Project Report

Rugby Ball Launcher

Joel Kumfer & Mitchell Olney

MET 494

Table of Contents

Design

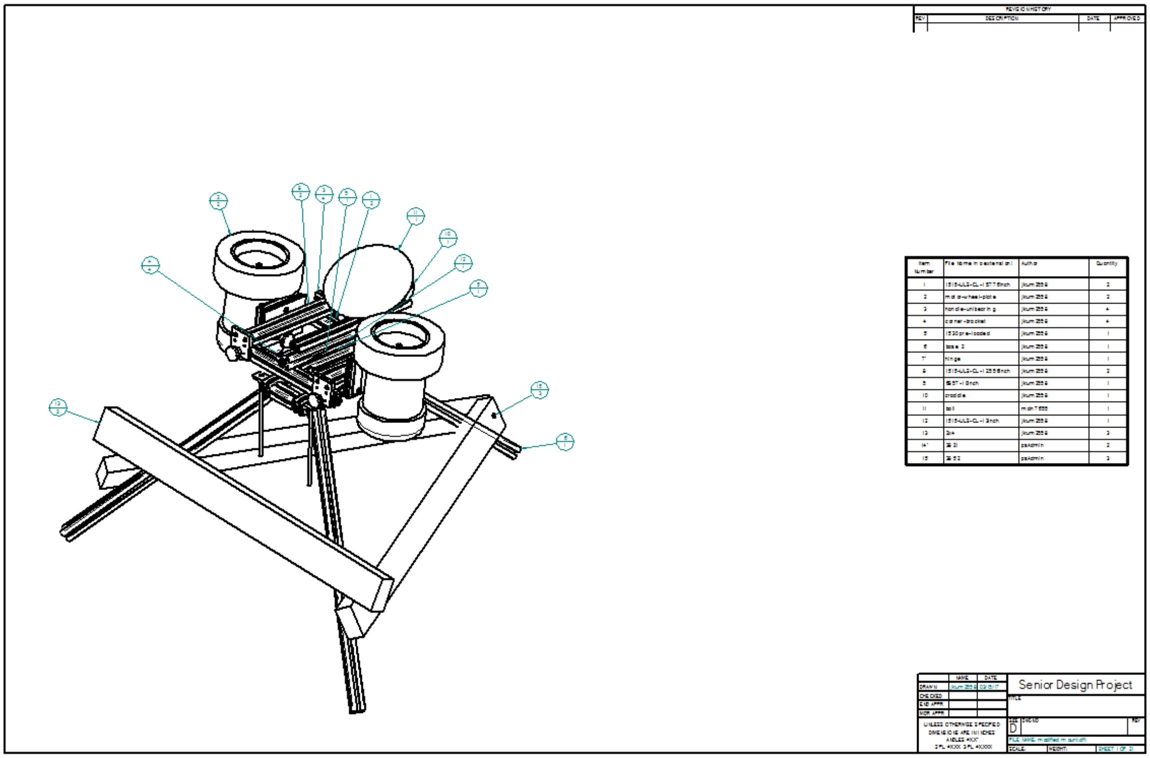


Image 1.1

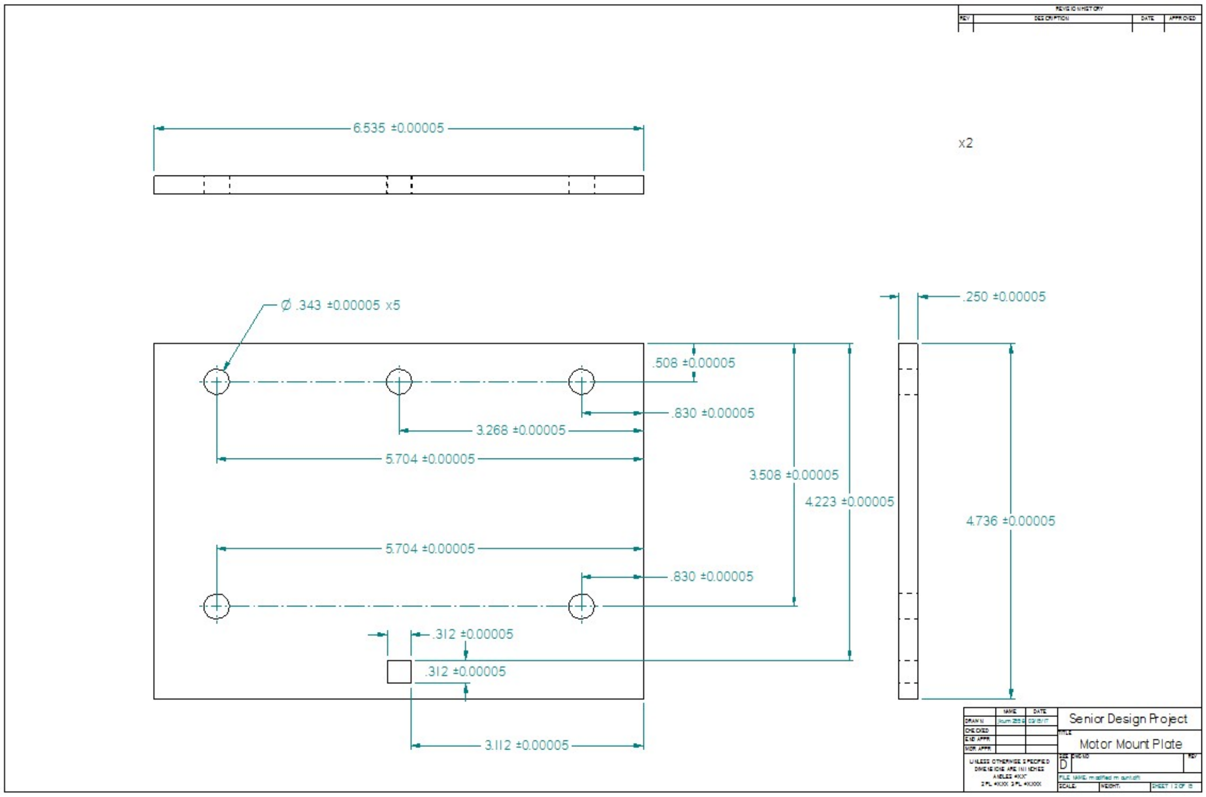


Image 1.2

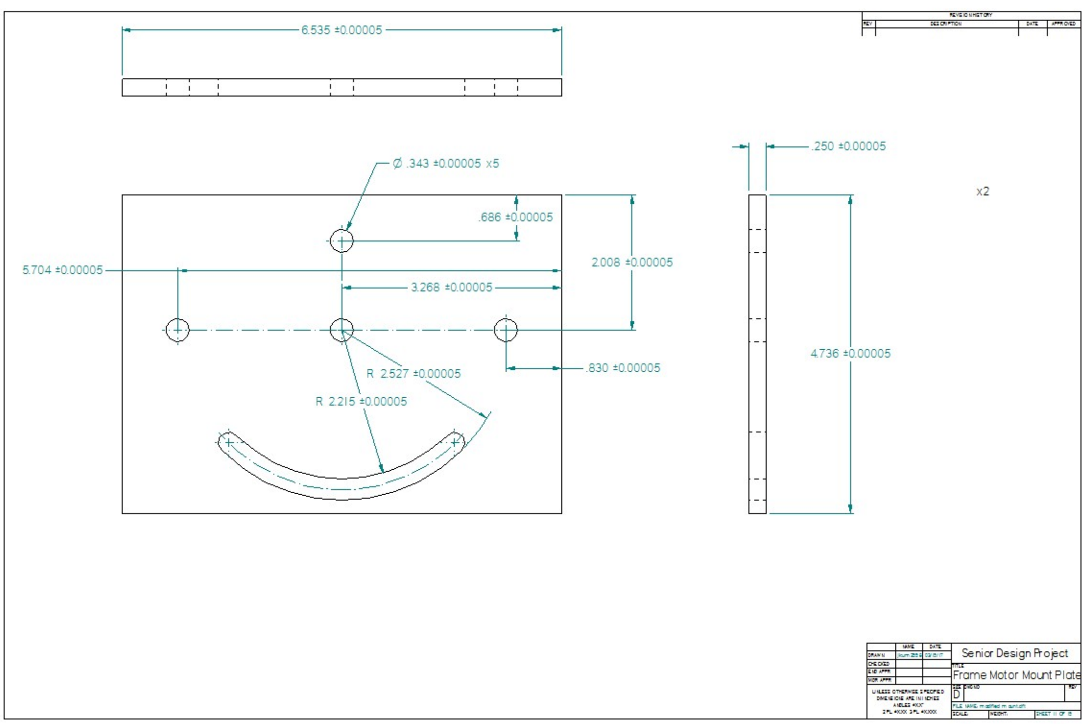


Image 1.3

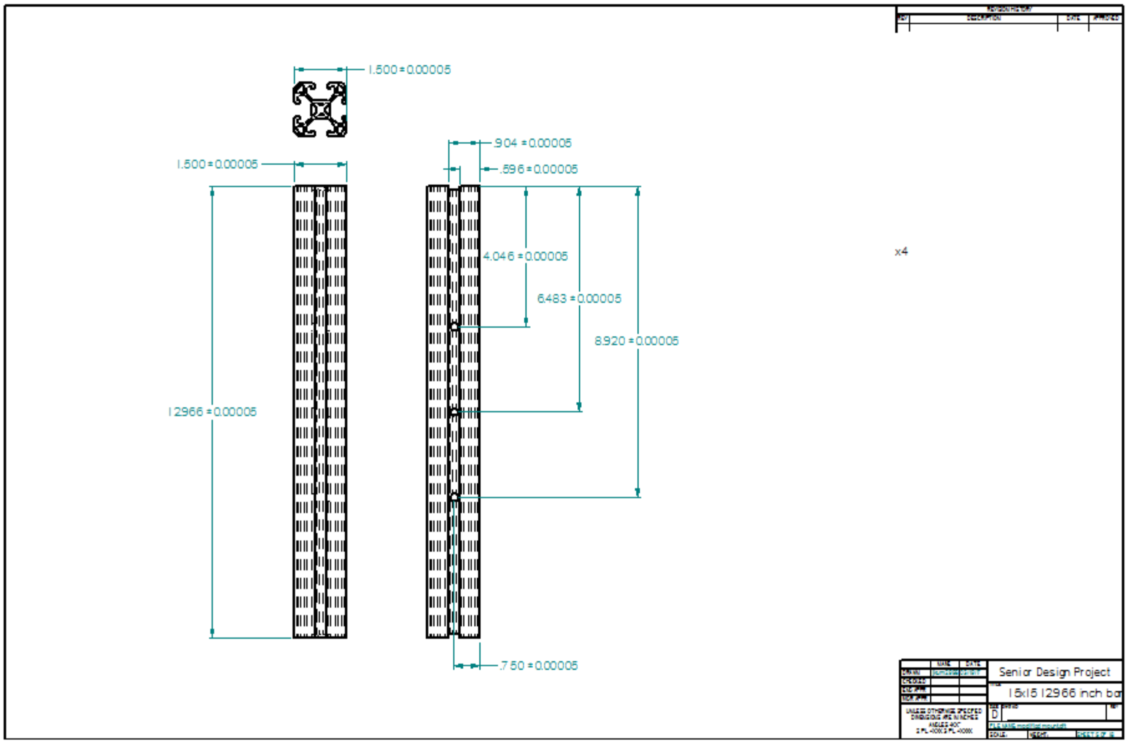


Image 1.4

Image 1.1 is our current design; the 2 motors are connected to a quarter inch steel plate (Image 1.2) which is than mounted to another quarter inch steel plate (Image 1.3). The second plate is mounted to two 15 series aluminum t-slotted bars 12.9 inches in length (Image 1.4). Here we calculated the deflection from just the weight of the motor hanging from the 15 series bars.

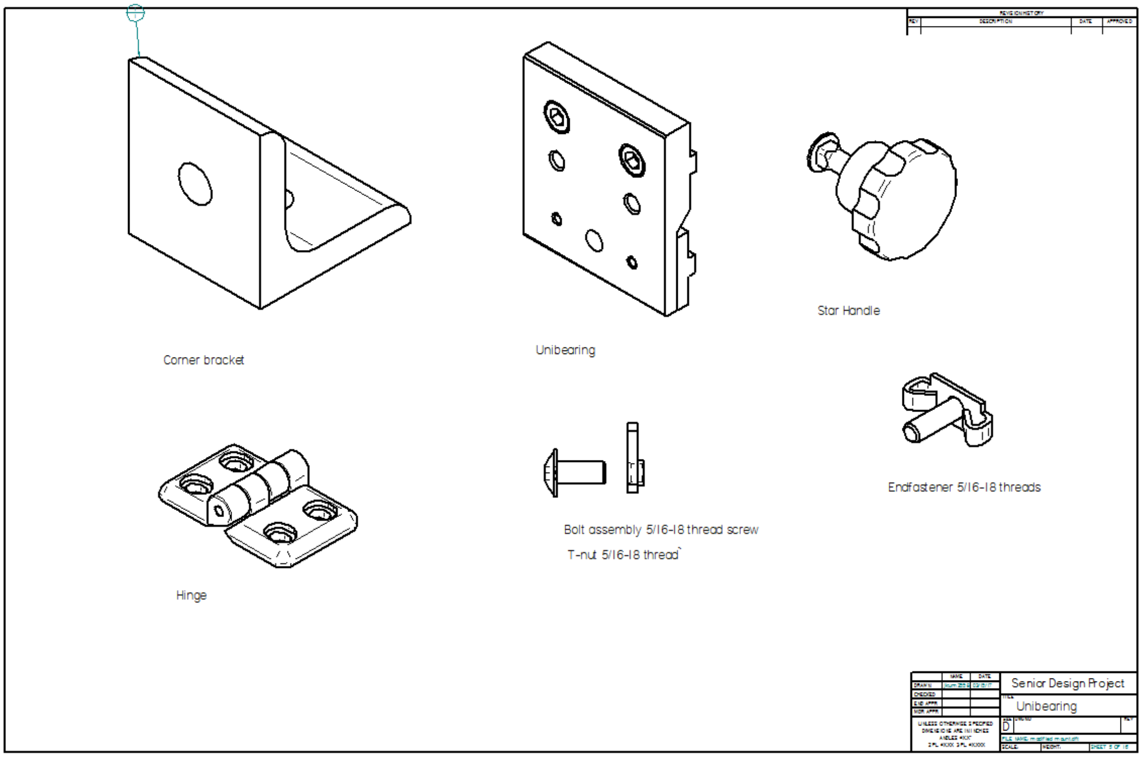


Image 1.5

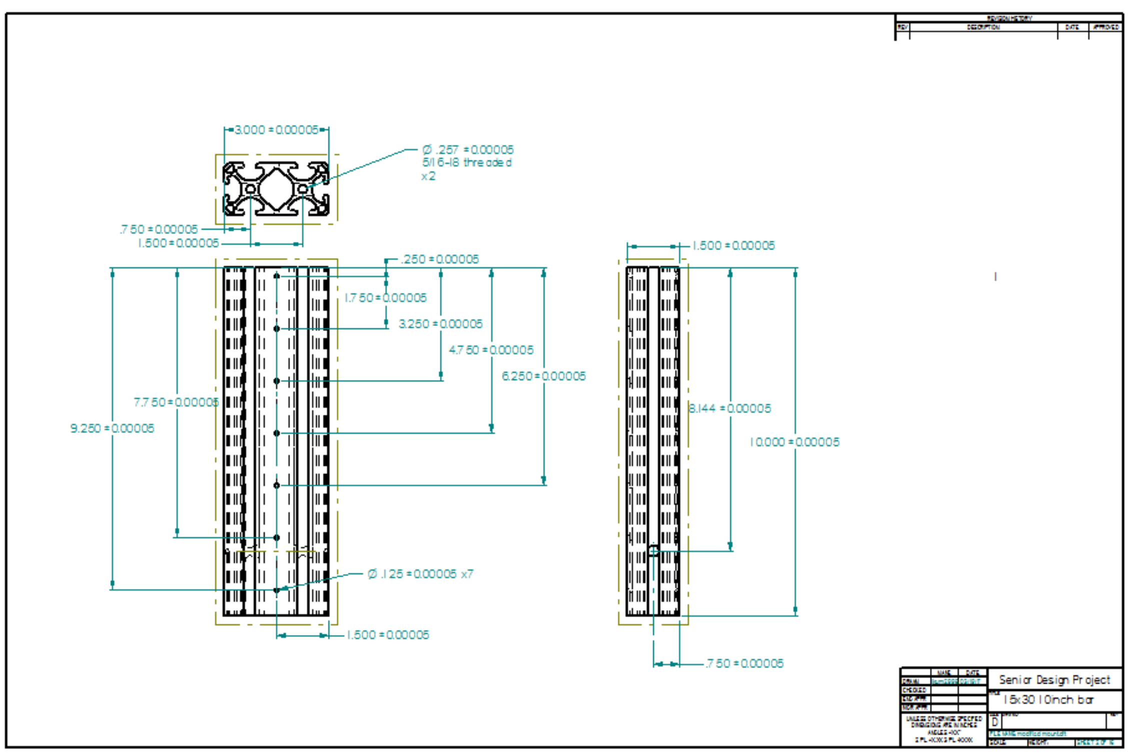


Image 1.6

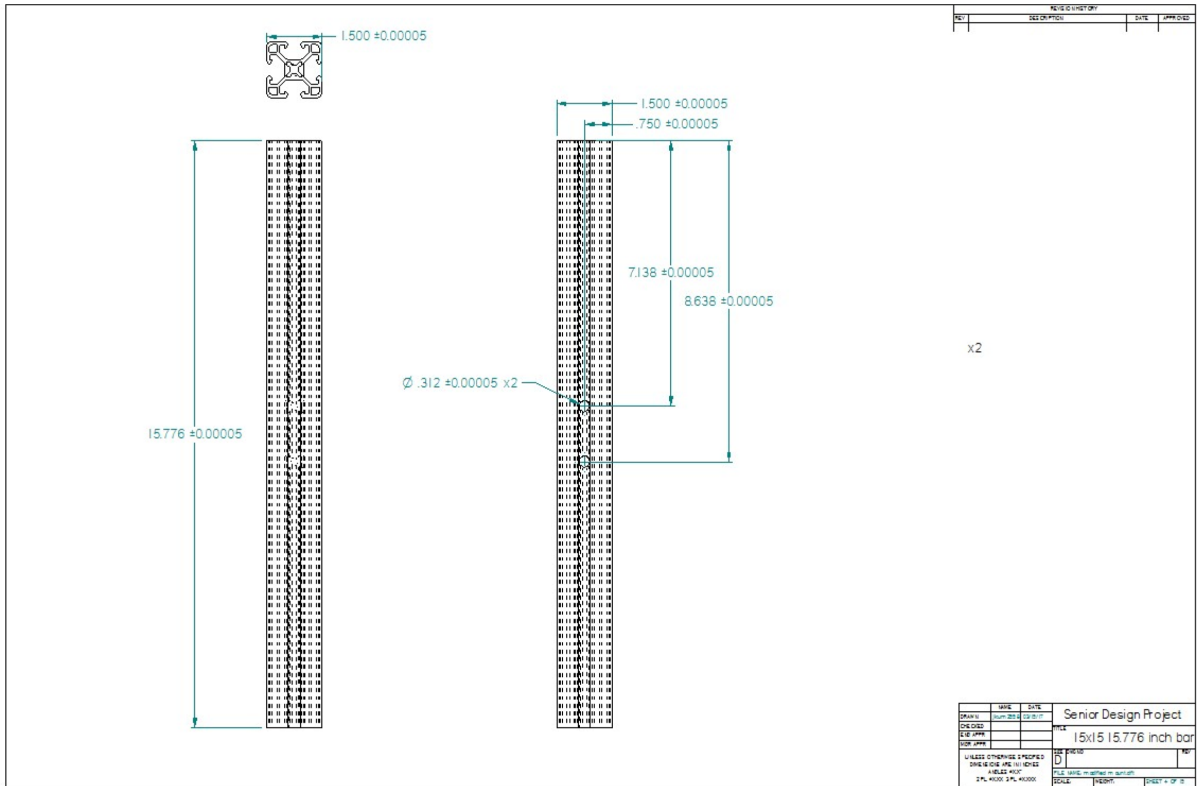


Image 1.7

The two 15 series bars are tapped at each end and connected to two unbearding's (Image 1.5) at each end with a star handle brake kit (Image 1.5) which is connected to the frame. The frame is made of a 15-series doublewide bar 10 inches in length (Image 1.6), this has taped ends for end fasteners to be fitted (Image 5). The end fasteners are tightened in on the through holes on the two 15 series bars 15.75 inches in length (Image 1.7) which are connected by end fasteners and corner brackets (Image 1.5). This allows us to move the motors closer to one another to launch different size balls and possibly flat balls. Here we calculated the deflection of the motor hanging from to fixed ends.

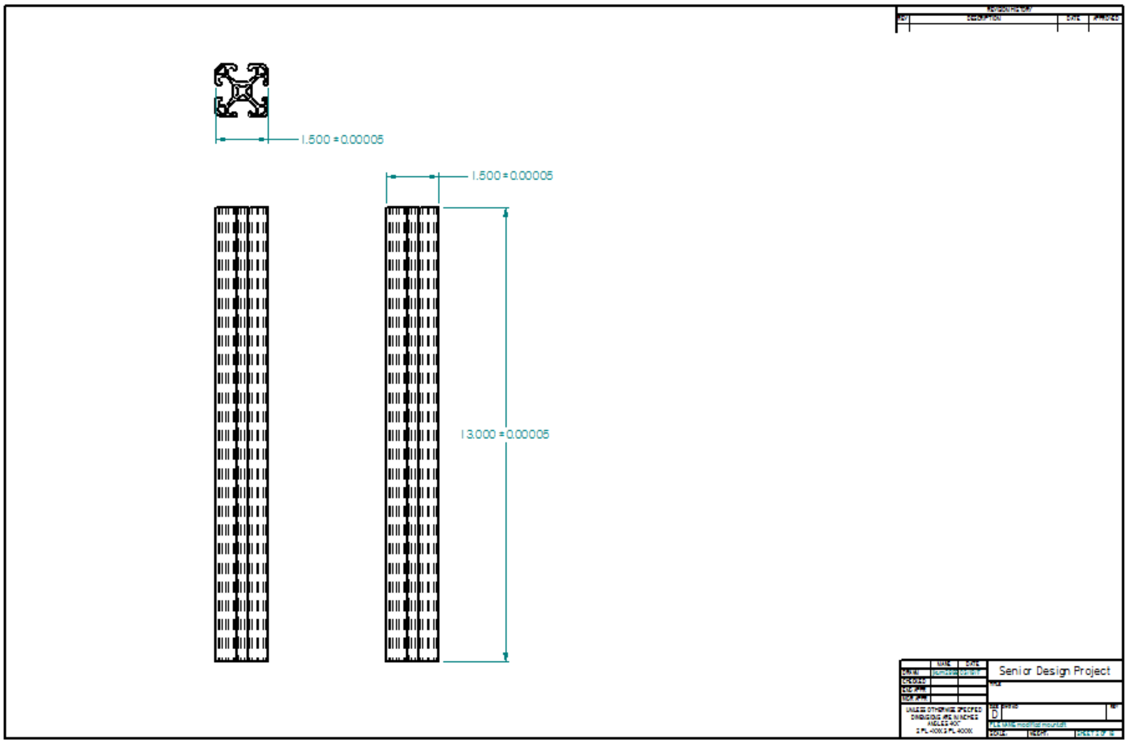


Image 1.8

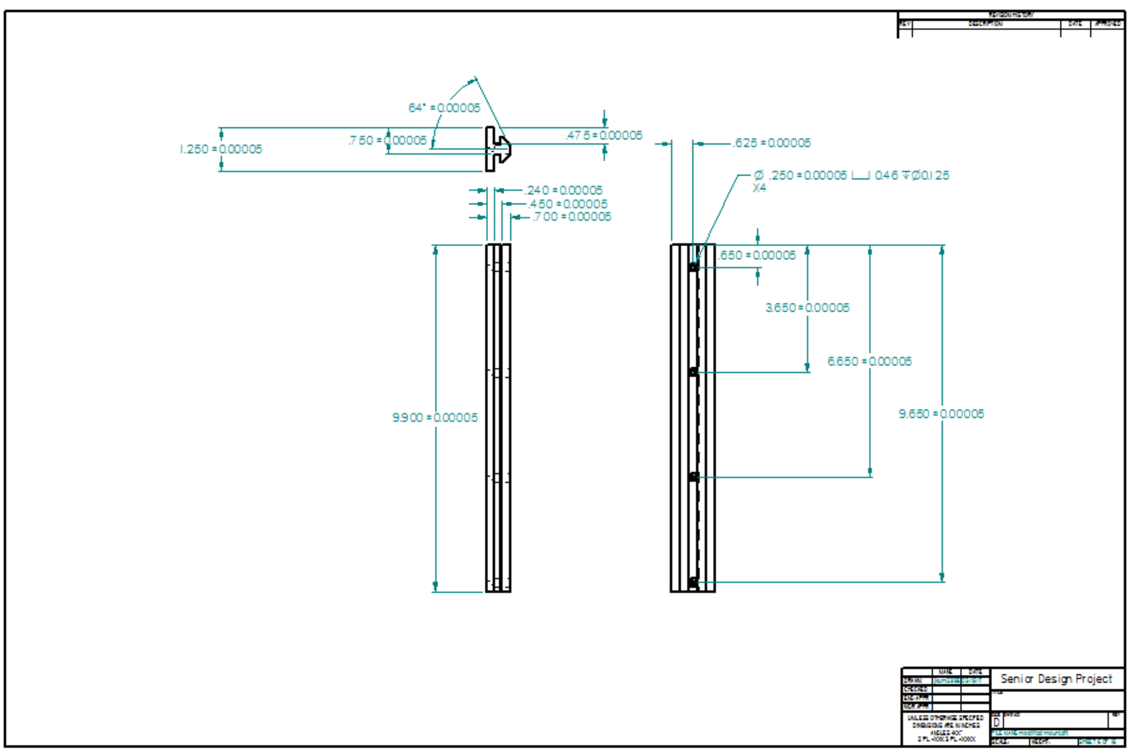


Image 1.9

The last part of the frame is a 15-series 13 inch bar (Image 1.8) is connected to 15-series double wide bar (Image 1.6) by the t-nut and a 5/16-18 1.75 inch long bolt (Image 1.5). Next, a 10-inch linear bearing pad (Image 1.9) is bolted to the 15-series 13-inch long bar with the t-nuts and 5/16-18 bolt (Image 1.5). This acts as a track so the cradle can slide forward moving the ball into contact with the tires.

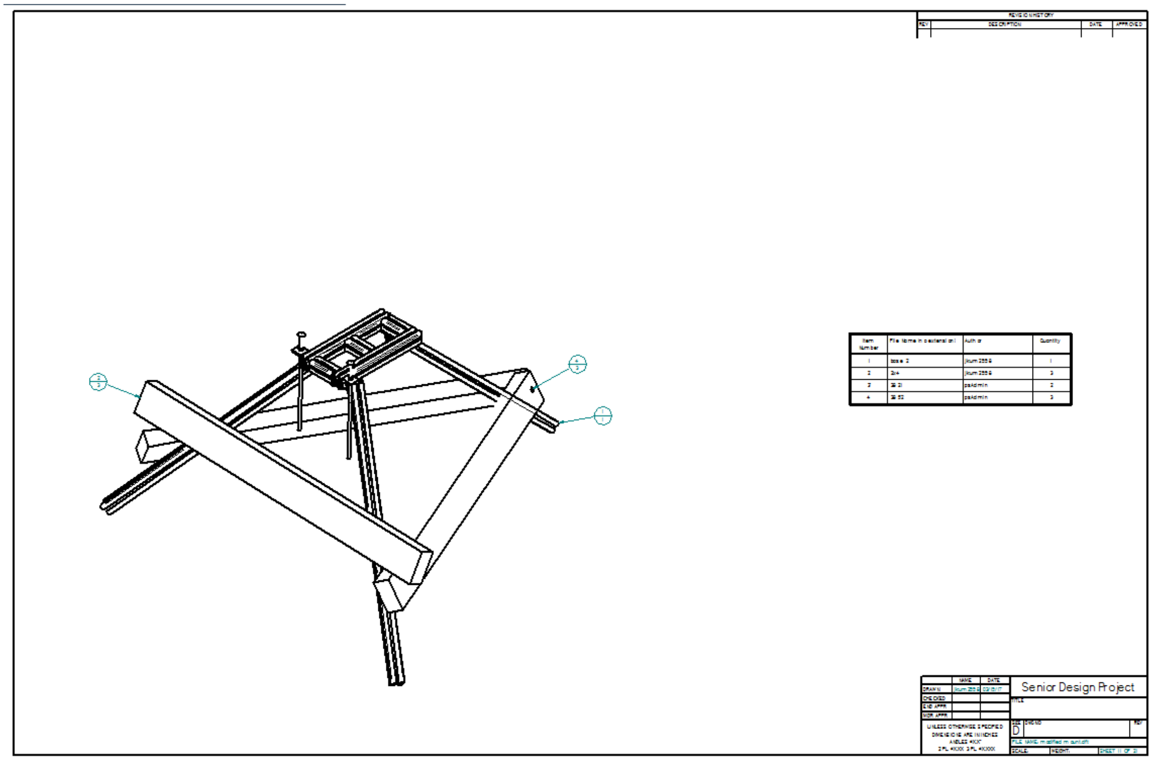


Image 1.10

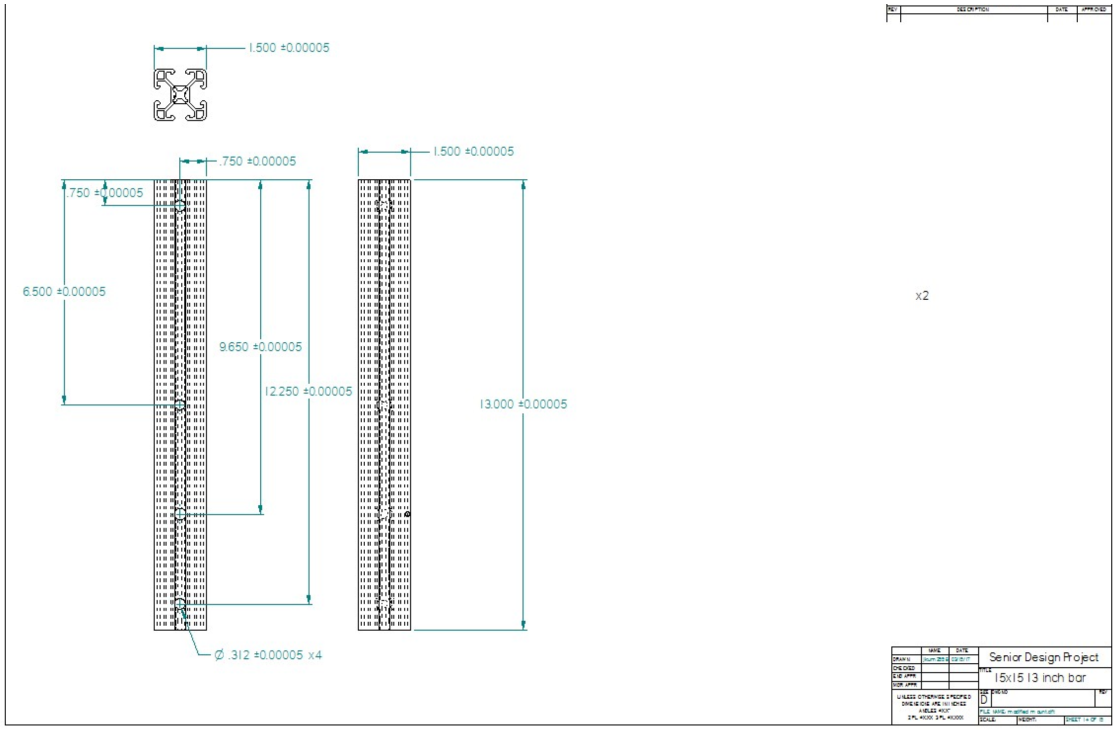


Image 1.11

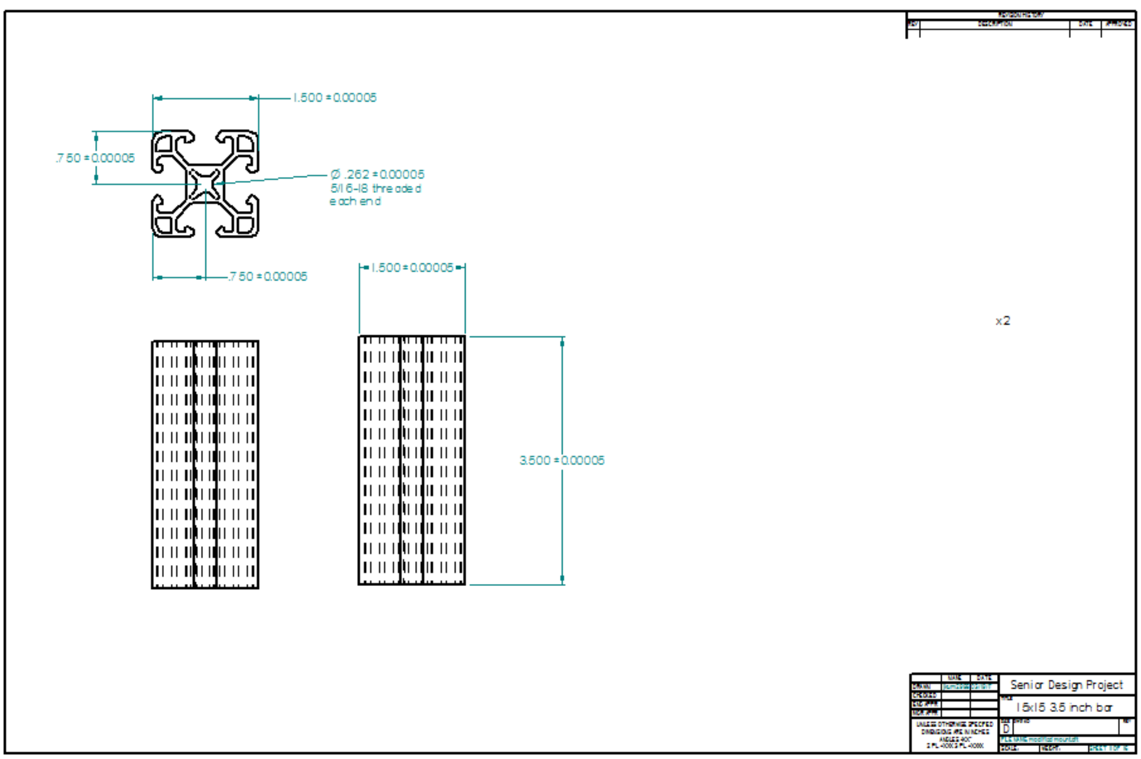


Image 1.12

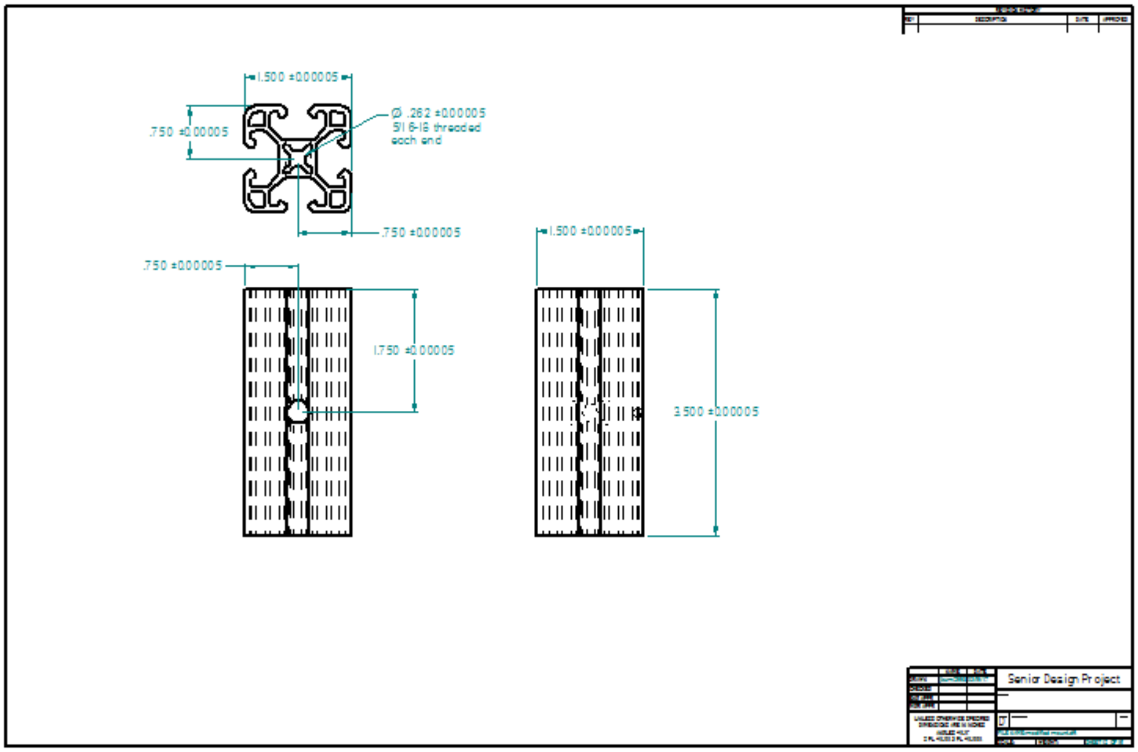


Image 1.13

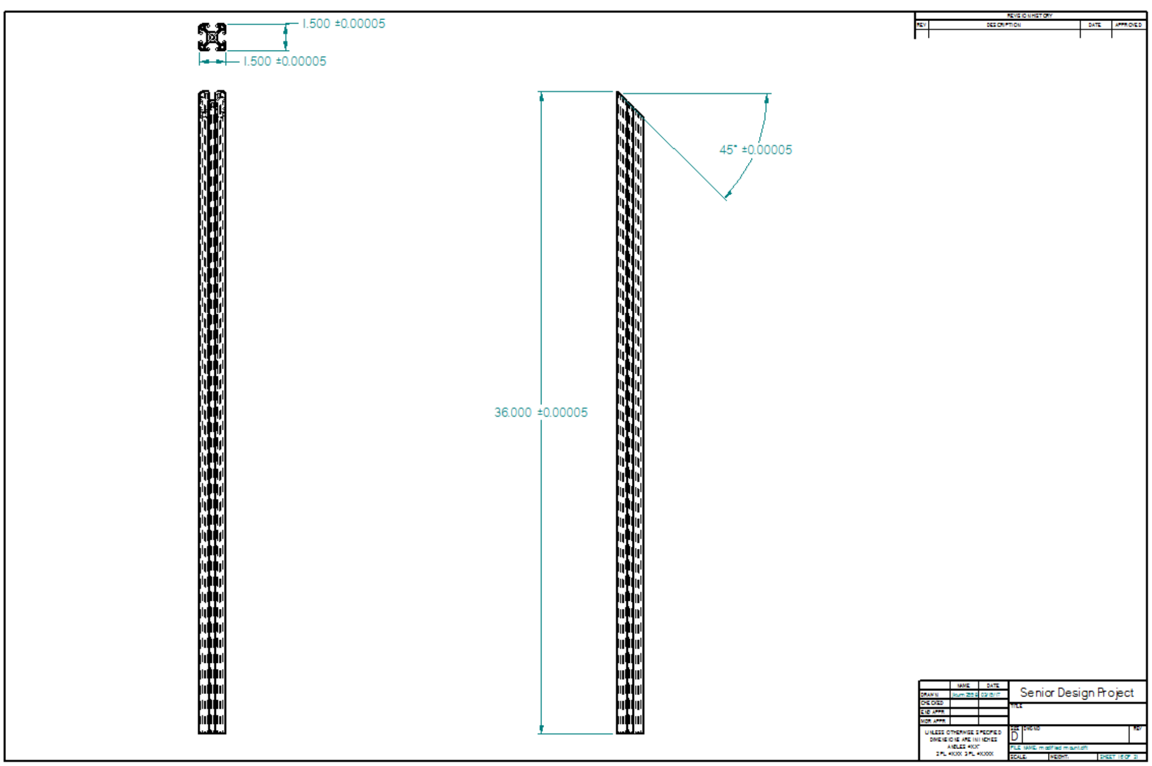


Image 1.14

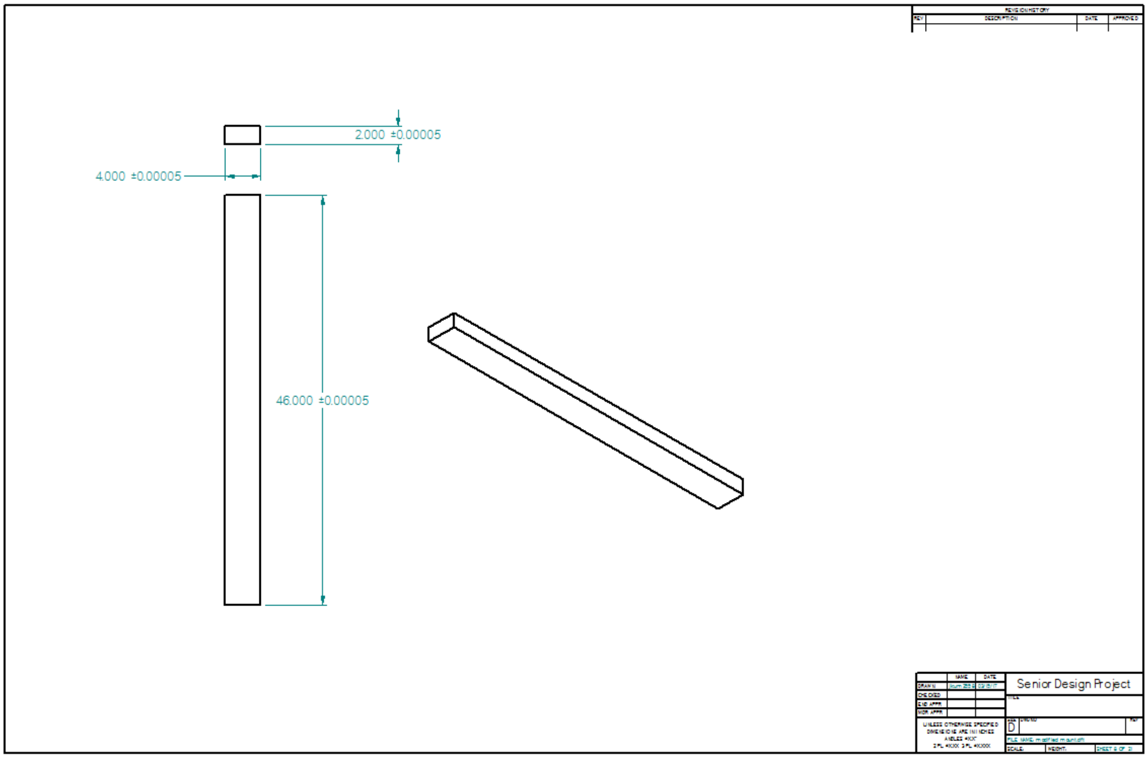


Image 1.15

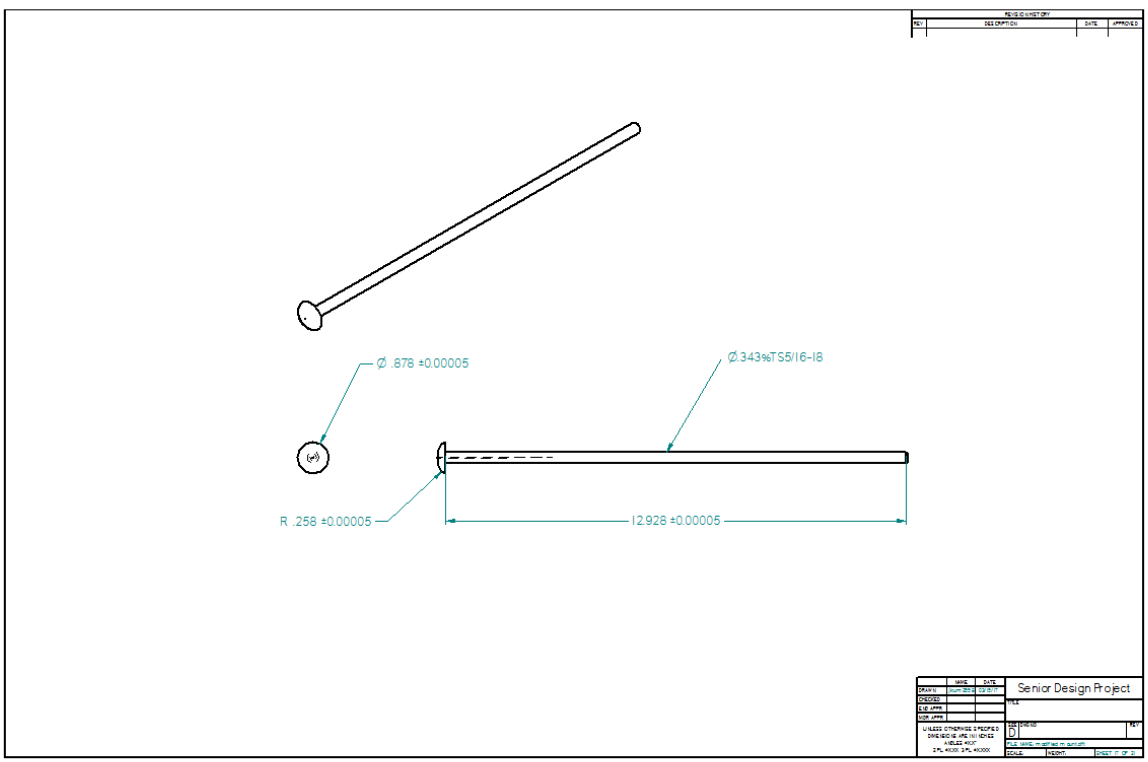


Image 1.16

The hinge (Image 1.5) attaches the frame to the base allowing us to lift the opposite end to achieve the desired angle to proceed. The bottom part of the frame (Image

1.10) is made of two 15 series 13 inch in length (Image 1.11). There at three 3.5 inch 15 series bars (Image 1.12) one which has a through hole in the center of the t-slot (image 1.13) which are taped on each end and fitted with an end fastener (Image 1.5) to be tightened to the 13 inch bars. The 13-inch bars have four through holes in the middle of the frame to allow the end fasteners to be tightened properly. Next, we attached the legs (Image 1.14) to the bottom of the base using corner brackets (Image 1.5). We attached two to the front and one to the rear under the hinge with two corner brackets. Than we added two more corner brackets to both sides of the front of the base and added a support (Image 1.16) it is secured by 5/16-18 inch threaded nuts to keep it in place. These where added for extra support for the frame to keep the motor from shaking the frame during use.

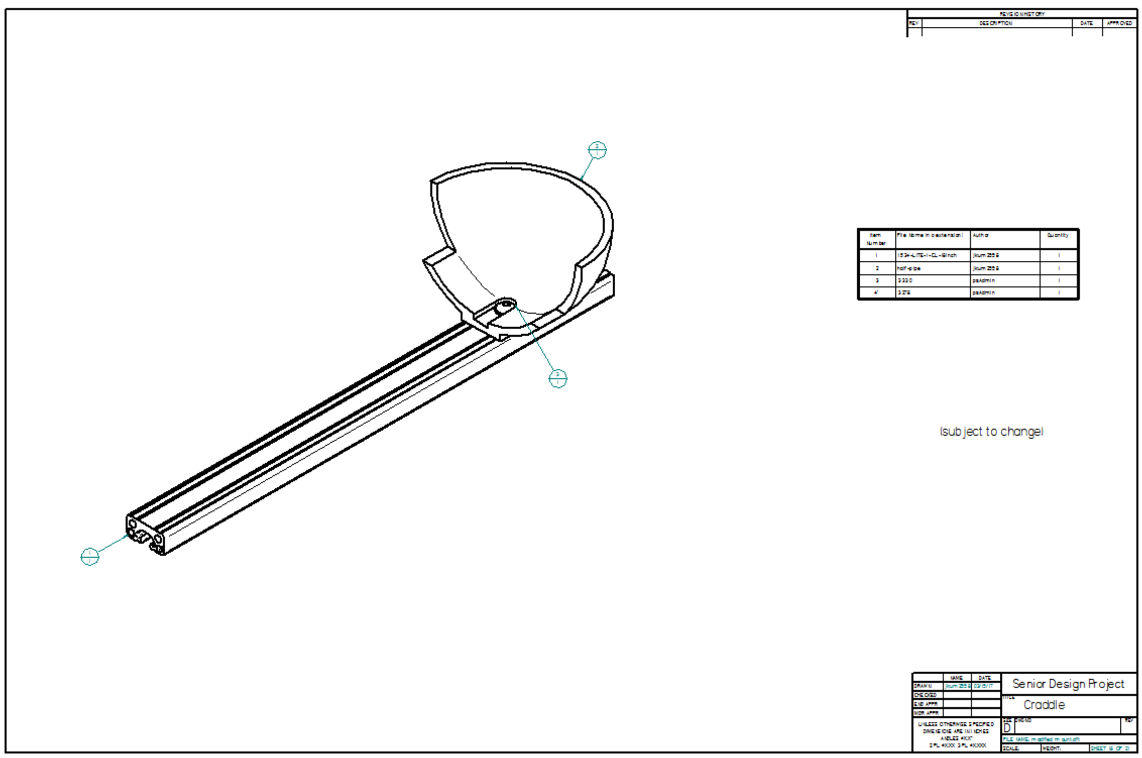


Image 1.17

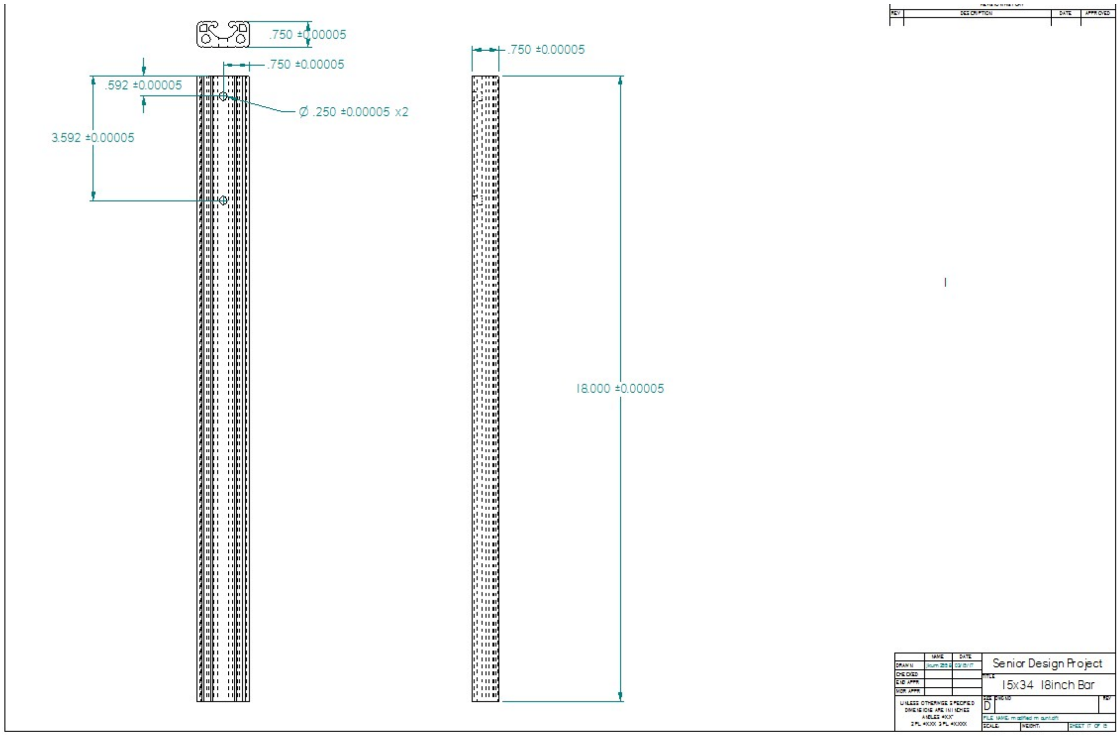


Image 1.18

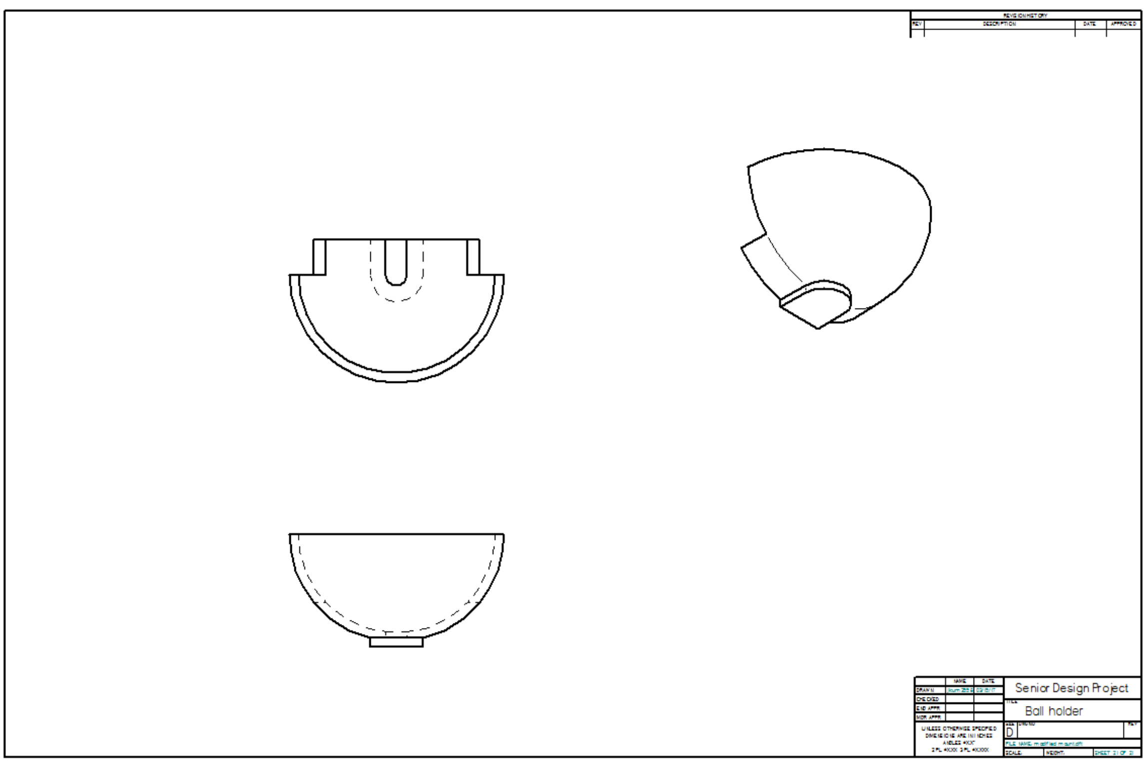


Image 1.19

The last part is where the balls will be placed and pushed toward the spinning tires (Image 1.17); this is all subject to change simply because we are looking for the right material. The 15-series linear bearing pad (Image 1.9)allows for the 15 series .75-

inch lite bar 18 inches in length which is capped at one end (Image 1.18) to be slide on. The next through hole above the one for the grip is for a ball holder (Image 1.19). This is slide onto the linear bearing pad.

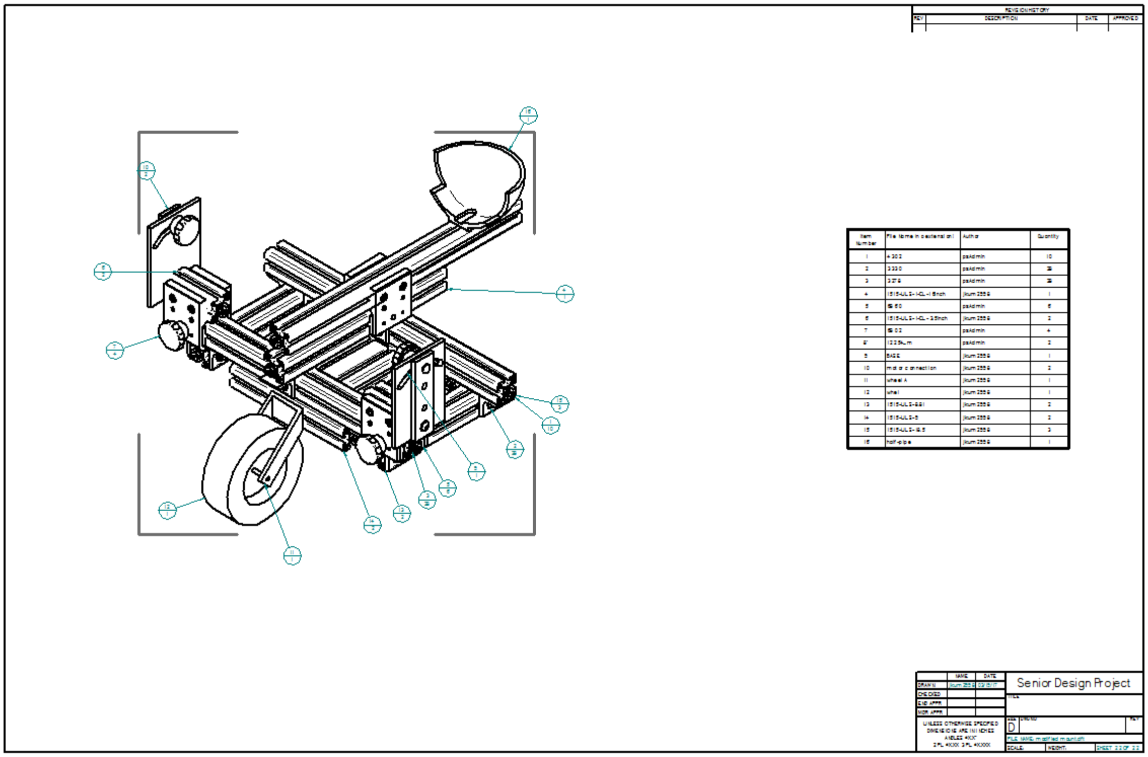


Image 1.20

This is the first design we came up with, but decided against it (Image 1.20). At the time the motors we planned to use where much smaller.

If we had more time, we would again go with a different design. The motors at their highest rpms shake the frame, to avoid this we would make the angled assembly attached to the motors much bigger and extend it past the motors. Another solution we wanted to try was shock absorbers on the base and on the motors themselves. When we tried to change the position of the motors to create different types of spin on the ball the motors did not exactly line up and the ball would go from one wheel to the other, this ended with the ball spinning in several directions making it difficult to catch. In order to avoid this we would calculate the necessary distance and adjust the motors accordingly. This may have to be situation specific during use. The entire launcher is particularly heavy and difficult to move around, this is something we planned for in the original design but did not have time to add to our second design. The base would be designed to detach and carry separately, and they would add wheels to the ends of the base to allow the user to move the launcher with little effort.

Velocity a Trajectory Calculations

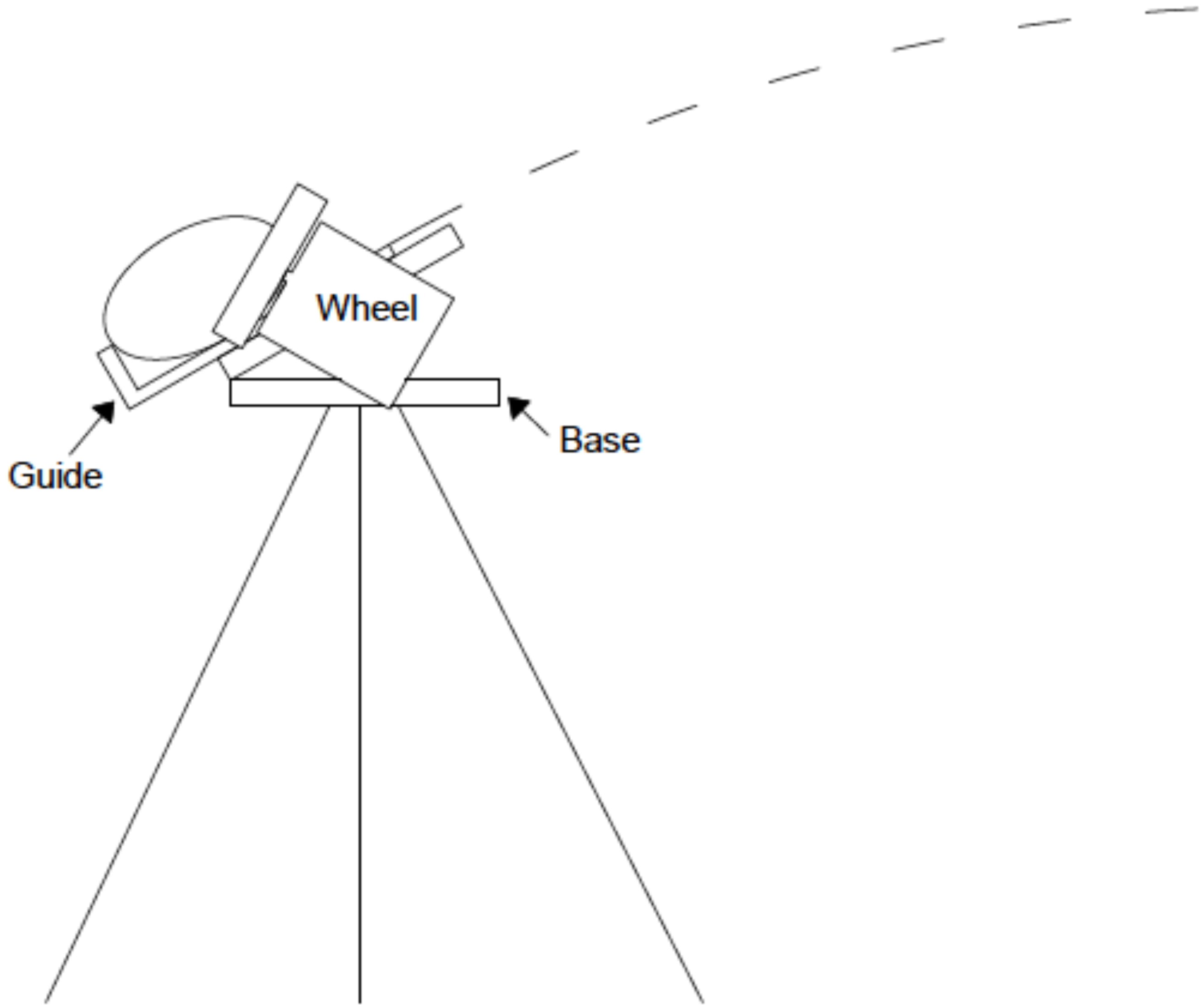


Image 2.1

Table 2.1

constant	R (wheel)	0.127	meter
	Gravity	-9.8	m/s
Inputs	RPM of motor	3500	
	enter angle of guide=θ	10	degree
	enter angle of left wheel=α1	35	degree
	enter angle of right wheel=α2	0	degree
	Hight of launcher	1	meter
	ball radius	0.09	meter
Outputs	ω=(2*π*rpm)/60	366.5083333	rad/sec
	Vtan=ω*r	46.54655833	m/s
	Vx of left wheel=cos(α1)*Vtan	38.12870869	m/s
	Vy of left wheel=sin(α1)*Vtan	26.69800866	m/s
	Vx of right wheel=cos(α2)*Vtan	46.54655833	m/s
	Vy of right wheel=sin(α2)*Vtan	0	m/s
	intial velocity of ball=Vi=max Vx	46.54655833	m/s
	tanget velocity of ball=max Vy	26.69800866	m/s
	spin of ball=(Vy*60)/(rball*2π)	2832.749092	rpm
	Vh=horizontal velocity=cos(θ)*vi	45.83941155	m/s
	Vv=vertical velocity=sin(θ)*vi	8.082724895	m/s
	time	1.765152679	sec
	distance=Vh*(t)	80.91356009	meter

The group made a spreadsheet to calculate and plot the trajectory of the ball after it leaves the launcher because of the adjustability of the rugby ball launcher there are many factors that go into calculating the flight path of the ball after it leaves the launcher.

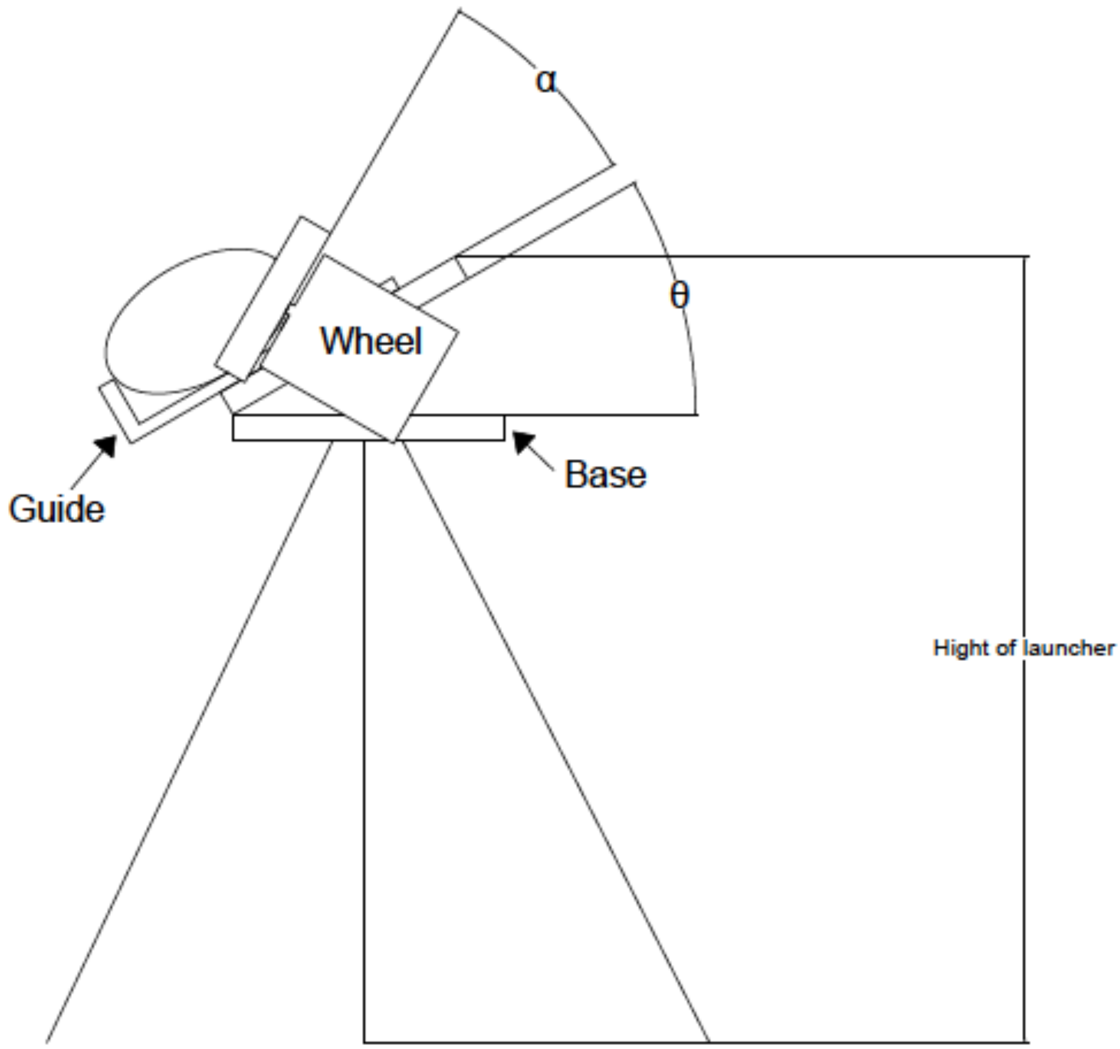


Image2.2

Table 2.1 starts with the constants of the launcher, which are the wheel diameter and gravity. Then it asks for the inputs (RPM of motor, Angle of guide, Angle of left wheel, angle of right wheel, height of launcher) these inputs are used to calculate the trajectory of the ball the location of the inputs can be seen on Image 2.2.

First it calculates the angular velocity in radians per second using the equation below

$\omega = (2 * \pi * rpm)/60$

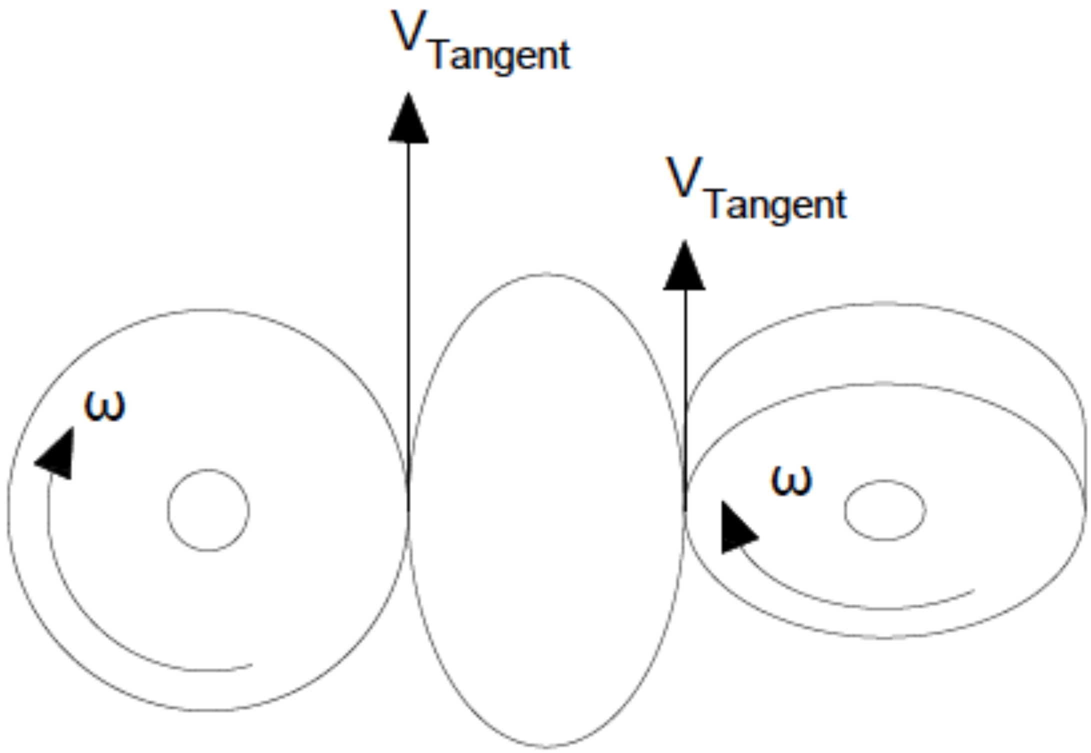


Image 2.3

This angular velocity is then used to find the tangent velocity of the wheel at the point that it will strike the ball this can be seen in Image 2.3. The two tangent velocities look like different magnitudes but they are not. The Tangent velocities are just at different angles because of the change in angle of the wheel. Using the equation below with the r being the radius of the wheel we are able to find the tangent velocity at each side of the ball.

$V_{tan} = \omega * \mathrm{r}$

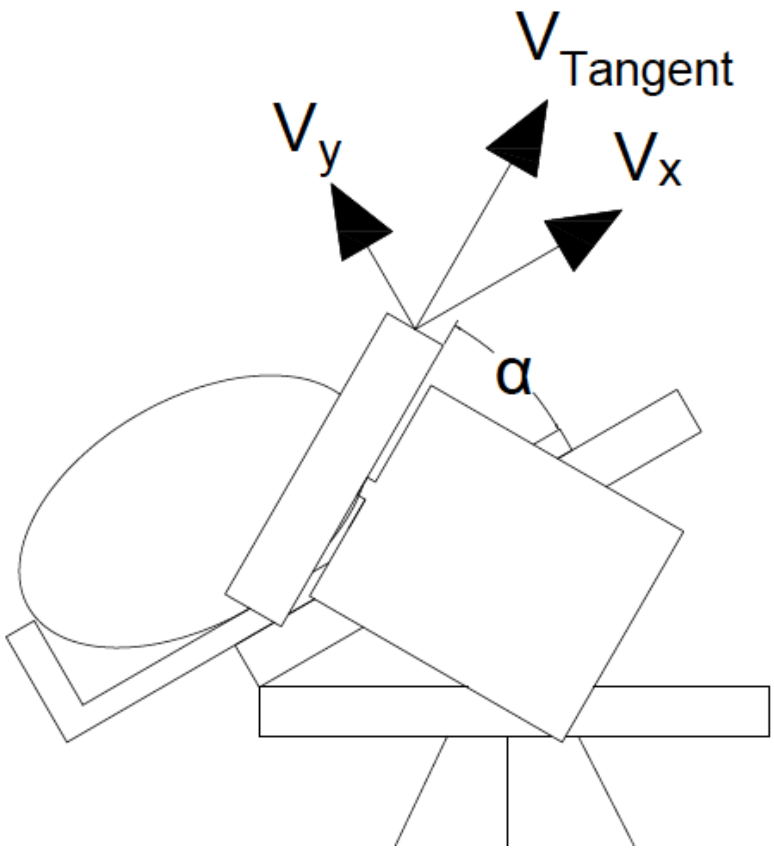


Image 2.4

The Calculated $V_{tangent}$ is then broken down into its components velocity in the lateral direction V_x and velocity in the vertical direction V_y depending on the angle of the wheel and the tangent velocity these components can be seen in Image 2.4. The V_x and V_y will be calculated for both wheels. The angle of the wheel is in relation to the angle of the guide, which can be seen on image 2.4.

$V_x = cos(\alpha) * V_{tan}$

$V_y = sin(\alpha) * V_{tan}$

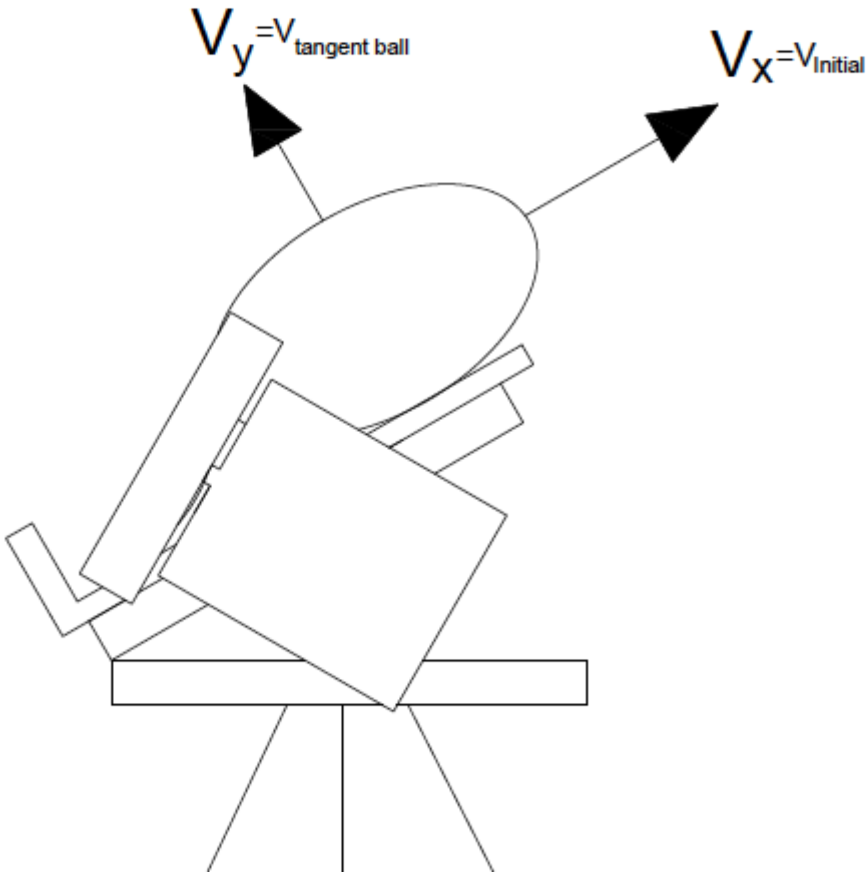


Image 2.5

V_x is then used as the initial velocity of the ball as it leaves the guide and V_y is used as the tangent velocity of the ball, which can be seen in Image 2.5. The tangent velocity of the ball is then used to calculate the RPM of the spin of the ball with the equation below.

$$\text{spin of ball} = (V_y * 60)/(r_{ball} * 2\pi)$$

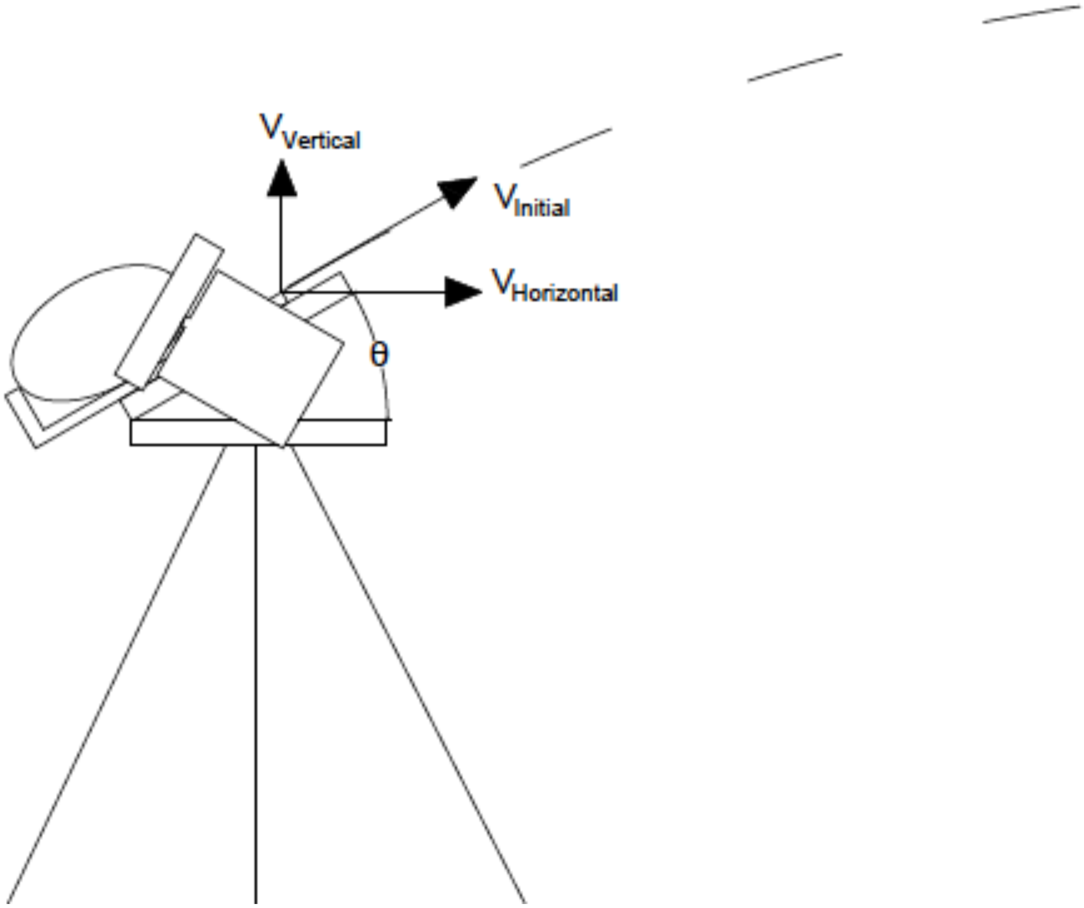


Image 2.6

Using the initial velocity of the ball and the angle of the guide which is in reference to the base which is parallel to the ground which can be seen in image 2.6 through this we are able to calculate the components of the velocity in the vertical and horizontal direction.

$$V_h = \cos(\theta) * V_i$$

$$V_v = \sin(\theta) * V_i$$

The vertical velocity is used to calculate the time the ball is traveling in the air with the equation below.

$$0 = .5gt^2 + V_v(t) + initial\ hieght$$

$$t = \frac{-V_v \pm \sqrt{(-V_v)^2 - 4 * (.5g)(initial\ hieght)}}{2 * (.5\mathrm{g})}$$

The horizontal velocity and the time is then used to calculate the distance traveled using the equation below.

$$\text{distance} = V_h * (\mathrm{t})$$

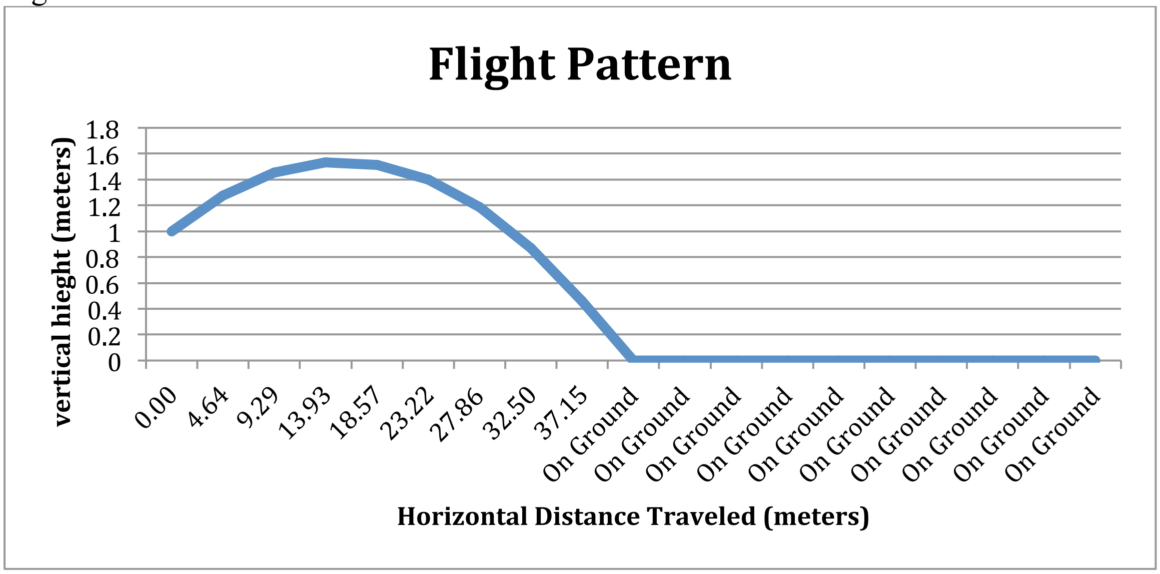
This give where the ball will land but to be able to predict where the person will stand to catch the ball we needed to make a graph of the height versus the distance of the ball to do this we made a table to calculate the height and distance every .1 second. Given in the table below.

Table 1.2

t sec	calculated value y (meter)	y meter	calculated value x (meter)	x meter
0	1	1	0.00	0.00
0.1	1.759272489	1.759272489	4.58	4.58
0.2	2.420544979	2.420544979	9.17	9.17
0.3	2.983817468	2.983817468	13.75	13.75
0.4	3.449089958	3.449089958	18.34	18.34
0.5	3.816362447	3.816362447	22.92	22.92
0.6	4.085634937	4.085634937	27.50	27.50
0.7	4.256907426	4.256907426	32.09	32.09
0.8	4.330179916	4.330179916	36.67	36.67
0.9	4.305452405	4.305452405	41.26	41.26
1	4.182724895	4.182724895	45.84	45.84
1.1	3.961997384	3.961997384	50.42	50.42
1.2	3.643269874	3.643269874	55.01	55.01
1.3	3.226542363	3.226542363	59.59	59.59
1.4	2.711814853	2.711814853	64.18	64.18
1.5	2.099087342	2.099087342	68.76	68.76
1.6	1.388359832	1.388359832	73.34	73.34
1.7	0.579632321	0.579632321	77.93	77.93
1.8	-0.327095189	0	82.51	On Ground

This is then put into a graph that can be seen in figure 2.1 below to show the flight pattern of the ball after it leaves the launcher.

Figure 2.1



The inputs on table 2.1 can be changed to get the desired distance and height for example to get a relatively short pass flatter more direct pass can be achieved by lowering the guide angle and increasing the RPMs of the motors and the angle wheel can be decreased like in table 2.3 to make the flight path have less of an arch. This can be seen in figure 2.2 below. If the desired height to catch the ball is approximately 1.4 meters off the ground and the pass has to go 20 meters before the player catches it then then the launcher will be passing the ball with the motors at there max speed of 3500 RPM and a short guide angle of 4 degrees with a small wheel angle of 5 degrees giving it a slower spin of 430 revolutions per minute. This will give the flight of the ball a max height of 1.53 meters and at 20 meters away the ball is 1.4 meters above the ground. Which are the desired results for a perfect pass.

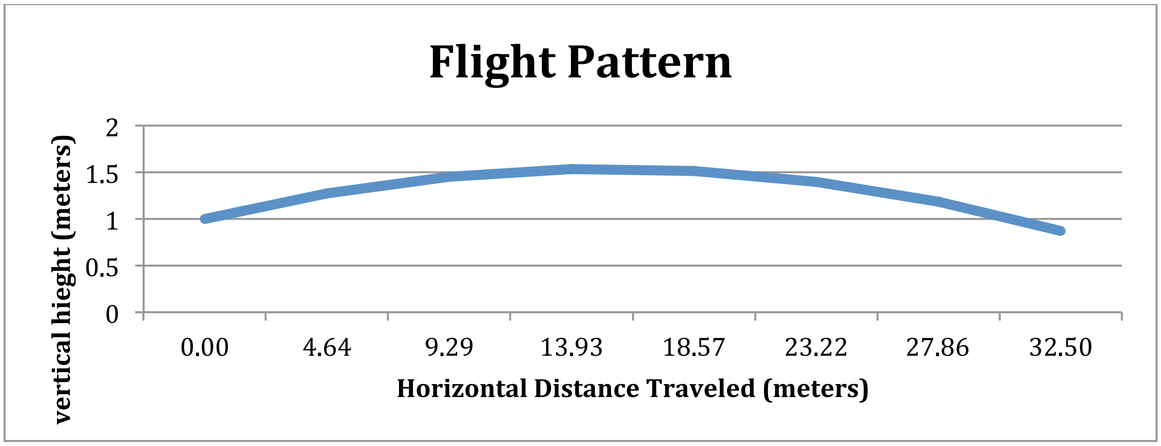
Table 2.3

constant	R (wheel)	0.127	meter
	Gravity	-9.8	m/s
Inputs	RPM of motor	3500	
	enter angle of guide=θ	4	degree
	enter angle of left wheel=α1	5	degree
	enter angle of right wheel=α2	0	degree
	Hight of launcher	1	meter
	ball radius	0.09	meter
Outputs	ω=(2*π*rpm)/60	366.5083333	rad/sec
	Vtan=ω*r	46.54655833	m/s
	Vx of left wheel=cos(α1)*Vtan	46.36943463	m/s
	Vy of left wheel=sin(α1)*Vtan	4.056799795	m/s
	Vx of right wheel=cos(α2)*Vtan	46.54655833	m/s
	Vy of right wheel=sin(α2)*Vtan	0	m/s
	intial velocity of ball=Vi=max Vx	46.54655833	m/s
	tanget velocity of ball=max Vy	4.056799795	m/s
	spin of ball=(Vy*60)/(rball*2π)	430.4401906	rpm
	Vh=horizontal velocity=cos(θ)*vi	46.43317326	m/s
	Vv=vertical velocity=sin(θ)*vi	3.246923719	m/s
	time	0.891545259	sec
	distance=Vh*(t)	41.39727547	meter

Table 2.4

t sec	calculated value y (meter)	y meter	calculated value x (meter)	x meter
0	1	1	0.00	0.00
0.1	1.275692372	1.275692372	4.64	4.64
0.2	1.453384744	1.453384744	9.29	9.29
0.3	1.533077116	1.533077116	13.93	13.93
0.4	1.514769488	1.514769488	18.57	18.57
0.5	1.398461859	1.398461859	23.22	23.22
0.6	1.184154231	1.184154231	27.86	27.86
0.7	0.871846603	0.871846603	32.50	32.50
0.8	0.461538975	0.461538975	37.15	37.15

Figure 2.2


Flight Pattern
vertical hieght (meters)
2
1.5
1
0.5
0
0.00
4.64
9.29
13.93
18.57
23.22
27.86
32.50
Horizontal Distance Traveled (meters)

Drag and Lift

Finding drag and lift force acting on the ball and Magnus effect

The drag and lift force can be calculated by using the formula below

$$F = \frac{C * \rho * A_{effected} * V^2}{2}$$

$F = force$

$C = coefficient$

$A = Surface\ area\ effected$

$V = Velocity$

$\rho = air\ density$

To calculate the Surface area effected by the drag and lift coefficient we had to use the dimensions of an international rugby ball which was acquired through the rugby union laws which can be seen in image 3.1.

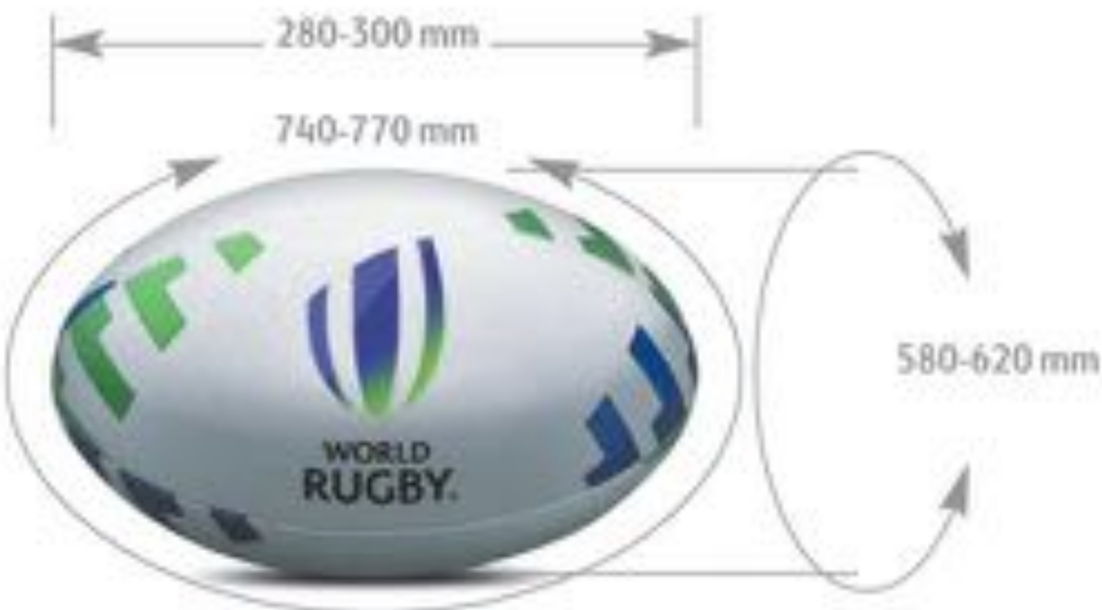


Image 3.1

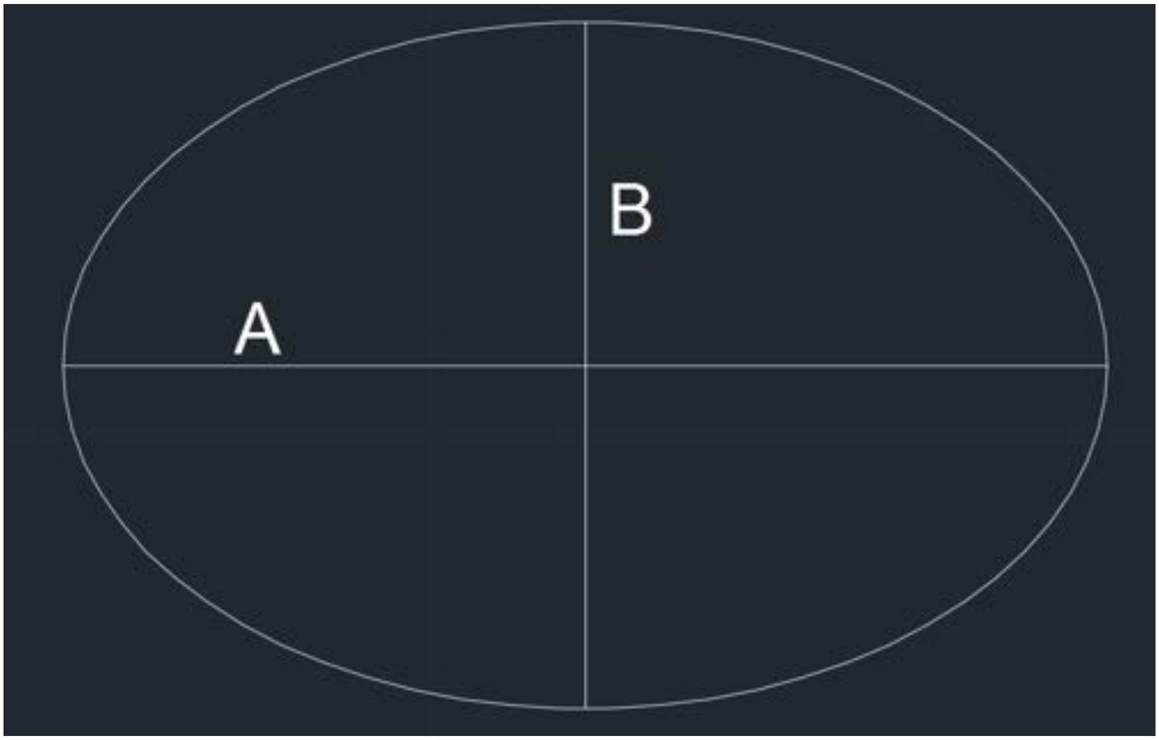


Image 3.2

Reference image 3.2 for deciding which dimension is A and B on the ball the shorter radius is always b for the surface area of an ellipsoid.

$\text{circumference} = \pi * \text{Diameter}$

$B = (cir/\pi)/2$

$B = \frac{.62}{\pi}/2 = .098676\ meters$

$A = .15\ meters$

$\text{m} = \text{sqrt}(1 - (\text{B/A})\text{\^{}}2)$

m = sqrt(1 - (.098676/.15)^2)

m=.753157 meters

$$\text{Surface area} = 2 * \text{pi} * \left[1 + .15 * \frac{\text{arcsin}(.753157)}{.753157 * .098676}\right] .098676\text{\^{}}2$$

$\text{Surface area} = 6.09\ \text{meters}^2$

$\text{Effected Surface area} = 3.045\ \text{meter}^2$ This is because the air resistance will only be acting on half the ball as it flies through the air because after that it gets over the curve of the ball there will actually be a significant drop in pressure causing cavitation.

The velocity can be taken from table 2.1

The Coefficeint of lift and drag is given in Martin Peters Computational Fluid Dynamics for Sport Simulation on pages 112-114. The calculated forces can be seen below in table 3.1.

Table 3.1

θ	Drag Coefficient	Lift Coefficient	Drag force (N)	Lift Force (N)
0	0.18	0	727.3459826	0
1	0.183	0.01	739.4684156	40.40811014
2	0.186	0.02	751.5908486	80.81622028
3	0.189	0.03	763.7132817	121.2243304
4	0.192	0.04	775.8357147	161.6324406
5	0.195	0.05	787.9581478	202.0405507
6	0.198	0.06	800.0805808	242.4486609
7	0.201	0.07	812.2030139	282.856771
8	0.204	0.08	824.3254469	323.2648811
9	0.207	0.09	836.4478799	363.6729913
10	0.21	0.1	848.570313	404.0811014
11	0.212	0.108	856.651935	436.4075895
12	0.214	0.116	864.733557	468.7340777
13	0.216	0.124	872.8151791	501.0605658
14	0.218	0.132	880.8968011	533.3870539
15	0.22	0.14	888.9784231	565.713542
16	0.222	0.148	897.0600452	598.0400301
17	0.224	0.156	905.1416672	630.3665182
18	0.226	0.164	913.2232892	662.6930063
19	0.228	0.172	921.3049112	695.0194944
20	0.23	0.18	929.3865333	727.3459826
21	0.237	0.19	957.6722104	767.7540927
22	0.244	0.2	985.9578875	808.1622028
23	0.251	0.21	1014.243565	848.570313
24	0.258	0.22	1042.529242	888.9784231
25	0.265	0.23	1070.814919	929.3865333
26	0.272	0.24	1099.100596	969.7946434
27	0.279	0.25	1127.386273	1010.202754
28	0.286	0.26	1155.67195	1050.610864
29	0.293	0.27	1183.957627	1091.018974
30	0.3	0.28	1212.243304	1131.427084
31	0.3095	0.288	1250.631009	1163.753572
32	0.319	0.296	1289.018714	1196.08006
33	0.3285	0.304	1327.406418	1228.406548
34	0.338	0.312	1365.794123	1260.733036
35	0.3475	0.32	1404.181827	1293.059525
36	0.357	0.328	1442.569532	1325.386013

37	0.3665	0.336	1480.957237	1357.712501
38	0.376	0.344	1519.344941	1390.038989
39	0.3855	0.352	1557.732646	1422.365477
40	0.395	0.36	1596.120351	1454.691965
41	0.4055	0.373	1638.548866	1507.222508
42	0.416	0.386	1680.977382	1559.753051
43	0.4265	0.399	1723.405898	1612.283595
44	0.437	0.412	1765.834413	1664.814138
45	0.4475	0.425	1808.262929	1717.344681
46	0.458	0.438	1850.691445	1769.875224
47	0.4685	0.451	1893.11996	1822.405767
48	0.479	0.464	1935.548476	1874.936311
49	0.4895	0.477	1977.976991	1927.466854
50	0.5	0.49	2020.405507	1979.997397
51	0.511	0.493	2064.854428	1992.11983
52	0.522	0.496	2109.303349	2004.242263
53	0.533	0.499	2153.752271	2016.364696
54	0.544	0.502	2198.201192	2028.487129
55	0.555	0.505	2242.650113	2040.609562
56	0.566	0.508	2287.099034	2052.731995
57	0.577	0.511	2331.547955	2064.854428
58	0.588	0.514	2375.996876	2076.976861
59	0.599	0.517	2420.445798	2089.099294
60	0.61	0.52	2464.894719	2101.221727
61	0.617	0.521	2493.180396	2105.262538
62	0.624	0.522	2521.466073	2109.303349
63	0.631	0.523	2549.75175	2113.34416
64	0.638	0.524	2578.037427	2117.384971
65	0.645	0.525	2606.323104	2121.425782
66	0.652	0.526	2634.608781	2125.466593
67	0.659	0.527	2662.894458	2129.507404
68	0.666	0.528	2691.180135	2133.548216
69	0.673	0.529	2719.465813	2137.589027
70	0.68	0.53	2747.75149	2141.629838
71	0.673	0.515	2719.465813	2081.017672
72	0.666	0.5	2691.180135	2020.405507
73	0.659	0.485	2662.894458	1959.793342
74	0.652	0.47	2634.608781	1899.181177
75	0.645	0.455	2606.323104	1838.569011
76	0.638	0.44	2578.037427	1777.956846
77	0.631	0.425	2549.75175	1717.344681

78	0.624	0.41	2521.466073	1656.732516
79	0.617	0.395	2493.180396	1596.120351
80	0.61	0.38	2464.894719	1535.508185

This can then be used to adjust the trajectory of the ball depending on the angle of the guide.

We still need the acceleration of the ball to find its force to calculate how much the ball is actually being effected by air resistance.

We will also have to take into consideration the Mangus effect because of the spiral on the ball causing a difference in air pressure acting on one side of the ball causing a slight curve in the pass depending on the distance and RPM of the ball.

Deflection Analysis

The deflection of the motor at the cantilever fixed to the 15 series 13-inch bar is very slight given the weight of the motor. It is the same in the x and y direction, but it is only one hundred of an inch. This tells us the motors will rotate the bar out slightly. This can be seen in table 4.1

Table 4.1

1515-ULS Cantilever Middle				
Variables	**Measurements**	**Units**		
Profile Length	13	in		
Maximum Length of Profile	242	in	D = (L^3*W)/(48*E*I)	
Profile load	30	lbs		
Profile weight/foot	0.936	lbs	Deflection x	0.012203522
Cross Sectional Area	0.781	in^2		
Moment of Inertia X	0.1765	in^4	Deflection y	0.012203522
Moment of Inertia Y	0.1765	in^4		
Yield Strength	35000	lbs/in^2		
Modulus of elasticity	10200000	lbs/in^2		

Next, we calculated the deflection of the same bar but fixed at both ends. The motor resting in the center as a single load. The deflection is again the same in the x and y direction, but at seven tens thousands an inch. The bar will deflect towards the ground at the placement of the motor but only slightly. This can be seen in table 4.2

Table 4.2

1515-ULS Fixed 2 Ends				
Variables	**Measurements**	**Units**		
Profile Length	13	in		
Maximum Length of Profile	242	in	D = (L^3*W)/(48*E*I)	
Profile load	30	lbs		
Profile weight/foot	0.936	lbs	Deflection x	0.00076272
Cross Sectional Area	0.781	in^2		
Moment of Inertia X	0.1765	in^4	Deflection y	0.00076272
Moment of Inertia Y	0.1765	in^4		
Yield Strength	35000	lbs/in^2		
Modulus of elasticity	10200000	lbs/in^2		

Next, we calculated the deflection of the 15 series 15.776 inch bars with the weight at each end of the bars but fixed in the center. The bars will have some deflection in the x and y direction both the same 2 hundred of an inch. The weight of the motors at the furthest point on the bars will deflect slightly towards the ground. This can be seen in table 4.3

Table 4.3

1515-ULS Cantilever ends		
Variables	**Measurements**	**Units**
Profile Length	15.776	in
Maximum Length of Profile	242	in
Profile load	30	lbs
Profile weight/foot	0.936	lbs
Cross Sectional Area	0.781	in^2
Moment of Inertia X	0.1765	in^4
Moment of Inertia Y	0.1765	in^4
Yield Strength	35000	lbs/in^2
Modulus of elasticity	10200000	lbs/in^2

D = (L^3*W)/(3*E*I)

Deflection x	0.021809505
Deflection y	0.021809505

Acquired Components

Image 5.1

We have purchased the required footage of bars from 80-20 seen in Image 5.1

Image 5.2
We have two 10in diameter 2 in thick solid rubber wheels that need to have the bearings welded to keep them steady with the motor shaft. See Image 5.2.

Image 5.3
This is our Three Phase induction motor to turn the wheels (Image 5.3) it has 3500rpm .5 hp with a 5/8 in diameter shaft. We are working on the circuit diagrams for the wiring on all electrical components. We hope to have the motor and Variable frequency AC drive (image 5.4). Motor schematics will be attached at end of report.

Image 5.4
This is the variable frequency AC drive it will convert the DC input into a AC output for the motor and also allow us to vary the speed of the motor with a speed control. See Image 5.4.

Assembly

Image 6.1

The 80-20 15 series bars have been cut to the needed size the 3.5inch bars seen in image 1.12 have also been taped with a 5/16 tap, and the 15-30 series bar has had all holes taped with a 5/16 tap. Cut three 3-foot bars with 45-degree angles on the top to attach to the base to create the tripod.


Image 6.2
The motors seen in Image 5.3 have been wired to a speed control which is connected to the Variable Frequency AC Drive (Image 5.4), which is then connected to a power source this assembly can be seen in Image 6.2.

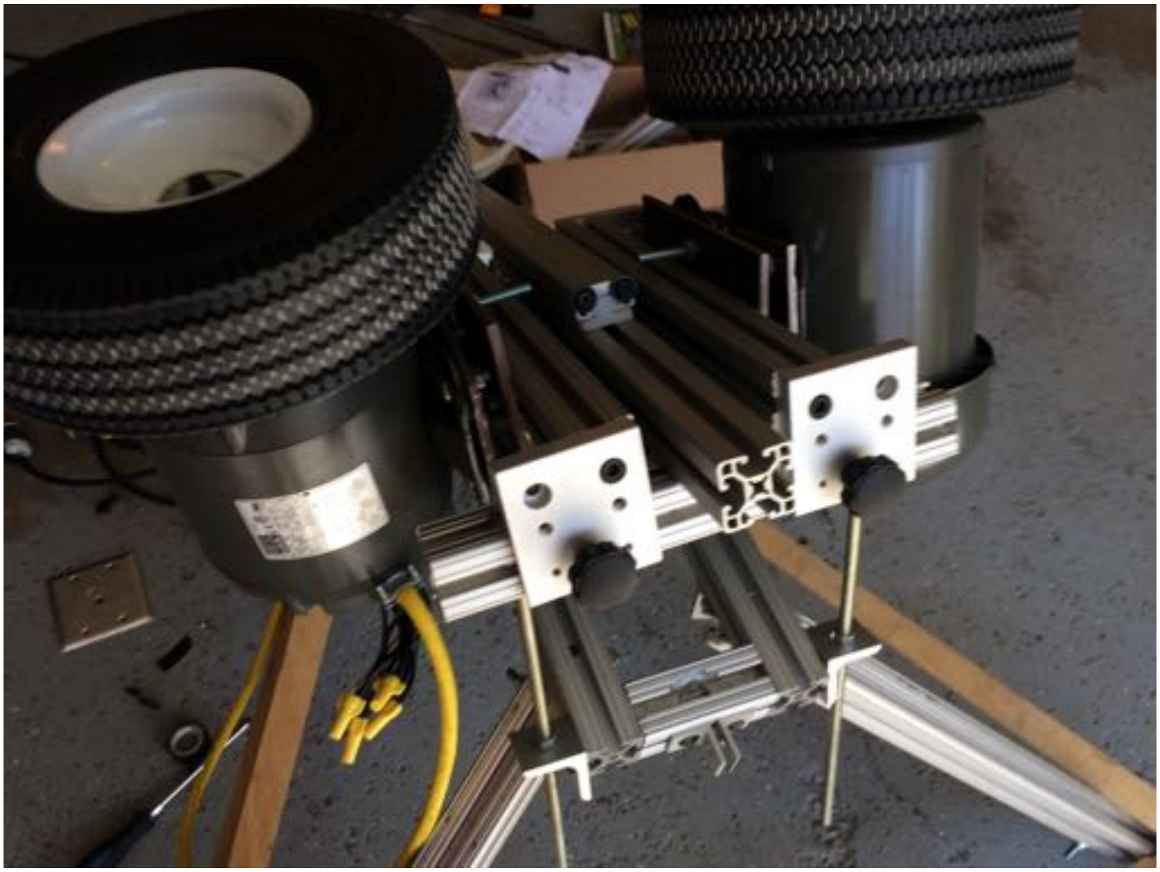
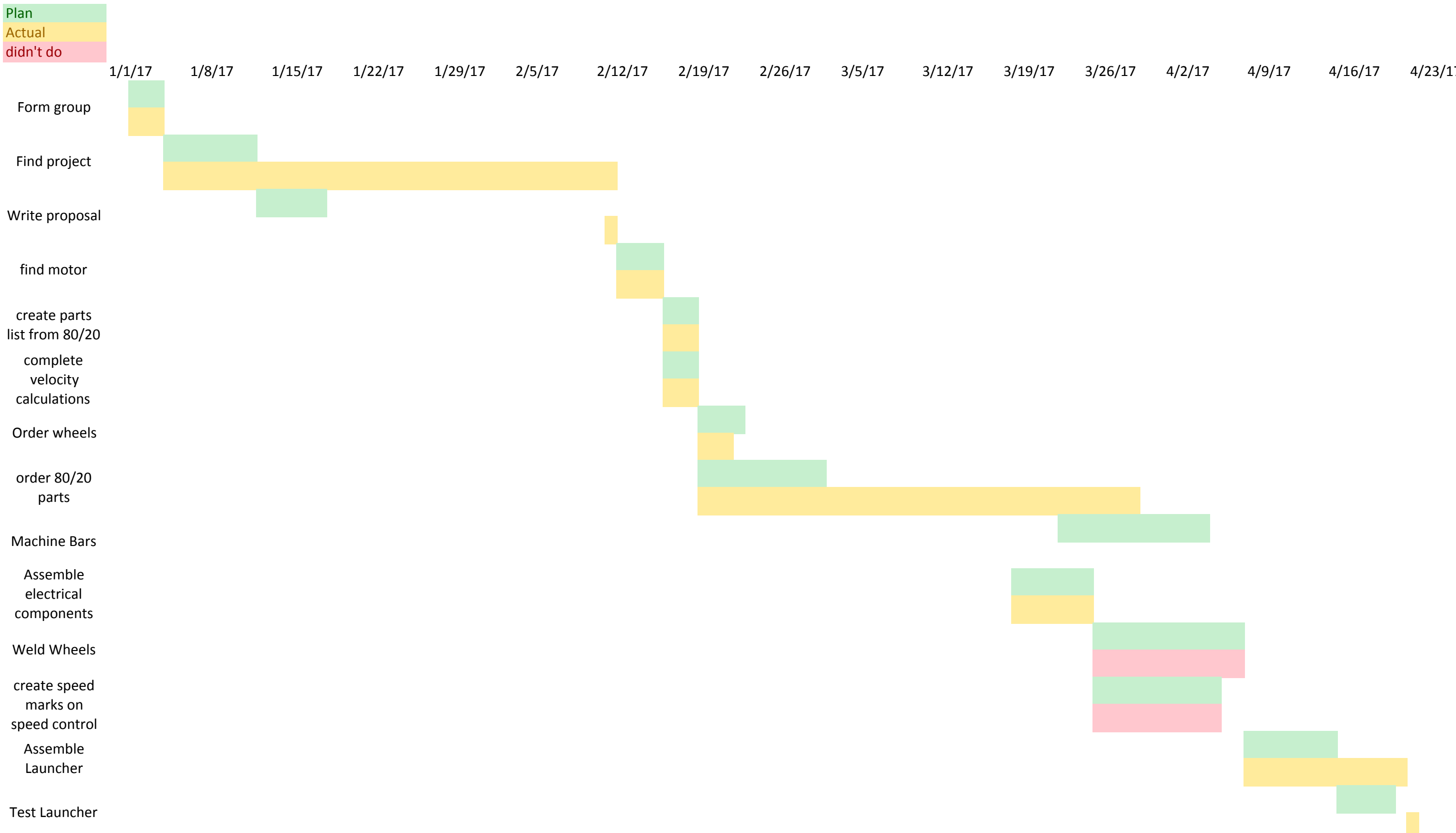


Image 6.3
This is the finished assembly. It is placed on a tripod supported by 2X4 wood boards to prevent the bars from moving at all. The angle of the launcher is changed by crewing up and down on the threaded rods on both sides of the front providing support to the motors. The wheels angles can also be changed and the distance between the wheels can be extended and reduced depending on the size of the ball. The assembly does everything that we need it to.

Ganntt Chart



Testing Observations

Our testing started out very well the launcher was able to launch small 20 meter passes with constant precision with a left and right spiral depending on which wheel was at an angle. It consistently hooked to whichever side's wheel was tilted. We realized this is because it hits the wheels at different times so the ball actually shoots away from the flat wheel because it is actually almost an inch ahead of the tilted wheel.

As we sped up the launcher to a higher rpm we realized the wheels weren't perfectly circular causing centrifugal force on the motors and makes them begin to vibrate even with the spacers we put on to prevent that. As we accelerated the revolutions of the motors the assembly would begin to vibrate at the hinge. This caused the ball to begin to shake and bounce on the guide plate making it nearly impossible to feed the ball straight through the wheels. This made it so we could not launch the ball at the high speeds that we wanted and still get a clean spiral. The ball would fly out very hard but in an erratic and unpredictable spiral.

We also realized after launching a small amount of balls the motors angle locking system would become loose from the vibration and impact and would start to try to settle back to parallel with the base. This caused us to have to retighten our locking system every few launches.

As we were starting to actually record our tests the variable frequency AC drive seen in image 5.4 failed due to a short circuit error indicated by a flashing red light. We tried to correct the problem and fried the variable frequency AC drive ultimately ending our testing.

Testing Assessment

The Rugby Ball Launcher worked at low speeds very well and launched consistent spirals. High speeds cause vibrations in our assembly and make it erratic.

Possible Improvements

We would consider this a good prototype. With more time we could make many improvements to this project. We would like to use hydraulic cylinders to change the angle because they will move faster and wont fall down after multiple launches they would also be able to rotate freely where the rods get stuck at the higher degrees. We would also make the hinge and sliding action more stable to prevent some vibrating while also making the base bigger to encompass the motors and hold them steady. Another change we would make is a pegging system with the motors angle to prevent slip. And also make sure that the wheels line up when they are rotated still to prevent the ball from coming out to one side or the other depending on which wheel is at an angle. Also if we used larger wheels then we wouldn't need as many rpms from the motors so the motors could be smaller. Another improvement would be having DC motors so we wouldn't need the variable frequency AC drive seen in image 5.4 because the components in the circuit are open to the elements and with this being considered sporting equipment it has to be able to withstand a bit of mistreatment.

Conclusion

We made many improvements throughout our construction and formation of our senior design project and used many skills learned in Dynamics class while creating a trajectory path for the balls flight pattern. We also used machining skills learned in basic machining to construct the final assembly. And we used the skills learned in strengths and materials to calculate our deflection of the materials under the stress of the motors. This project used many skills learned throughout both of our educational careers at IPFW.

References

(1) Peters, Martin. Computational fluid dynamics for sport simulation. Springer, 2009.

(2) Beer, Johnston and Flori. Mechanics for Engineers, Dynamics. Fifth Addition, December 3, 2007