Drivetrain 33% Build Update

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Updated Charts/CAD

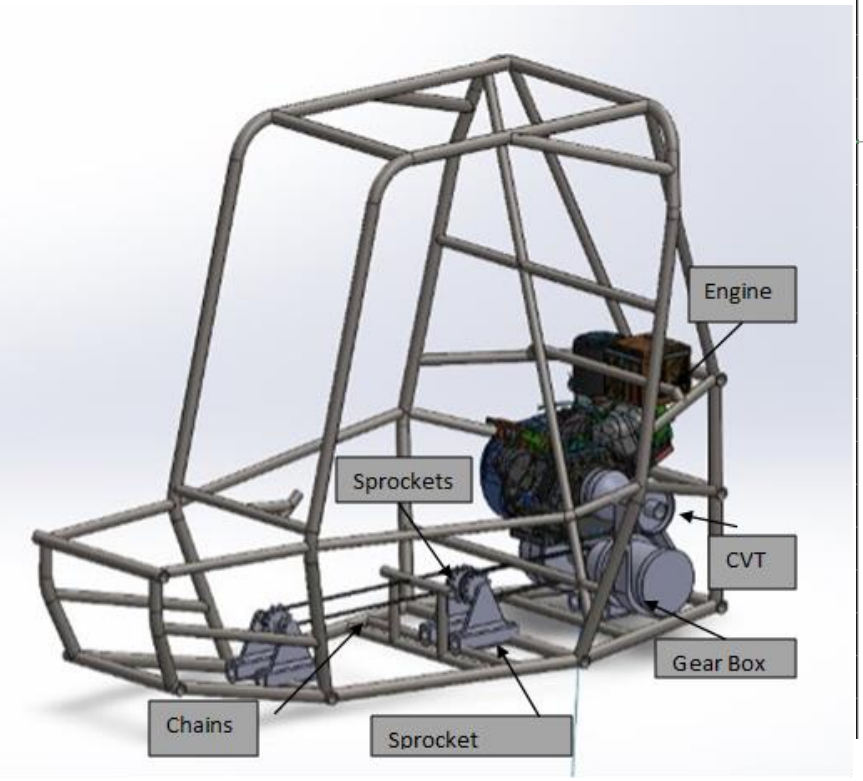


Figure 1: Full CAD Assembly

SAE Baja Team 9 Gantt chart

Lumberjack motorsports baja team
Zachary Biehl,Jared Bonds, Dylan Wi

SIMPLE GANTT CHART by Vertex42.com
https://www.vertex42.com/ExcelTemplates/simple-gantt-chart.html

Project Start: Fri, 1/20/2023
Display Week: 1

TASK	ASSIGNED TO	PROGRESS	START	END
1/16/2023-2/13/23				
Time Card Week 1	Team	100%	1/20/23	1/24/23
Project Management Assignment	Team	100%	1/24/23	1/25/23
Engineering Model Summary	Team	100%	1/24/23	1/29/23
Individual learning assignment	Indvidual	100%	1/29/23	2/3/23
Time Card Week 2	Team	100%	1/24/23	1/30/23
Time Card Week 3	Team	100%	1/30/23	2/6/23
Hardware Status Update/ 33% build	Team	25%	2/6/23	2/13/23
Peer Eval 1	Individual	0%	2/6/23	2/13/23
Time Card Week 4	Team	100%	2/6/23	2/13/23
2/13/23-3/6/23				
Time card Week 5	Team	0%	2/13/23	2/20/23
Ordering wire edm	Drivetrain	25%	2/13/23	2/18/23
Machining shafts, casing	Drivetrain	10%	2/18/23	2/21/23

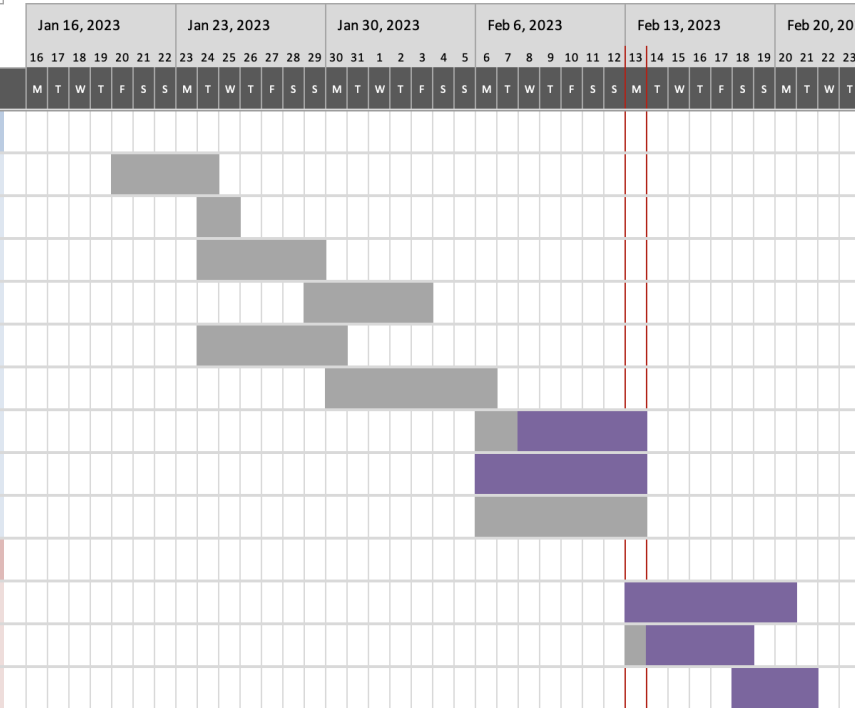


Table 1: Updated Ghantt Chart

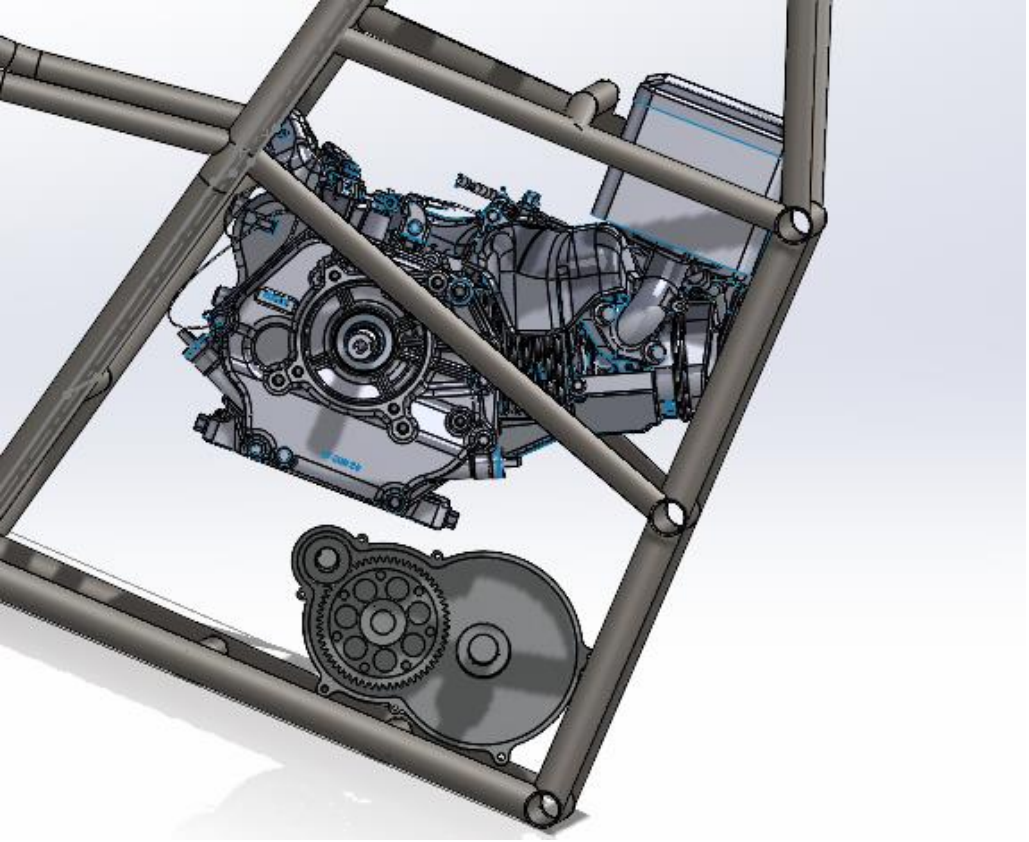


Figure 2: Side view of Engine and Gearbox

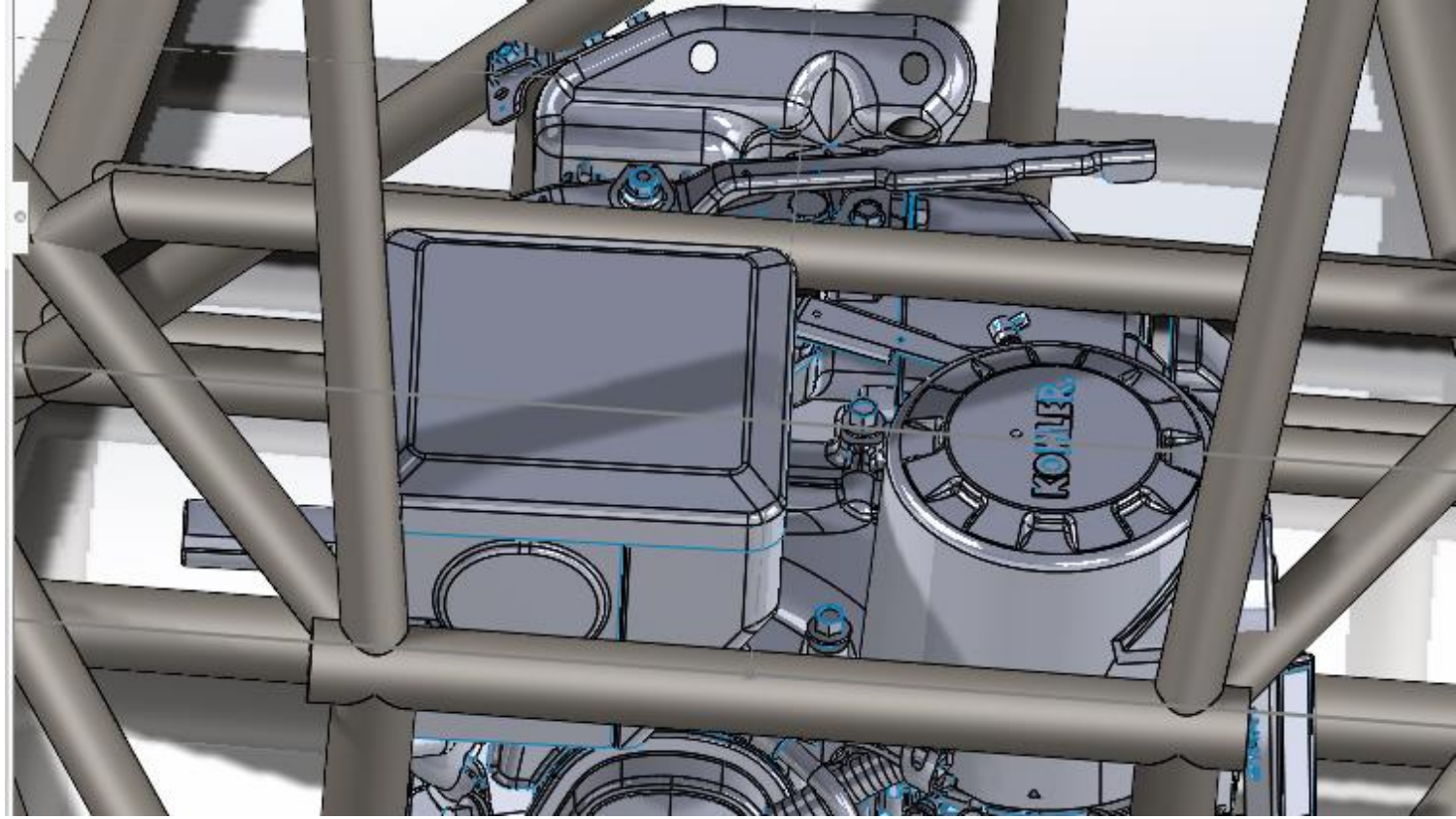


Figure 3: Top View of Engine and Gearbox

Engine Troubles

- Some Parts would not fit within the Frame which is needed for frame tech inspection.
- Made Gas Tank mount 4 inches taller to account for needed room

Fixtures

- Plan to make new plate to hold kill switch, currently in CAD design.

Figure 4: Kohler Engine

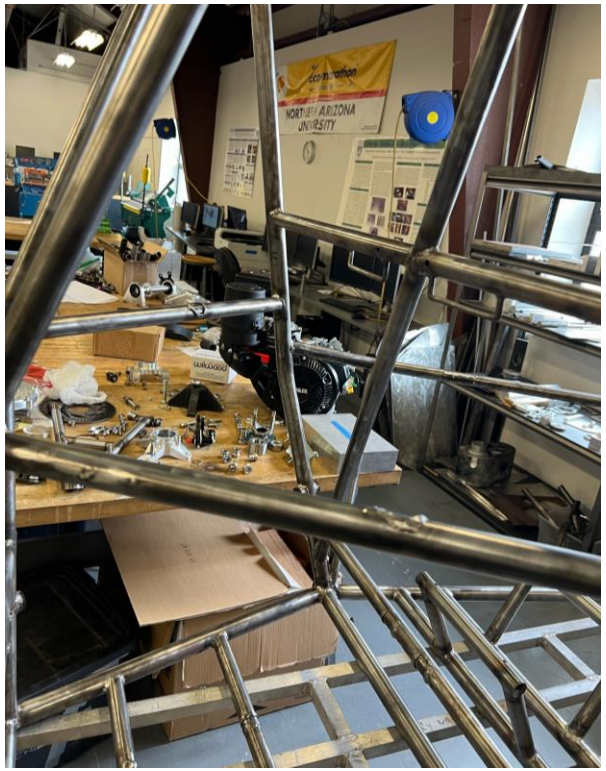
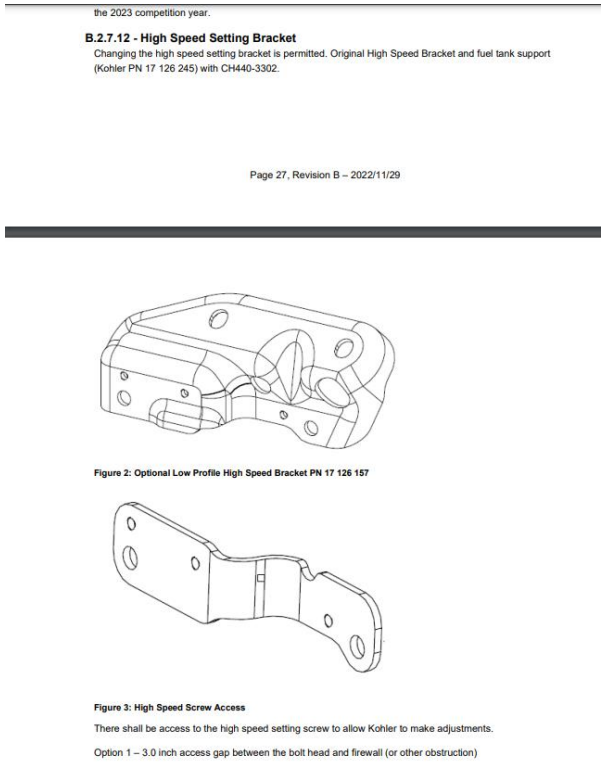


Figure 5: Frame without gas tank support

Figure 6: Gearbox Location



the 2023 competition year.

B.2.7.12 - High Speed Setting Bracket

Changing the high speed setting bracket is permitted. Original High Speed Bracket and fuel tank support (Kohler PN 17 126 245) with CH440-3302.

Page 27, Revision B – 2022/11/29

Figure 2: Optional Low Profile High Speed Bracket PN 17 126 157

Figure 3: High Speed Screw Access

There shall be access to the high speed setting screw to allow Kohler to make adjustments.

Option 1 – 3.0 inch access gap between the bolt head and firewall (or other obstruction)

Figure 7: SAE BAJA rulebook about engine

Gearbox Materials

Casing

Figure 8: Gearbox Shaft Materials

Gear and Shafts

- Materials for specific designs done
- Gears and Case must fit within a block that is 11X8X4 (inches)

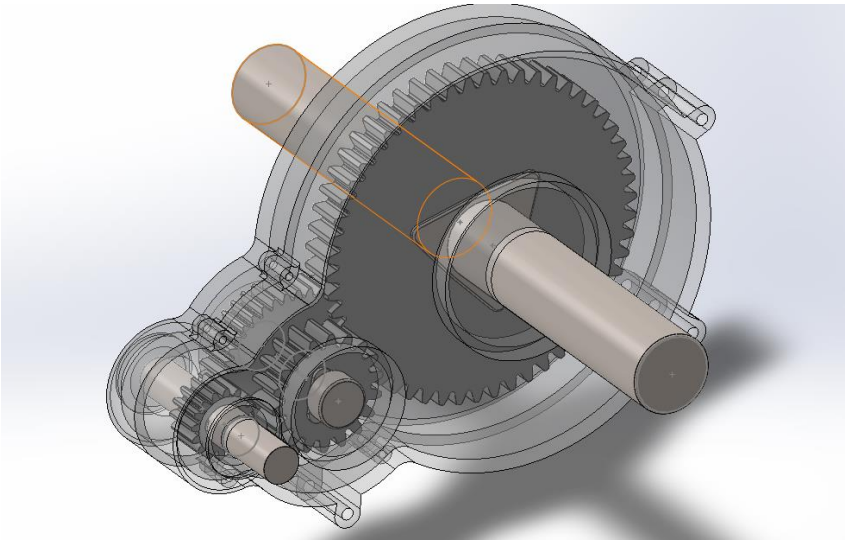


Figure 9: Full CAD Gearbox Assembly

Figure 10: Steel for Gears

Shaft Calculations (Gearbox)

Shaft 1

Shaft 2

Shaft 3

99.99% Reliability Correction (ke)

Initial Shaft Size in		0.75	
kb		0.906478108	EQN 6-19
Se		15.70315296	
Enter	Location	D&E	
lbf*in	Ma	267	
lbf*in	Mm	0	
lbf*in	Ta	0	
lbf*in	Tm	24.92	
Notch Radius	in	0.12	
qt		0.759333434	EQN 6-33
qs		0.808155487	EQN 6-33
Kt		2.5	
Ks		2.5	
Kf		2.139000151	EQN 6-34
Kfs		2.212233231	EQN 6-34
A		1.142226081	EQN 7-6
B		0.095485973	EQN 7-6
n		1.114420488	EQN 7-7

Table 2: Shaft 1 calculations

Initial Shaft Size in		0.98	
kb		0.88090218	EQN 6-19
Se		15.26009461	
Enter	Location	D&E	
lbf*in	Ma	505.15	
lbf*in	Mm	0	
lbf*in	Ta	0	
lbf*in	Tm	62.31	
Notch Radius	in	0.12	
qt		0.759333434	EQN 6-33
qs		0.808155487	EQN 6-33
Kt		2.5	
Ks		2.5	
Kf		2.139000151	EQN 6-34
Kfs		2.212233231	EQN 6-34
A		2.161031853	EQN 7-6
B		0.238753249	EQN 7-6
n		1.269314233	EQN 7-7

Table 3: Shaft 2 calculations

Initial Shaft Size in		1.54	
kb		0.839313402	EQN 6-19
Se		14.53964153	
Enter	Location	D&E	
lbf*in	Ma	748.4	
lbf*in	Mm	0	
lbf*in	Ta	0	
lbf*in	Tm	186.92	
Notch Radius	in	0.12	
qt		0.759333434	EQN 6-33
qs		0.808155487	EQN 6-33
Kt		2.5	
Ks		2.5	
Kf		2.139000151	EQN 6-34
Kfs		2.212233231	EQN 6-34
A		3.201655427	EQN 7-6
B		0.71622143	EQN 7-6
n		3.089187353	EQN 7-7

Table 4: Shaft 3 calculations

$$A = \sqrt{4(K_f M_a)^2}$$
$$B = \sqrt{3(K_{fs} T_m)^2}$$

$$n = \frac{\pi d^3}{16}\left(\frac{A}{S_e} + \frac{B}{S_{ut}}\right)^{-1}$$

$$\frac{1}{n} = \frac{\sigma'_a}{S_e} + \frac{\sigma'_m}{S_{ut}}$$

$$S_e = k_a k_b k_c k_d k_e S'_e$$

$$K_f = 1 + \frac{K_t - 1}{1 + \sqrt{a}/\sqrt{r}}$$

$$q = \frac{1}{1 + \frac{\sqrt{a}}{\sqrt{r}}}$$

$$k_b = \begin{cases} (d/0.3)^{-0.107} = 0.879d^{-0.107} & 0.3 \le d \le 2 \text{ in} \\ 0.91d^{-0.157} & 2 < d \le 10 \text{ in} \end{cases}$$

$$\sqrt{a} = 0.246 - 3.08\left(10^{-3}\right)S_{ut} + 1.51\left(10^{-5}\right)S_{ut}^2 - 2.67\left(10^{-8}\right)S_{ut}^3 \quad 50 \le S_{ut} \le 250 \text{ kpsi}$$

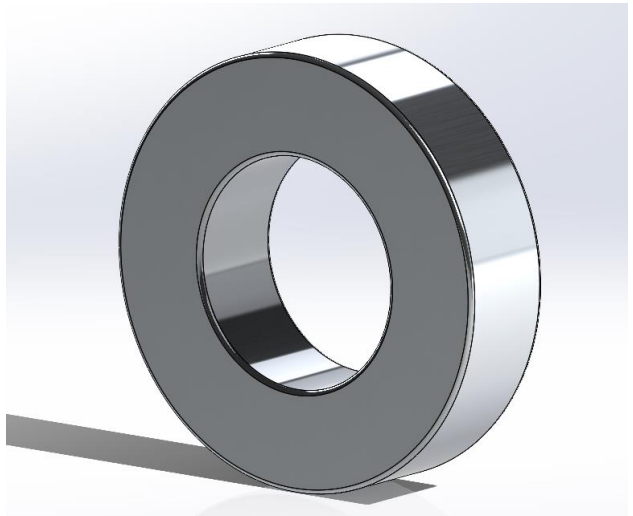
$$\sqrt{a} = 0.190 - 2.51\left(10^{-3}\right)S_{ut} + 1.35\left(10^{-5}\right)S_{ut}^2 - 2.67\left(10^{-8}\right)S_{ut}^3 \quad 50 \le S_{ut} \le 220 \text{ kpsi}$$

Bending

Torsion

Bearings

Figure 11: Bearing Material



Bore, mm	02-Series OD, mm	02-Series Width, mm	02-Series Load Rating, kN C_{10}	02-Series Load Rating, kN C_0	03-Series OD, mm	03-Series Width, mm	03-Series Load Rating, kN C_{10}	03-Series Load Rating, kN C_0
25	52	15	16.8	8.8	62	17	28.6	15.0
30	62	16	22.4	12.0	72	19	36.9	20.0
35	72	17	31.9	17.6	80	21	44.6	27.1
40	80	18	41.8	24.0	90	23	56.1	32.5
45	85	19	44.0	25.5	100	25	72.1	45.4
50	90	20	45.7	27.5	110	27	88.0	52.0
55	100	21	56.1	34.0	120	29	102	67.2
60	110	22	64.4	43.1	130	31	123	76.5
65	120	23	76.5	51.2	140	33	138	85.0
70	125	24	79.2	51.2	150	35	151	102
75	130	25	93.1	63.2	160	37	183	125
80	140	26	106	69.4	170	39	190	125
85	150	28	119	78.3	180	41	212	149
90	160	30	142	100	190	43	242	160
95	170	32	165	112	200	45	264	189
100	180	34	183	125	215	47	303	220
110	200	38	229	167	240	50	391	304
120	215	40	260	183	260	55	457	340
130	230	40	270	193	280	58	539	408
140	250	42	319	240	300	62	682	454
150	270	45	446	260	320	65	781	502

Table 5: Bearing sizing

Chosen bearings for Gear box
Bearings 1+2
Bore 20 mm OD 40mm
Bearings 3+4
Bore 25mm OD 52 mm
Bore 40mm OD 80mm

Equations

$$x_D = \frac{L_D}{L_{10}} = \frac{60\mathscr{L}_D n_D}{L_{10}}$$

$$C_{10} = a_f F_D \left[\frac{x_D}{x_0 + (\theta - x_0)(1 - R_D)^{1/b}}\right]^{1/a}$$

Assumptions
No axial forces on gear box shafts, so X1 and Y1 are the same, no iterations needed

Chain drive

Roller Chain Sprocket

for ANSI 40 Chain, 17 Teeth, for 1-1/4" Shaft Diameter

6280K717

Figure 12: Sprocket

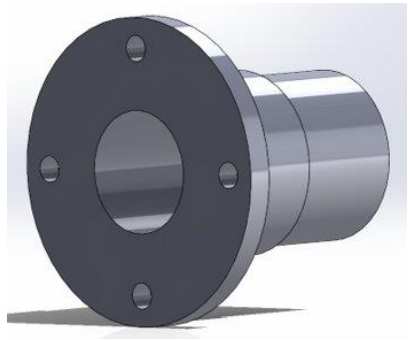


Figure 13: Bearing to axle fitting

Figure 15: Shaft Bearing

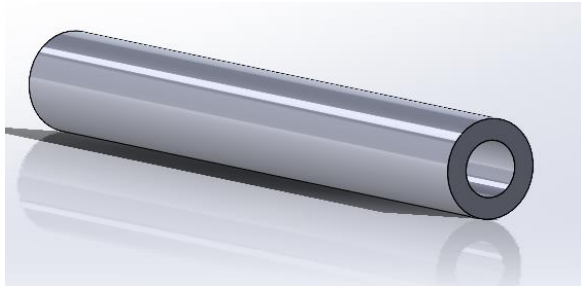


Figure 16: Shaft for sprocket holders

Figure 14: Ansi-40 chain

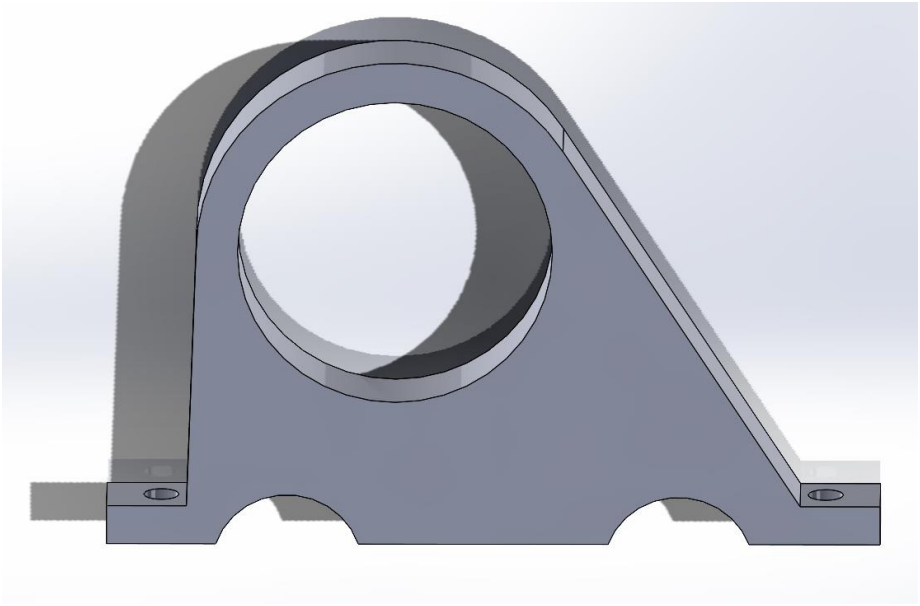


Figure 17: Bearing holder for middle shaft

Updated BOM/Purchasing/ Manufacturing

54% purchased

10-15% built

15% Assembled

90% Design Done

Figure 18: Purchasing Key

Drivetrain

Priority No.	Part Name	Action Needed	Size/Dimensions	QTY	Price (Each)	Price (Total)	Link to Website	Part No. (From Website)	Notes
1	Gear Casings (2 sides)	already owned	n/a	2	0	0			CAD done, will be ordered next week
2	Gears	Make in house	4 different sizes	4	0	0			CAD done, finalizing Wire EDM quote
3	Input Shaft	make in house	Length: TBD, D: 15mm	1	0	0			Dimensions currently being updated to the nearest millimeter to assure optimization
4	Middle Shaft	make in house	Length: TBD, D: 15-20mm	1	0	0			Dimensions currently being updated to the nearest millimeter to assure optimization
5	Output Shaft	Make in house	Length: TBD, D: 25mm	1	0	0			Dimensions currently being updated to the nearest millimeter to assure optimization
6	Gearbox Casing Bearings (Input)	Ordered	(8x22x7mm)	2	9	18	https://www.amazon.com/Pcs-608-2RS-Ball-Bearings/dp/B09PKD8QZZ/ref=asc_df_B09PKD8QZZ/?tag=hyprod-20&linkCode=df0&hvadid=564832768295&hvpos=&hvnetw=g&hvrand=15508056620382503717&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=1013406&hvtargid=pla-1645667255021&psc=1	608-2RS	
7	Gearbox Casing Bearings (Middle)	Ordered	(8x22x7mm)	2	0	0	"" ""		
8	Gearbox Casing Bearings (Output)	Ordered	(8x22x7mm)	2	0	0	"" ""		
9	Gearbox Spacers	already owned	aluminum tubes	8	0	0	Aluminum in house		
10	Retaining Rings	already owned	Dia: 10-20mm	4	0	0			Dimensions currently being updated to the nearest millimeter to assure optimization
11	Keyways	Make in house	TBD	26		0			Might not use for the build
12	Keys	Make in house	TBD	26		0			Might not use for the build
13	Casing Bolts	Need to order	Dia: TBD	12	4	48	grab from copper mountain nut and bolt		Finding best bolts and Nuts to use, research going on now.
14	Casing Nuts	Need to order		12	6	72	grab from copper mountain nut and bolt		Finding best bolts and Nuts to use, research going on now.
15	Casing Washers	Need to order		12	6	72	grab from copper mountain nut and bolt		

16	Guard for Chain Drive (Sheet Metal	already owned	n/a	1		0			
17	Sprockets	ordered		4		0			Currently working on CAD
18	Throttle Cable	need to order	4ft or 48inches	1	50	50	https://www.summitracing.com/parts/csi-6004	CSI-6004	
19	Bearings for axels	Need to order		4		0	https://www.amazon.com/Pcs-608-2RS-Ball-Bearings/dp/B09PKD8QZZ/ref=asc_df_B09PKD8QZZ/?tag=hyprod-20&linkCode=df0&hvadid=564832768295&hvpos=&hvnetw=g&hvrand=15508056620382503717&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=1013406&hvtargid=pla-1645667255021&psc=1	608-2RS	
20	Chains	Need to order	2 ft/chain	2		0			
20	Belt	need to order	length 34.83", width 7/8"	2	39.95	79.9	https://www.gopowersports.com/40-series-drive-belt-203786/	203786	
21	Chain Links	need to order	Carbon Steel, 0.25 pitch	2	11	22	https://www.amazon.com/Roller-Chain-Connecting-Links-Pack/dp/B085FQ9P6F/ref=asc_df_B085FQ9P6F/?tag=hyprod-20&linkCode=df0&hvadid=459618092337&hvpos=&hvnetw=g&hvrand=32659201014748835 29&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=1013406&hvtargid=pla-945359385976&psc=1	RC-25-CL/10	
22	Chain Tightener	need to order	n/a	2	36	72	https://www.amazon.com/dp/B07GKXLYBS/ref=sspa_dk_detail_3?pd_rd_i=B07GKXLYBS&pd_rd_w=YdfFF&content-id=amzn1.sym.88097cb9-5064-44ef-891b-abfacbc1c44b&pf_rd_p=88097cb9-5064-44ef-891b-abfacbc1c44b&pf_rd_r=DN24X03N03HTKZQ7QBCK&pd_rd_wg=wRDjx&pd_rd_r=d5340de9-5634-4e84-9245-015d782bfd36&s=industrial&sp_csd=d2lkZ2V0TmFtZT1zcF9kZXRhaWw&spLa=ZW5jcnlwdGVkUXVhbGlmaWVyPUEyS1RFRUpBSDBVTzhYJmVuY3J5cHRlZElkPUEwMDU2MzczMVA5M1VHR0Q5TFhOQSZlbmNyeXB0ZWRBZElkPUEwNzY5NjA3MUYyMlpSMTZBUUYzSyZ3aWRnZXROYW1IPXNwX2RldGFpbCZhY3Rpb249Y2xpY2tSZWRpcmVjdCZkb05vdExvZ0NsaWNrPXRydWU&th=1	08DE-60-100	
23	Guard for CVT (Aluminum/Steel)	already owned	n/a	1		0			
24	Metal Mesh for CVT Guard	already owned	n/a	1		0			
25	External Kill Switch	Need to order	n/a	1	62.95	62.95	https://www.amazon.com/Ski-Doo-1994-1996-Snowmobile-27-0152-414612700/dp/B079FSJSWT	27-0152	
26	Cockpit Kill Switch	item owned	n/a	1	62.95	62.95	https://www.amazon.com/Ski-Doo-1994-1996-Snowmobile-27-0152-414612700/dp/B079FSJSWT	27-0152	
27	Sheet metal for back plate	already owned				0			
28	Lubrication	already owned	n/a	1	13	13			
29	CVT	already owned	n/a	1		0			
30	Engine	owned	n/a	1		0			
31	Gear cutters	need to order	module 2	1	238.6	238.6	https://www.amazon.com/YJYGR-Diameter-20degree-Involute-Circular/dp/B09CYNXR14		Might not use for the build
32	Gear cutters	need to order	module 3	1	245.7	245.7	https://www.amazon.com/YJYGR-Diameter-20degree-Involute-Circular/dp/B09CYNXR14		Might not use for the build

Torque required to get uphill climb

Max length (From 2013 competiion) 32 (m?)	Hill Climb Torque required given % grade (80%)
Mass (kg)	226.7573696
	0.624695048
Force required (N) (9.81m/s^2 for gravity)	1389.627759
Torque Required (N*m)	176.4827254
Torque Required (ft-lbs)	130.1495025

Proof our vehicle design can do it

RPM			Torque
0	22.7	18.91666667	140.2058824
100	22.5	18.75	138.9705882
200	22	18.33333333	135.8823529
300	21	17.5	129.7058824
400	21.4	17.83333333	132.1764706
500	20.6	17.16666667	127.2352941
600	20.3	16.91666667	125.3823529
700	20.15	16.79166667	124.4558824
800	20	16.66666667	123.5294118
900	19.85	16.54166667	122.6029412
1000	19.75	16.45833333	121.9852941
1100	19.6	16.33333333	121.0588235
1200	19.5	16.25	120.4411765
1300	19.4	16.16666667	119.8235294
1400	19.3	16.08333333	119.2058824
1500	19.2	16	118.5882353
1600	19.15	15.95833333	118.2794118
1700	19.05	15.875	117.6617647
1800	19	15.83333333	117.3529412
1900	18.95	15.79166667	117.0441176
2000	18.9	15.75	116.7352941
2100	18.8	15.66666667	116.1176471
2200	18.7	15.58333333	115.5
2300	18.6	15.5	114.8823529
2400	18.5	15.41666667	114.2647059
2500	18.3	15.25	113.0294118
2600	18.1	15.08333333	111.7941176
2700	17.75	14.79166667	109.6323529
2800	17.4	14.5	107.4705882
2900	17	14.16666667	105
3000	16.6	13.83333333	102.5294118
3100	16	13.33333333	98.82352941
3200	15.4	12.83333333	95.11764706
3300	14.95	12.45833333	92.33823529
3400	14.5	12.08333333	89.55882353
3500	14	11.66666667	86.47058824
3600	13.5	11.25	83.38235294