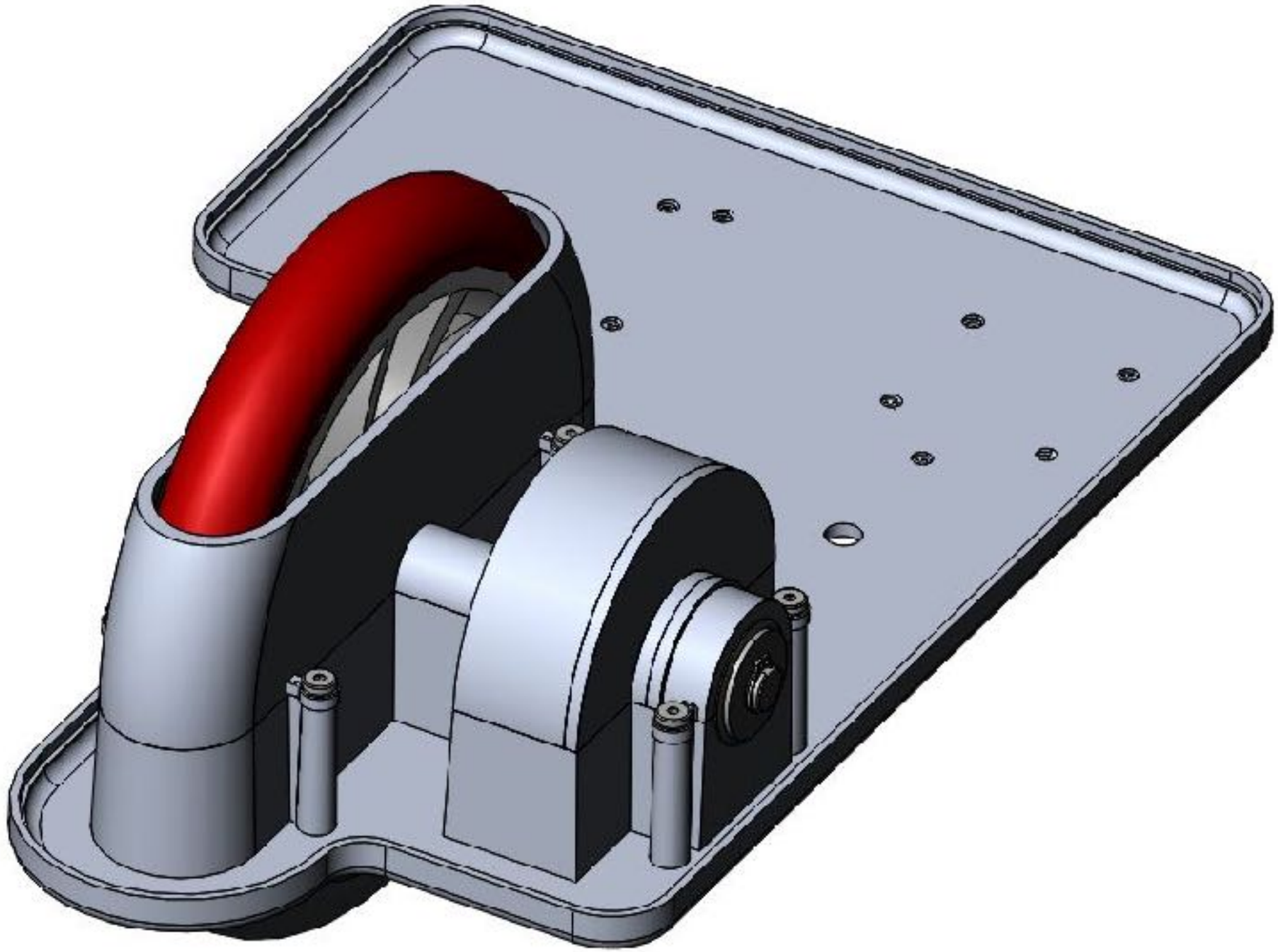
Belt Preload Sub-Assembly



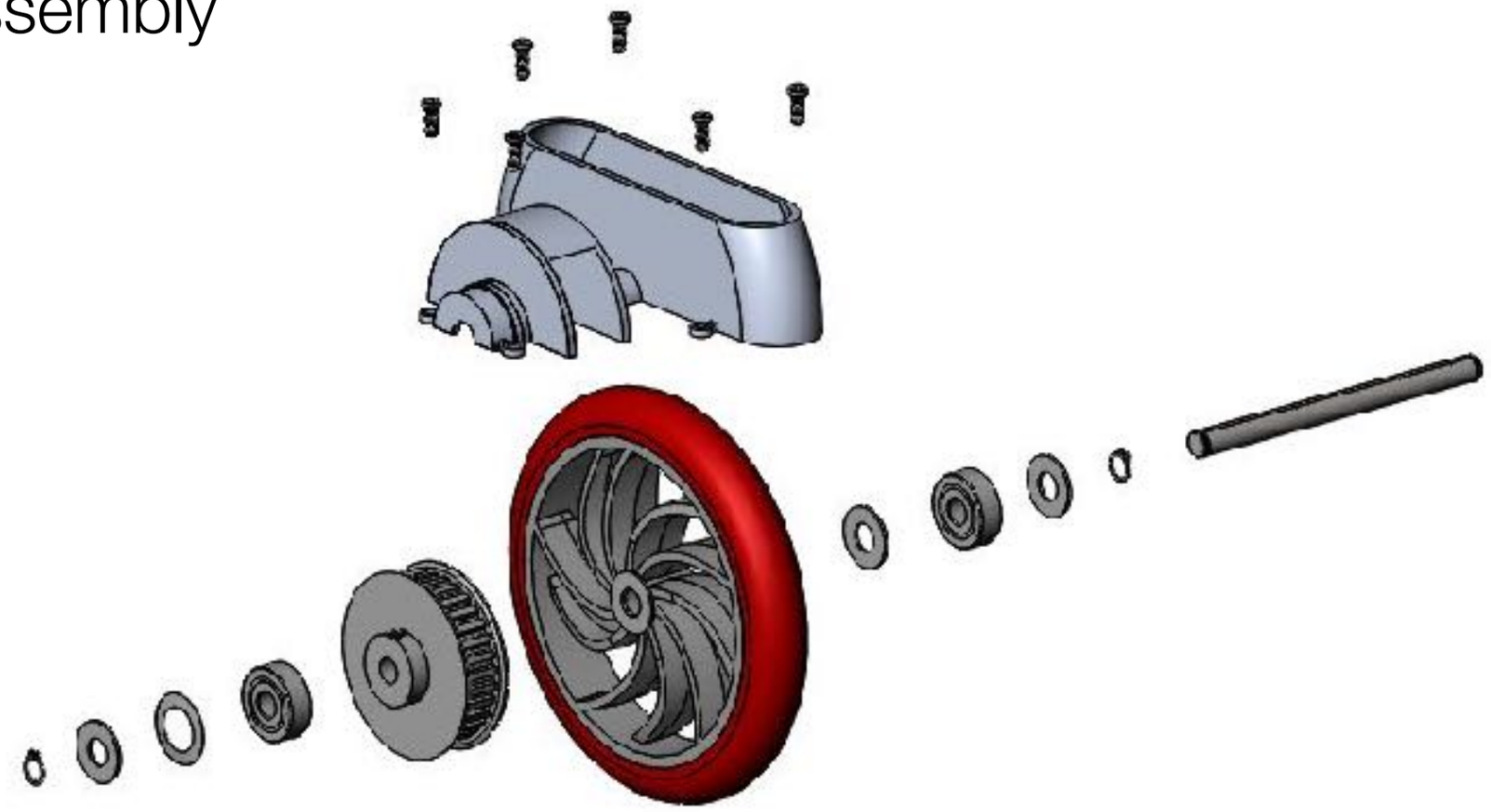
Belt Preload Sub-Assembly

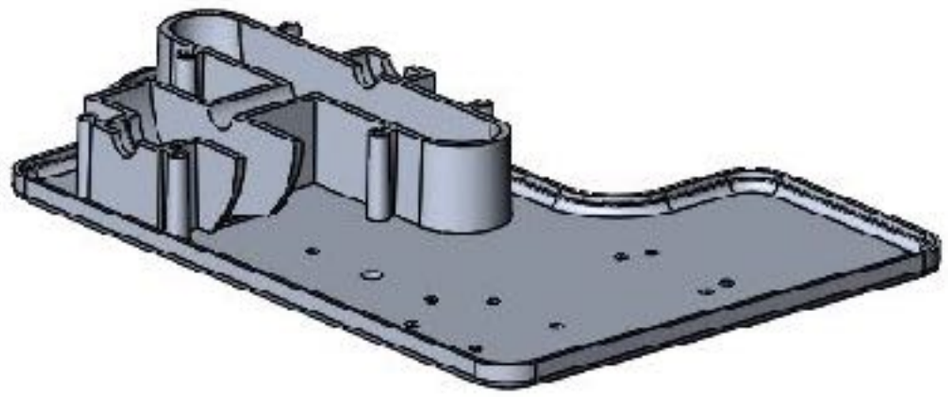
Part Name	Part Num	Material	Quantity	In pack	Order	Price	Notes	URL
belt_preload_base		diecast aluminum 6061, post machined	1					
belt_preload_top		diecast aluminum 6061, post machined	1					
belt_preload_pully		Steel	1					
Oil-Embedded Flanged Sleeve Bearing	6338K414	SAE 841 Bronze	2	1	2	$0.74	flange 1/16, Need to be cut to length	https://www.mcmaster.com/6338k414
belt_preload_pully_shaft	1327K103	12L14 Carbon Steel	1				Need to be turned to length	https://www.mcmaster.com/1327k103
belt_preload_spring_shaft	1346K11	1566 Carbon Steel	2				Need to be turned to length	https://www.mcmaster.com/1346k11
Compression Spring	9657K278	Zinc-Plated Music-Wire Steel	2	6	1	$10.51	pack 6, ID = .376	https://www.mcmaster.com/9657k278
18-8 Stainless Steel Low-Profile Socket Head Screws	93615A217	18-8 Stainless Steel	1	25	1	$11.22		https://www.mcmaster.com/93615a217
Aluminum Unthreaded Spacer	92510A641	Aluminum	2	1	2	$0.93	belt preload spacer	https://www.mcmaster.com/92510a641
Oil-Embedded Bronze Sleeve Bearing	6391K124	SAE 841 Bronze	1	1	1	$0.73		https://www.mcmaster.com/6391k124

Rear Sub-Assembly



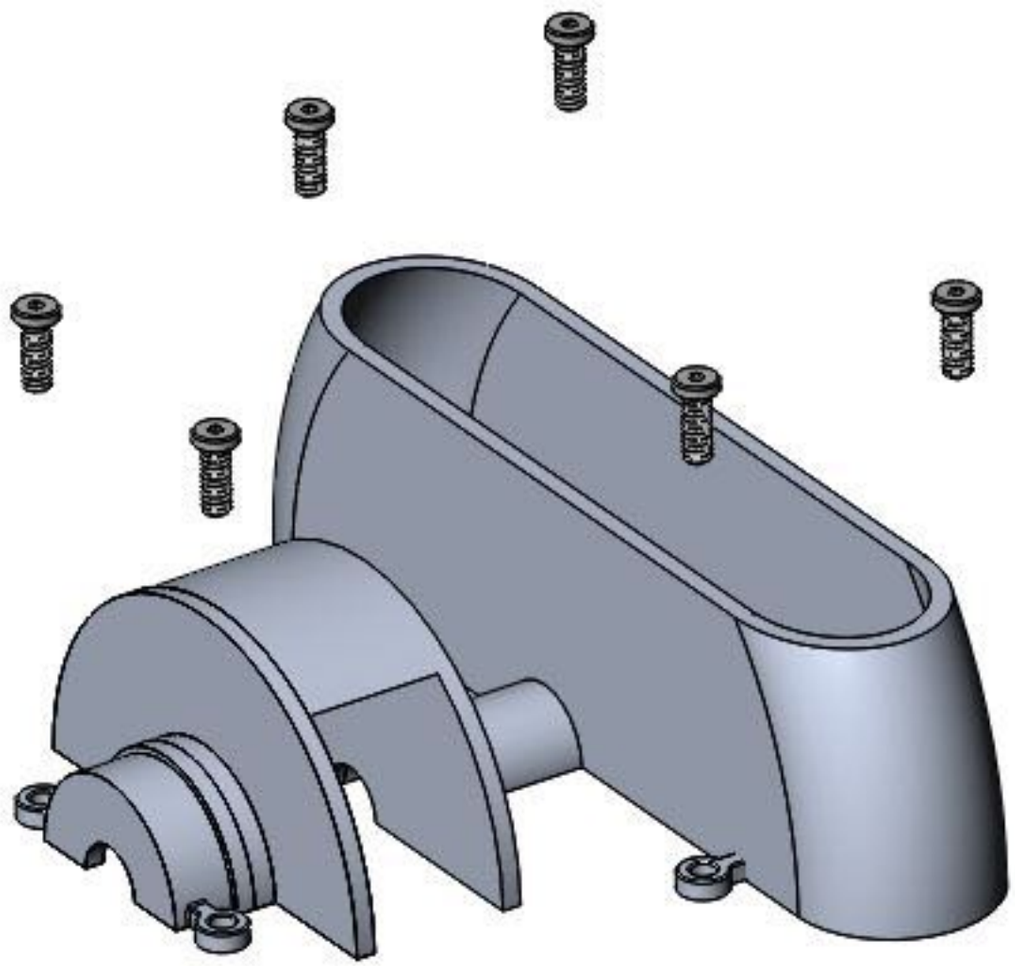
Rear Sub-Assembly





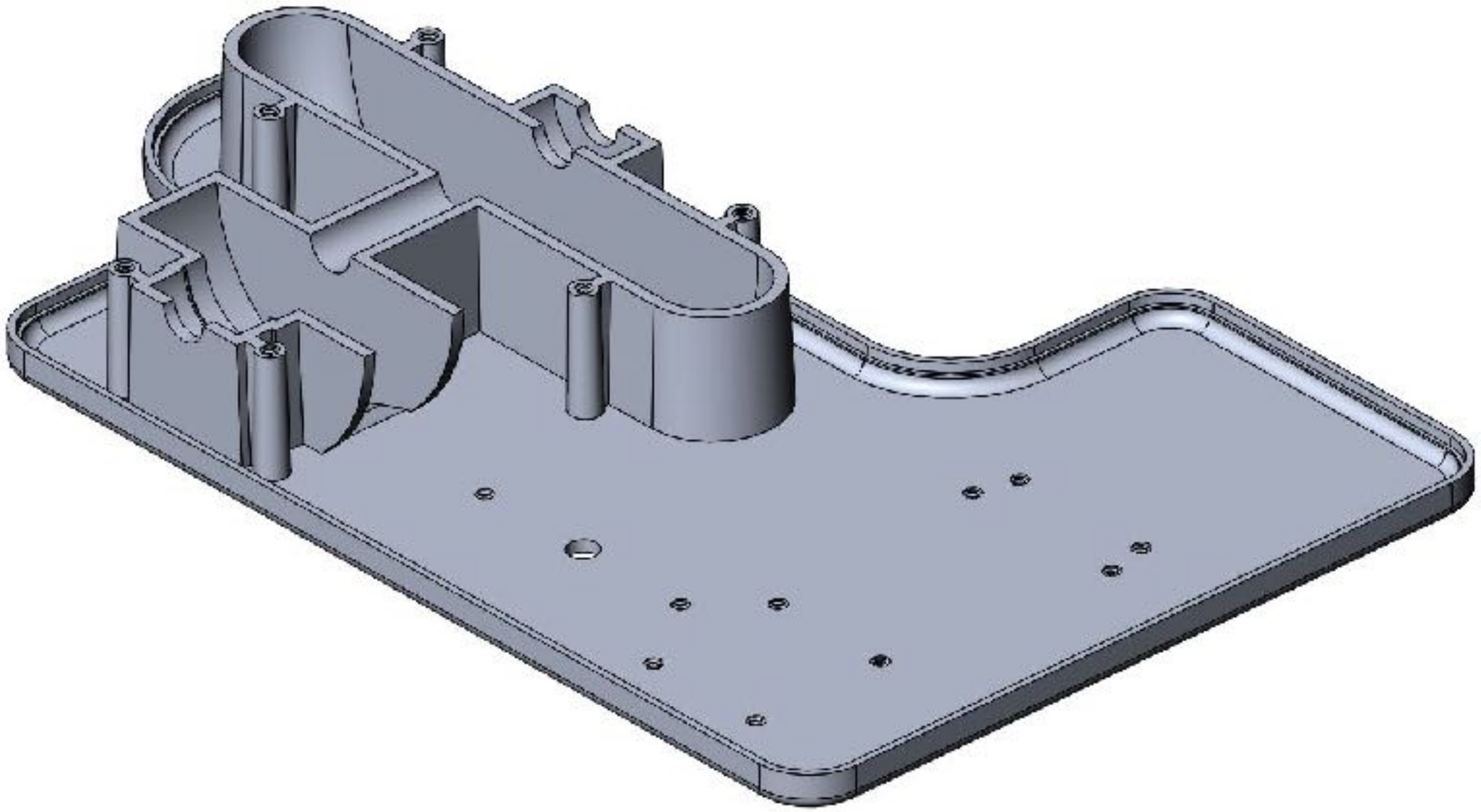
\5/16” Dshaft supported by pair of ball bearings, two grooves are added to the stock shaft for the external retaining rings, machining the shaft to save valuable real-estate in housing instead of using shaft collars.
\Two flat washers on either side of the drive wheel prevent rubbing on housing.

Rear Sub-Assembly



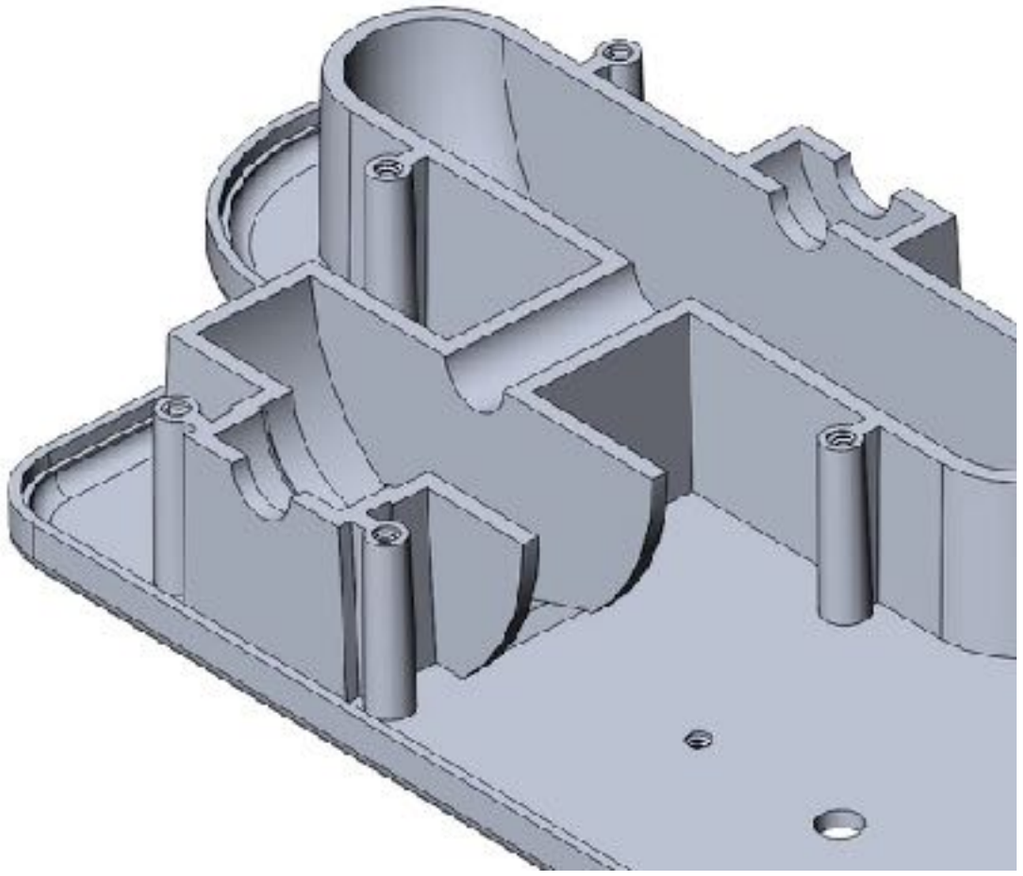
\Die cast aluminum, post machined - corrosion resistance (on the underside of the scooter), mating with other die cast aluminum parts
\Housing encases the components most at risk for exposure to the elements, most dirt should remain in wheel hub with little entering the shaft and belt driven transmission

Rear Sub-Assembly



\Die cast Aluminum, post machined - Key structural component, strength to weight ratio, corrosion resistance (on the underside of the scooter)

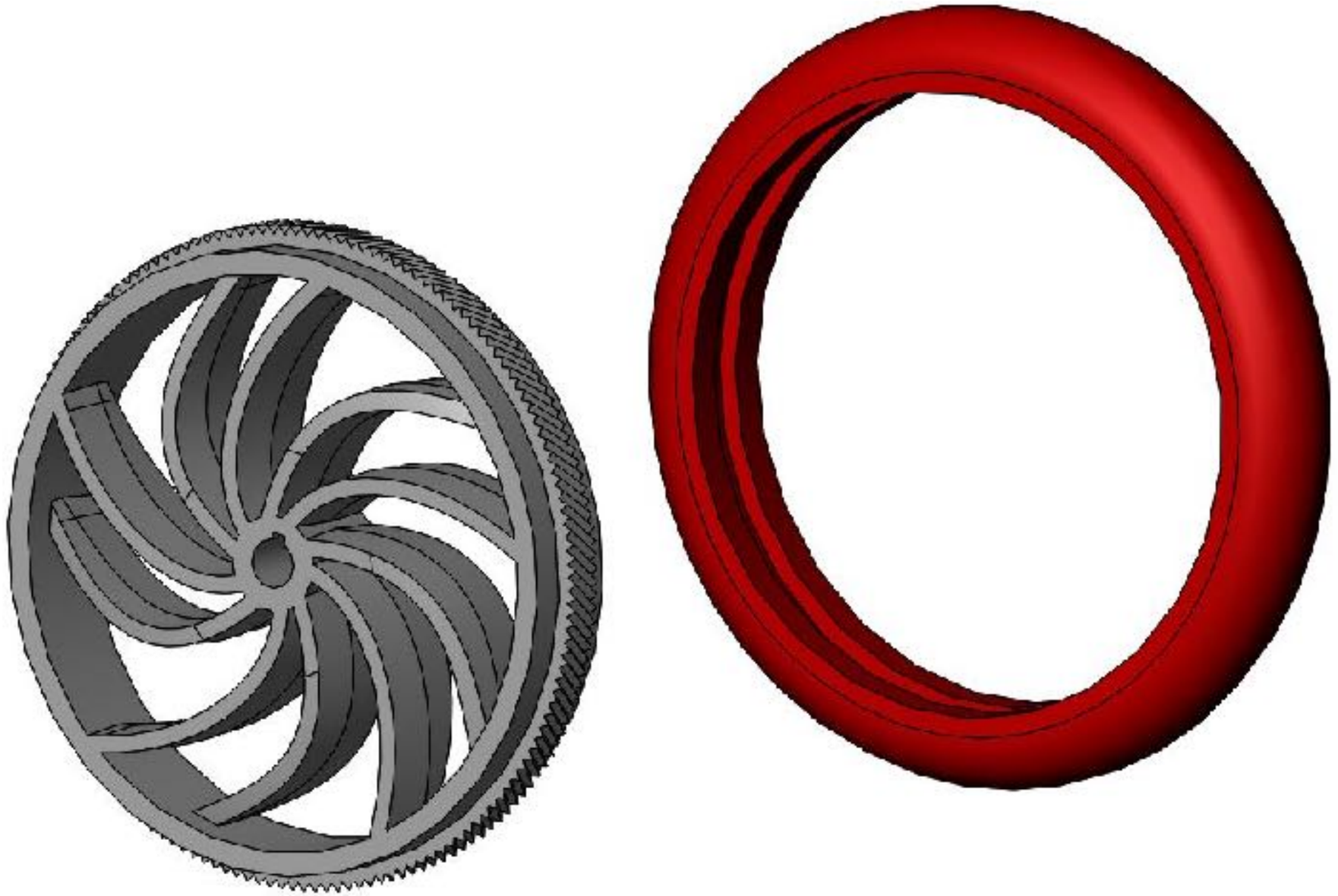
Rear Sub-Assembly



\Standardized tapped holes 8-32 throughout assembly
\Lip & Grove mating for enclosure

\Uniform wall thickness, thread bosses are through holes to minimize excess material effecting cooling time thus defects
\Boss are offset from body to also minimize sink
\Draft on drive enclosure and bosses

Rear Sub-Assembly



\HDPE wheel (high tensile strength and abrasion resistance), Polyurethane over mold (high impact, abrasive resistance, noise reduction)
\Custom designed wheel to move in tandem with keyed shaft
\Knurled pattern helps ensure polyurethane over mold doesn’t fail

Rear Sub-Assembly

Part Name	Part Num	Material	Quantity	In pack	Order	Price	Notes	URL
shaft_516		304 SS	1				5/16" shaft	
wheel		HDPE	1					
wheel_overmold		PU	1					
rear_hub		diecast aluminum 6061, post machined	1					
rear_top		diecast aluminum 6061, post machined	1					
XL Series Lightweight Timing Belt Pulley	57105K26	Aluminum/Acetal	1	1	1	$8.91	5/16 shaft, 3/8in belt, 32 teeth	https://www.mcmaster.com/57105k26
High-Load Ball Bearing	2780T34	Steel	2	1	2	$13.15	5/16 shaft bearings	https://www.mcmaster.com/2780t34
External Retaining Ring	97633A150	1060-1090 Spring Steel	2	100	1	$9.20	pack 100	https://www.mcmaster.com/97633a150
316 Stainless Steel Washer	90107A030	316 Stainless Steel	2	100	1	$10.29	pack 100	https://www.mcmaster.com/90107a030
Belleville Disc Springs	94065K44	High-Carbon Steel	1	10	1	$3.65	pack 10, h=.0295	https://www.mcmaster.com/94065k44
18-8 Stainless Steel Low-Profile Socket Head Screws	93615A215	18-8 Stainless Steel	6	25	1	$7.85	pack 25	https://www.mcmaster.com/93615a215