Automated Bow Fishing Platform

A Baccalaureate thesis submitted to the
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College of Engineering and Applied Science
University of Cincinnati

in partial fulfillment of the
requirements for the degree of

Bachelor of Science

in Mechanical Engineering Technology

by

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ABSTRACT

Bow fishing has become a popular past time in the south and is starting to gain some ground into boat modifications. The modifications and designs being made for boats at the moment is a welded or bolted platform to a boat while a foldable platform is also a stowaway possibility. The redesign of a platform will be the premise of this build. There are many factors that require a platform for bow fishing, however it shouldn’t have to affect boating operation. The design will be a hybrid platform that can raise and lower inside the boat while sitting level with the deck of the boat. The design of this platform will be decided over comparing current models to decide on an innovative design.

PROBLEM DEFINITION AND RESEARCH

PROBLEM STATEMENT

Bow Fishing requires a raised platform for increased visibility of the water and refraction compensation. The higher the platform the easier the shot in the water will be due to the arrows angle of impact on the water. The platform should not take away visibility and normal operation of the vessel due to it being retractable.

BACKGROUND

Bow Fishing has become a popular past time for many hunter/fisherman. Bow fishing is the art of using a bow and hunting fish along the bank or atop the surface of the water. Current bow fishing boat setups are a fishing boat with a welded platform frame onto the boat. This however takes away maritime use through decreased gas mileage, increased weight, slower speeds, and decreased driver vision. The solution would be to have a platform that raises for bow fishing but lowers for normal maritime use.

RESEARCH

SCOPE OF THE PROBLEM

The problem faced with bow fishing boats right now is the uneconomical reasoning to have two boats for two types of fishing. The main issue is a bow fishing platform has many flaws when made for a boat. A boat operator’s biggest issue is that with a large platform in the front of the boat, visibility becomes a huge concern for proper operation. From a fisherman’s perspective the issue is that you must either have a welded frame for bow fishing however there is no even level for switch to an even level for rod/reel fishing. The reasons a flat boat lower to the water is more sufficient for rod reel is: a rod will get tangled on the bow fishing platform rails while casting; netting a fish with the net from the raised platform is problematic; if the fish swims around or under the boat it is harder to keep changing elevations and the line will weaken rubbing on the metal. Many bow and reel fisherman own two boats, one for bow fishing and one for rod-reel fishing.

The reason for a bow fishing platform is to help with the challenges of bow fishing. When bow fishing, two challenges are present, especially when in a fishing boat or “Jon boat”. The two challenges include vantage point as well as refraction of light due to the water. Having a higher vantage point will allow the bow fisherman to see through the water more clearly as well as allow them to look farther out in the lake to spot fish. Refraction is another main issue when bow fishing. This occurs because when light passes from one medium to another, in this case air and water, the light path will bend (1). This can be seen in Figure 1 below.

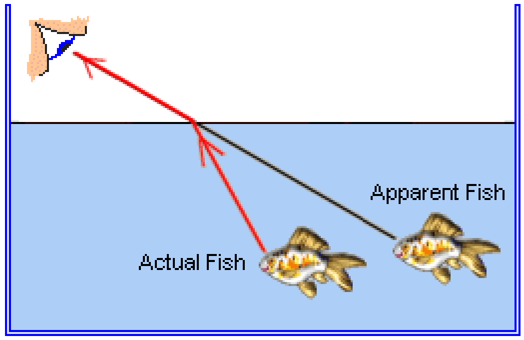


Figure 1 Refraction Example

Refraction from air to water can be increased or decreased. This will depend on the angle of sight between the person and the fish in the water (1). If the bow fisherman can get above the fish by being on an elevated platform on a boat, the amount of refraction will decrease therefore giving the bow fisherman an advantage in hitting its target (1).

Most beginner bow fisherman do not understand that a high line of sight is key for accuracy. The common rule of thumb is to always aim low, but it is still a guessing game at how much you need to aim lower than the fish (1). Ultimately our project will help increase the accuracy of a bow fisherman as well as allow for a clear line of sight when driving the boat. With a fishing boat, you steer the boat from the very back next to the motor so having a permanent elevated platform in the front of the boat is not ideal.

A ship at sea moves in six degrees of motion: heave, sway, surge, roll, pitch and yaw. The first three are linear motions. Heaving is the linear motion along the vertical Z-axis, swaying is the motion along the transverse Y-axis, and surging is the motion along the longitudinal X-axis. Rolling is a rotation around a longitudinal axis, pitching is a rotation around the transverse axis and yawing is a rotation around the vertical axis. (2) These motions, especially the rotational motion, are important for a raised platform that will make the rotational motions amplified. This is a safety concern for anyone on a bow fishing platform in rough water. Roll (figure 2) is extremely dangerous and is most likely to send a user overboard.

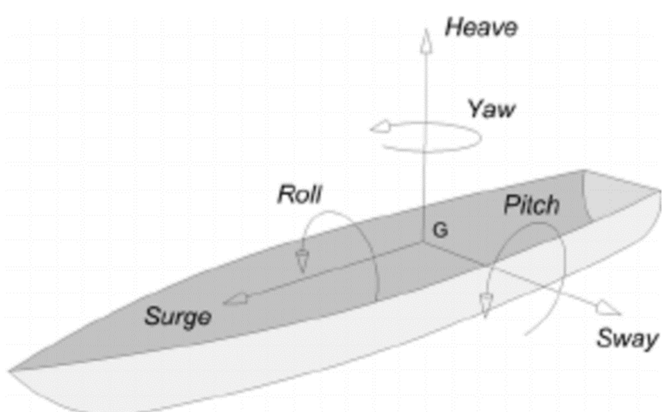


Figure 2 Boat axes of translation.

CURRENT STATE OF THE ART

Figure 3 2017 Tracker Grizzly 1860 with platform

Today, bow fishing platforms are welded or fastened frames that rest on the hull of the boat. The 2017 Tracker Grizzly 1860 MVX CC Sportsman (Figure 3) (3) shows the front platform raised with lights. This boat has the driver behind the platform which blocks his vision while operating. There is no possible way of lowering the platform to adjust for rod/reel fishing operation. It does offer a sturdy platform that gives the bow fisherman room to move around. It offers good height and is equipped with lights for night fishing. For an 18 foot boat the size of the platform is well sized allowing for multiple people on the platform at one time. With a large motor on the back the ballast isn't much of a factor. A console to hold arrows and cup holders as well as on/off switches for the lights is a nice customer feature. Safety railings all around the front help to keep people from walking to far to the edge.

Some flaws would be the driver sitting low and behind the tall platform. There is no way of seeing around the platform unless the platform is taken off the boat. The platform cannot be removed while on the water and stored somehow, so there is no way of switching to rod/reel possibilities while on the water.

Figure 4 2017 Tracker Grizzly 1860 without platform

This model is the same boat as before without the frame attached onto the hull. The 2017 Tracker Grizzly 1860 MVX CC Sportsman (Figure 4) without the bow fishing platform has a nice flat platform for rod/reel fishing as well as good visibility for the driver. This also helps for ease of fish capture with net after they have been hooked and no large step ups if the fish is swimming around the boat or underneath it.

Figure 5 Portable Platform

EDGE Bowfishing has a stowaway platform that can be folded up for normal fishing. The tied down is a simple bungie tie down underneath the frame to anchor to the boat. The platform features: non slip titan decking; lightweight Aluminum construction; folds for easy storage; adjustable legs; wheel kits; LED light kits; safety rails; universal seat mounts. The dimensions are 36" Long X 36" Wide (Tapers to 24") X 8" to 21" Height. (4)

The flaws with this are stability size and safety. With this small platform for the larger boat, the platform will tilt easier when rollers, large waves caused by large vessels, hit the boat from the side. The fastener to the boat is a single bungie that holds the platform in place heavily relying on the weight of the user to steady. This is dangerous because of the boats roll axis changing due to large waves. This will likely cause failure of this platform.

END USER

The customer profile for this product would be someone who enjoys fishing as well as bow fishing. The user also would rather have 1 universal boat to do both activities. Someone who is into outdoors would like the opportunity to try both that lives in a place that is capable of using boats. The customer could also order the universal design and install in their boat themselves to allow for personal use. Manufactures of boats could also use this as a selling point for boat sales to allow for a hybrid boating/hunting vessel.

The end user does not need to be an expert to use this product. A beginner bow fisherman will be able to use this product from the day of purchase without any skills required. A simple setup is all it will take to have any fisherman with the required gear to use this product efficiently.

The necessities for the end user would be a boat that will service to be a smart upgrade to the boat. The boat should be Aluminum or a specified fishing boat. Gel coat marine vessels would not be able to accommodate this platform for reasonable operation.

CONCLUSIONS AND SUMMARY OF RESEARCH

Common themes for bow fishing boats are that while they serve a purpose, they take away from the normal operation of a boat. A hybrid alternative could allow for the ownership of a single boat that serves both purposes as a rod/reel and a bow fishing boat. A customer would rather have one boat for both problems rather than 2 boats for each problem. The user would also like good visibility while driving and the ability to choose which type of fishing he/she would like to do while on the water.

CUSTOMER FEATURES

Based on an interview with Brad Martin, an avid bow fisherman from the south for many years, we concluded the following information in table 1. This interview was to determine the best features that our design could include. Using a long time bow fisherman as an interviewee, it will allow for finding the best suitable results to making a great bow fishing platform.

Table 1 Customer Features

Customer Features	Customer Importance	Relative Weight
Durability	1	3.18
Lifting Capacity	.7	2.33
Automated	1	2.7
Compactness	.9	1.5
Height of Lift	.8	1.3
Setup Speed	.85	1.05

PRODUCT OBJECTIVES

- **Durability**
  - The platform is built to be strong to allow for people to be standing on it over a decently long period of time. Should not wear over time.
- **Functionality**
  - The platform will raise and lower on command as preferred by the user with no issues.
- **Price**
  - Product should be designed using standard material sizes to reduce cost. Try to eliminate special purpose parts because it will increase the price dramatically due to the material processes.
- **Weight Capacity**
  - The weight capacity will be set at 600 lbs.
- **Weight**
  - Product will be light weight to allow for more carrying capacity on the boat

- **Setup Time**
  - Platform should be setup in a timely manner. To get the safety components set up and from the platform to rise to its peak, it should take minimal time.
- **Reliability**
  - Product should be able to perform time and time again. Should be able to satisfy customer requirements and specifications at a consistent rate for a long period of time.
- **Noncorrosive**
  - Product will be interacting with water being attached to a boat. Should be made with rust resistant materials.
- **Safety**
  - Product should be built rigidly and should have railings as it will be elevated from the surface of the boat.
- **Ballast Compensator**
  - Keep boat balanced in the water when the product is in use. Would compensate for the weight of the user and weight of the product.

QUALITY FUNCTION DEPLOYMENT

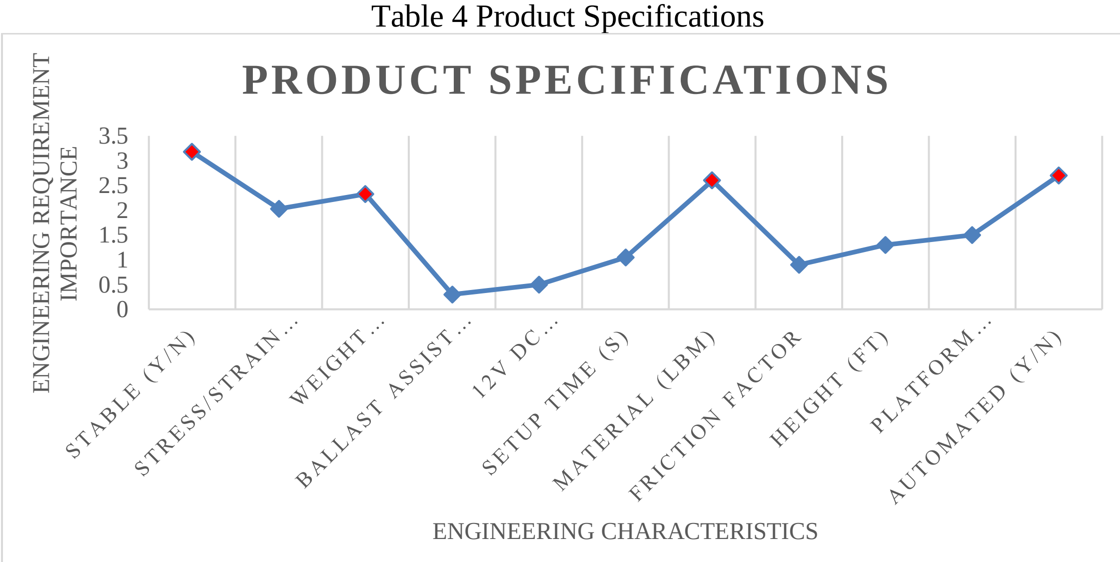
Table 2 House of Quality

			Engineering Requirements (units)														Customer Satisfaction Rating (0.00 - 1.00)			
		Importance wt.	Stable (Y/N)	Stress/Strain Force (lb*ft^	weight Capacity (lbs)	Ballast assist (lb*ft)	12V DC Battery (Y/N)	Setup Time (s)	Material (lbm)	Friction Factor	Height (ft)	Platform Area (ft^2)	Automated (Y/N)							
	Customer Requirements		1	2	3	4	5	6	7	8	9	10	11	12	13	14	CP	A	B	C
1	Doesn't shift while using	0.10	9		3				1		1	3						1	0.4	
2	Stays in upright position	0.20	9	9	9				3		3	3						1	0.8	
3	Can hold multiple people	0.03	1	9	9	3			3			9						1	0	
4	Setup is quick	0.05					3	9			1		9					0.1	1	
5	Weather/Rust resistance	0.20							9									1	0	
6	Battery Powered	0.05					9						9					0	0	
7	Sway Compensation	0.05	9			9					3	1						1	0	
8	Automated	0.20					1	3					9					0	0	
9	Non-slip Surface	0.10								9		1						0.7	1	
10	Step up to platform	0.03									9							0.4	0.2	
	Total Importance	1.00	28	18	21	12	13	12	16	9	17	17	27							
	Engineering requirement importance		3.18	2.03	2.33	0.3	0.5	1.05	2.6	0.9	1.3	1.5	2.7							
Performance	Current Product																			
	competitor A		Y	N/A	575	N	Y	N/A	250	Low	1	16	N							
	competitor B		N	N/A	250	N	N	60	20	high	2	4	N							
	competitor C																			
	New Product Targets		Y		600	Y	Y	30	100	High	2	9	Y							

Table 3 Interaction Matrix

Engineering Requirements		1 Stable (Y/N)	2 Stress/Strain Force (lb*ft^2)	3 weight Capacity (lbs)	4 Ballast assist (lb*ft)	5 12V DC Battery (Y/N)	6 Setup Time (s)	7 Material (lbm)	8 Friction Factor	9 Height (ft)	10 Platform Area (ft^2)	11 Automated (Y/N)	12 0	13 0	14 0
Stable (Y/N)	1		9	9	9			3		-3	3				
Stress/Strain Force (lb*ft^2)	2			9				3		1	9				
weight Capacity (lbs)	3				-3			1			9				
Ballast assist (lb*ft)	4					9	1	1		3	3				
12V DC Battery (Y/N)	5						9					9			
Setup Time (s)	6									1		9			
Material (lbm)	7									1	3				
Friction Factor	8														
Height (ft)	9											1			
Platform Area (ft^2)	10														
Automated (Y/N)	11														
0	12														
0	13														
0	14														

Table 4 Product Specifications



DESIGN

CONCEPT DESIGN

Concept 1: Hydraulic Cylinder Scissor Lift

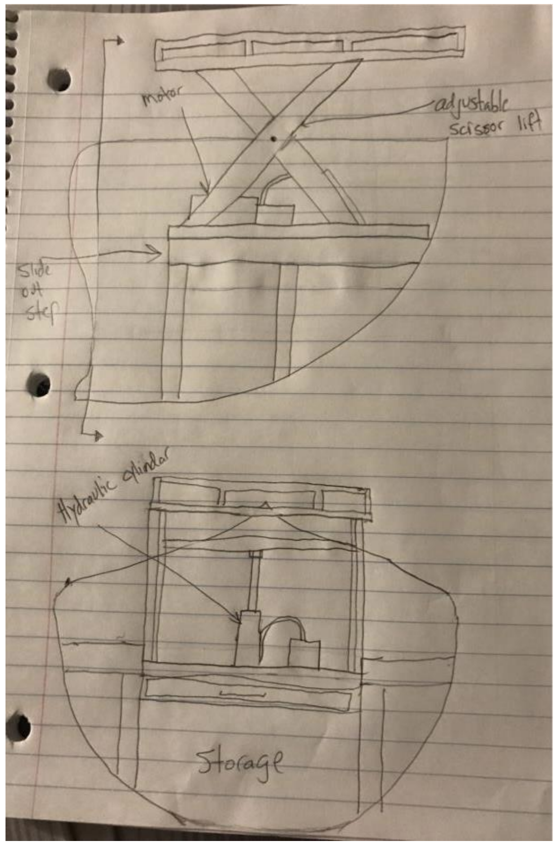


Figure 6 Concept Design Alpha

This design would have a hydraulic cylinder. It would be connected to a pin joint to allow for rocking at its base and connected to a horizontal rod at the top end where it will push up the lift. It will have a two scissor links per side for simplicity and will use roller bearings in all rotating parts to eliminate friction.

Cons: Hydraulic cylinders are heavy and is not ideal to put in a little fishing boat. Hydraulic cylinders can have oil leaks and involve more maintenance then other options. Most of all, the cylinder would have to be pretty big to reach the 20” of height we are looking for.

Concept 2: Hydraulic Cylinder Scissor Lift

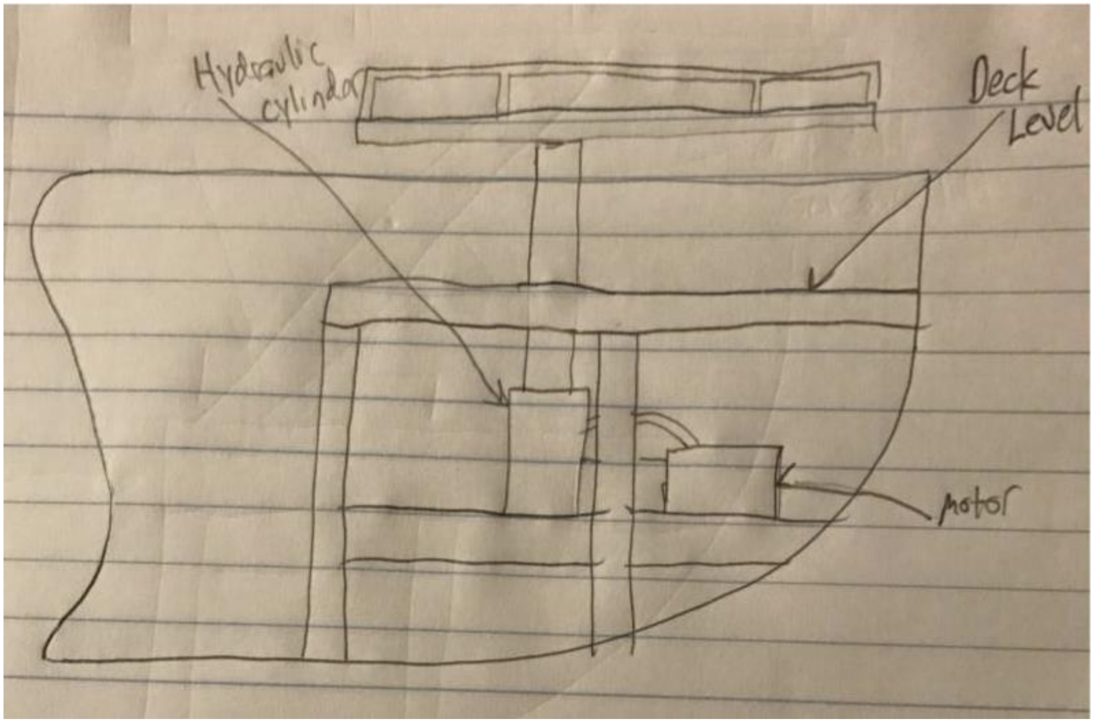


Figure 7 Concept Design Beta

This design will also contain a hydraulic cylinder. The cylinder will be fixed in the vertical direction and push the platform straight up. Having a lifting action completely vertical will keep things simple and easy to manufacture.

Cons: Hydraulic cylinders are heavy and is not ideal to put in a little fishing boat. Hydraulic cylinders can have oil leaks and involve more maintenance then other options. Most of all, the cylinder would have to be pretty big to reach the 20" of height we are looking for.

Concept 3: Threaded Rod Scissor Lift

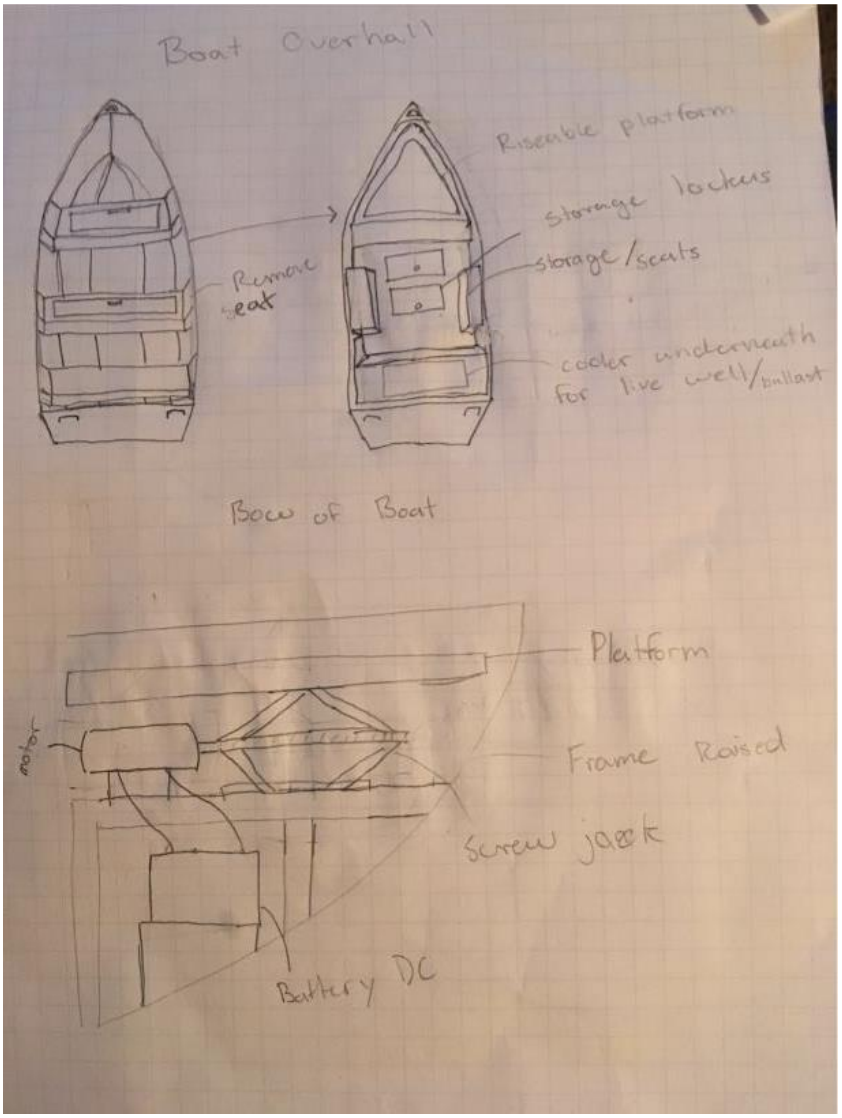


Figure 8 Concept Design Charlie

This concept will be driven by a motor connected to a threaded rod. The threaded rod will turn through the horizontal bars that connect the links in the center of the lift which will translate the platform vertically. This concept is very similar to how a car jack works.

Cons: The motor would translate vertically with the platform due to the threaded rod connect to the center of the links. Keeping the motor in a fixed position is more ideal.

Concept 4: Threaded Rod Scissor Lift

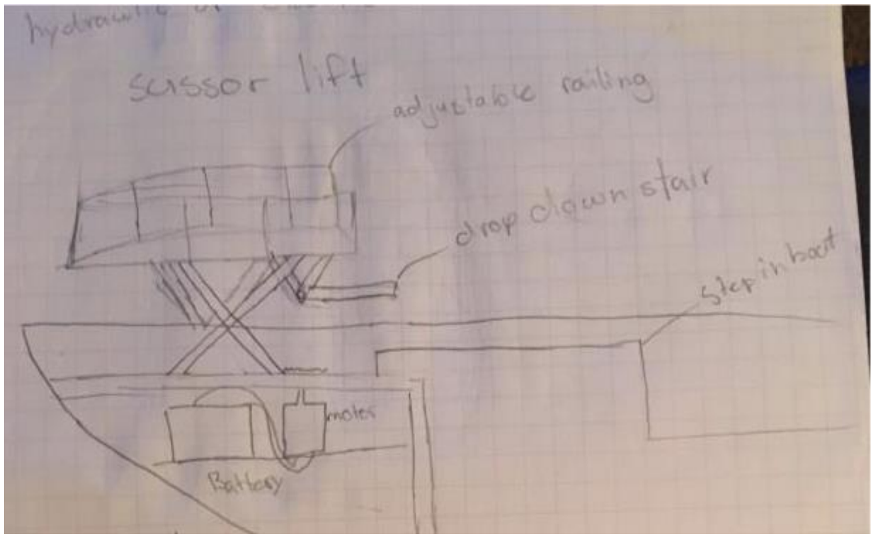


Figure 9 Concept Design Delta

This concept will be driven by a motor connected to a threaded rod. The threaded rod will turn through the horizontal bars that connect the links at the bottom of the lift which will translate the platform vertically. This concept is very similar to how a car jack works as well.

DESIGN SELECTION:

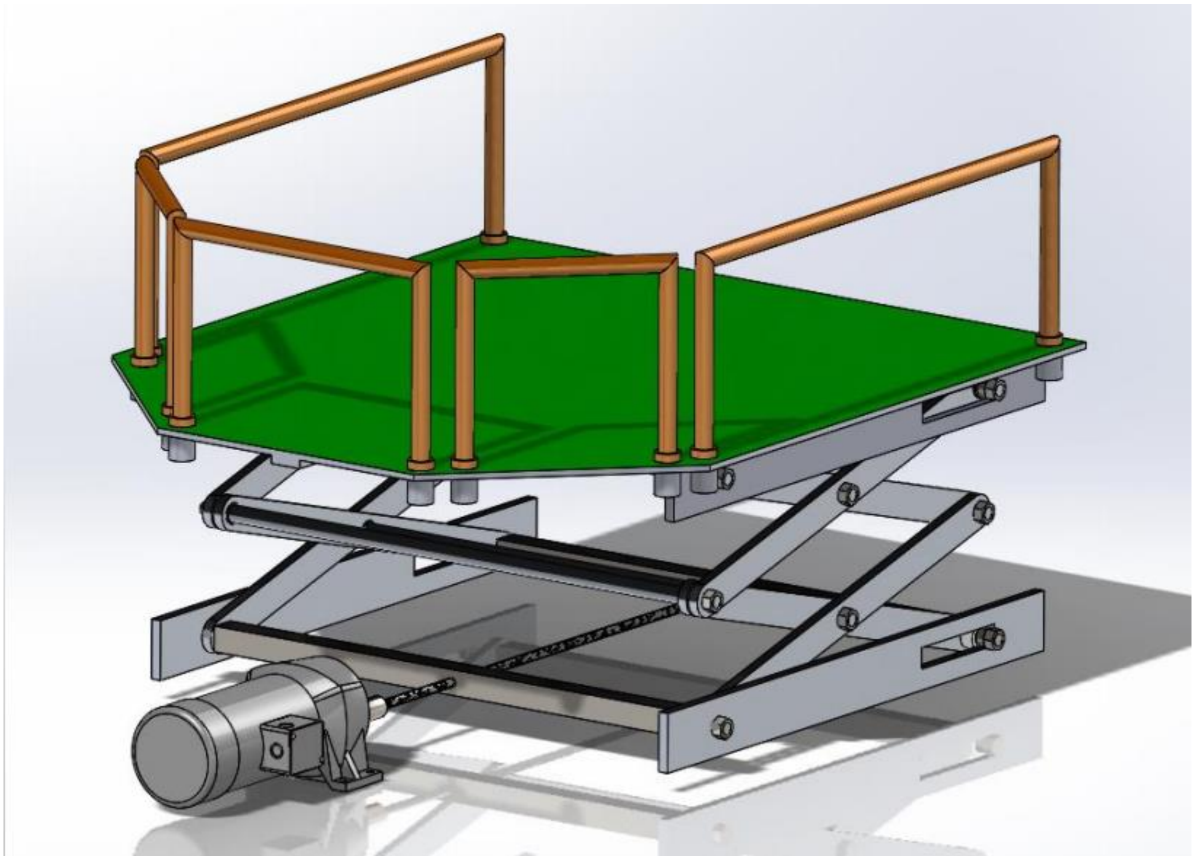


Figure 10 Design Selection Concept

Double Scissor Threaded Rod Lift

This contains standard thickness materials, standard roller and thrust bearings, a standard threaded rod, a standard motor, and standard pipes.

Loading Conditions

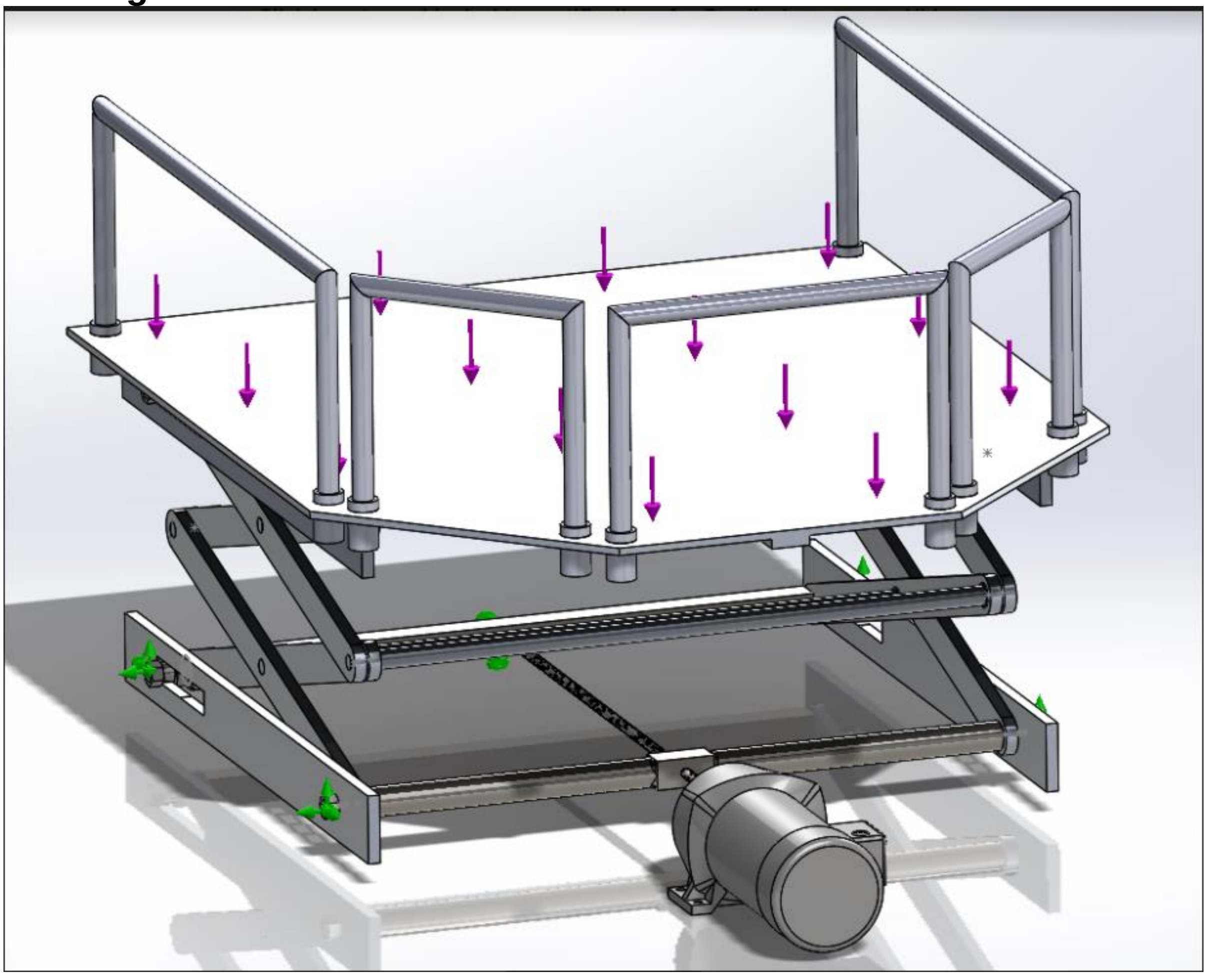


Figure 11 Loading Conditions

For Load Conditions the platform will support the applied weight. The forces will go through the linkages into the side panel and the threaded rod. These areas will hold the load in worst case scenarios, such as all weight on a single link and not evenly dispersed. The load conditions should not have any other forces applied besides that of the weight of objects on top of the platform. The loads should support a 600 lbs. load from any object but not to exceed 600 lbs.

DESIGN ANALYSIS

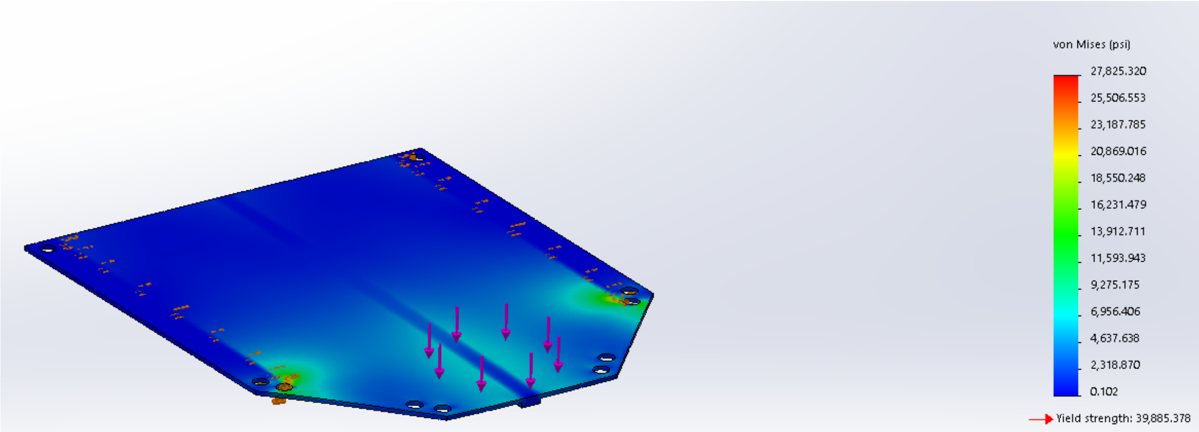


Figure 12 Stress Analysis Platform

The loading conditions were 800 lbs. on the front end of the platform. This shows that the platform chosen holds enough weight past the factor safety of two to hold. The deflection caused by the 800 pounds was half an inch. The yield strength of plate is 39,9885 psi which is greater than the stress of 27,825. This proves the plate will hold the loading conditions.

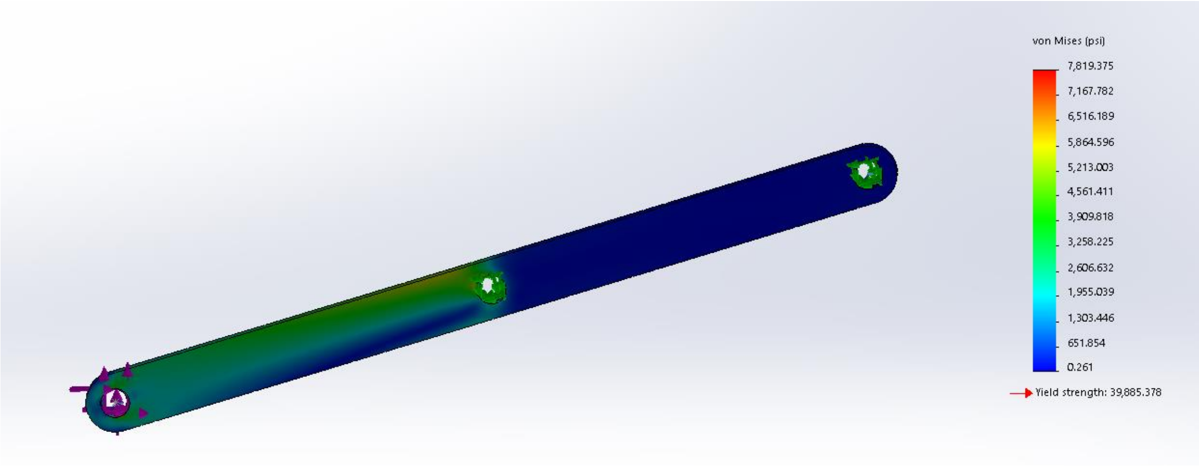


Figure 13 Stress Analysis Link

The load on the member is worst case by standing directly on one pin. This shows that the member can hold the weight The load in the x direction is 1,639 lbs. and the load in the y is 600 lbs. The maximum yield is 39,885 lbs. and maximum displacement is .156 inches.

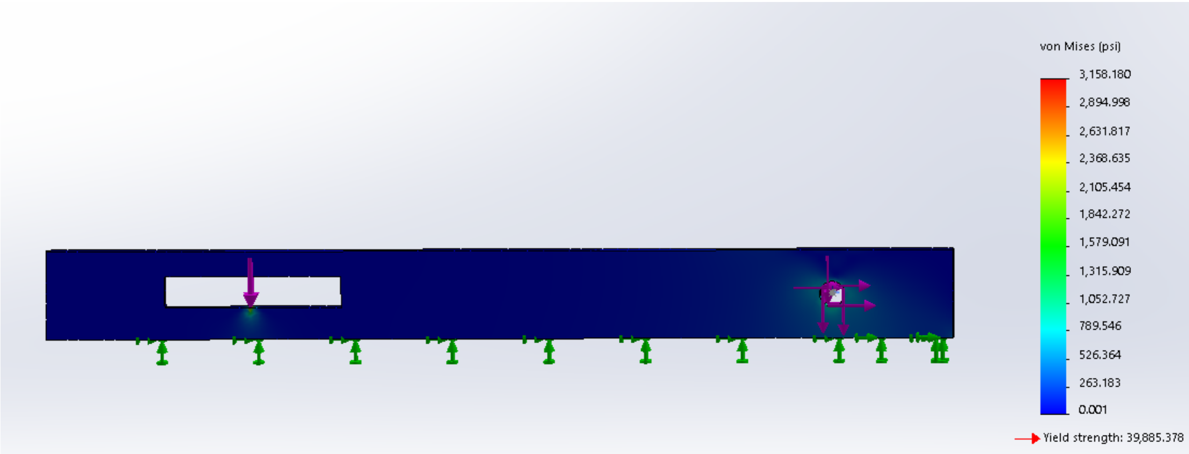


Figure 14 Stress Analysis Slide Panel

The bottom and top link anchors were force tested. There was no displacement and max yield is 3,158 psi. The yield strength is rated for 39,885 lbs.

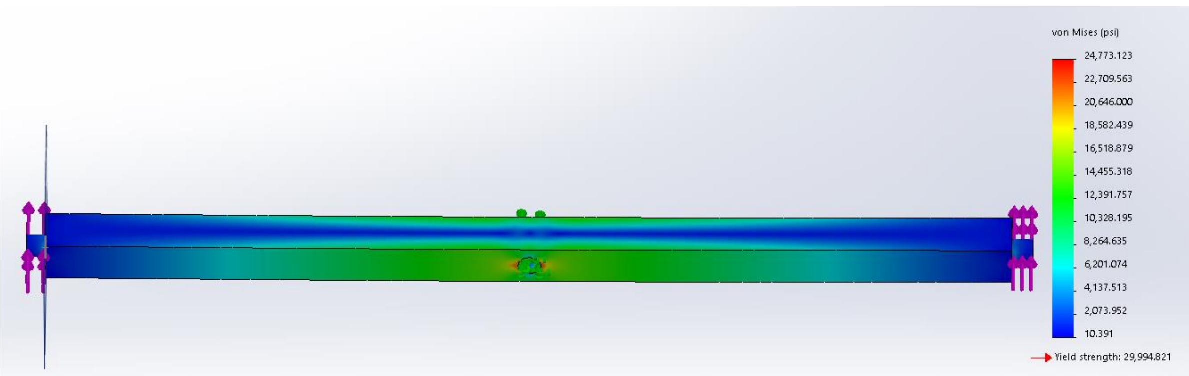


Figure 15 Stress Analysis Threaded Cross Member

The cross link with the screw hold has a yield strength of 29,994 psi and the max yield stress is 22,607 psi. The flection of the bar is .05 inch flection.

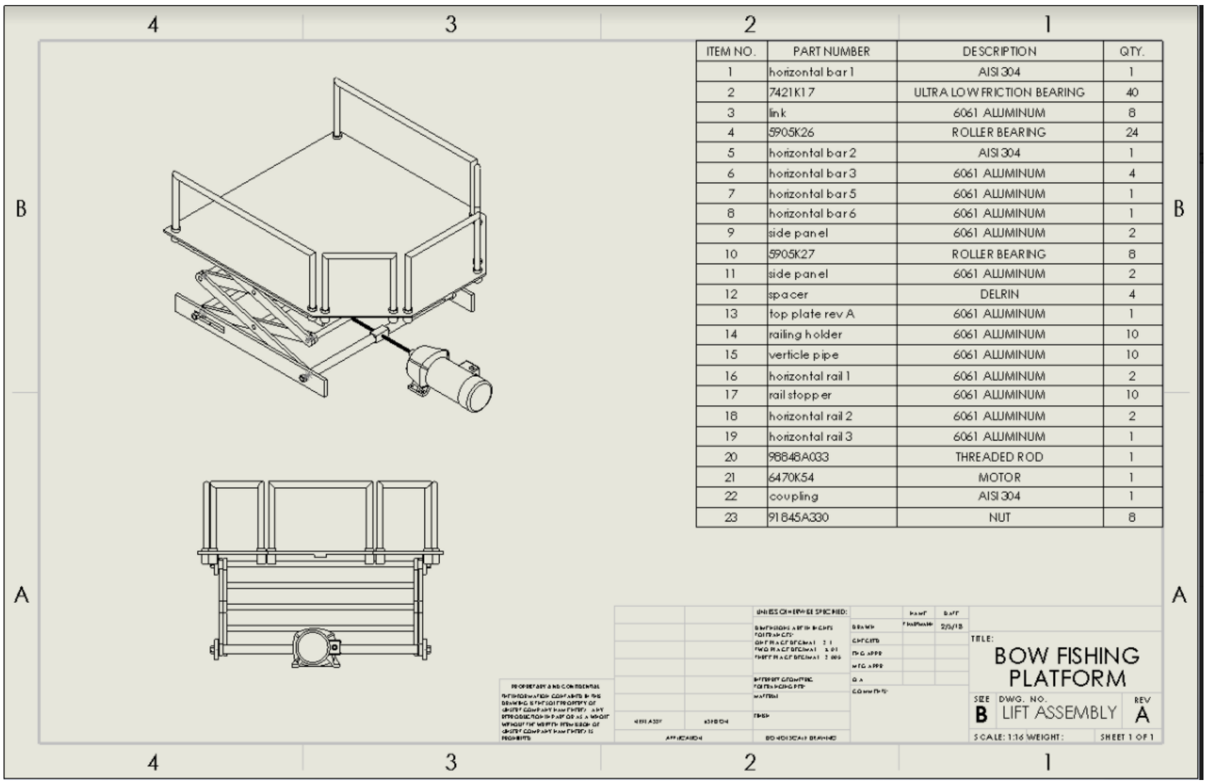
Factor of Safety of Concern

The factor of safety on this lift is set for a factor of two. This should allow for no more than 600 lbs. on the platform at a single time. The factor of two was chosen due to the size of the platform going into the size of the boat. The platform is not big enough for two people to bow fish at a given time. This allows for one person on the boat and one person in the back of the boat.

Component Selection

Choosing each component for the lift was driven by factors such as weight, corrosion resistance, yield strength, and the forces the components can handle. We are using a 12' aluminum fishing boat, so starting with weight and corrosion resistance, we were looking at materials that were lighter in weight and corrosion resistant. Other than the bearings, motor, threaded rod, and the two horizontal bars on the bottom of the lift, we chose 6061 aluminum for the majority of the structure. Everything else will be made of stainless steel because we don't want any part of the lift to rust because it will get wet. After running stress analysis of individual parts of the lift, the materials and configurations we chose will not yield with the forces that we are rating our lift for. We chose standard bearings that could withstand our calculated radial forces, standard threaded rod that can handle the tensional force, and a motor that could handle the torque needed to make the lift rise.

BILL OF MATERIAL



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	horizontal bar 1	AISI 304	1
2	7421K17	ULTRA LOW FRICTION BEARING	40
3	link	6061 ALUMINUM	8
4	5905K26	ROLLER BEARING	24
5	horizontal bar 2	AISI 304	1
6	horizontal bar 3	6061 ALUMINUM	4
7	horizontal bar 5	6061 ALUMINUM	1
8	horizontal bar 6	6061 ALUMINUM	1
9	side panel	6061 ALUMINUM	2
10	5905K27	ROLLER BEARING	8
11	side panel	6061 ALUMINUM	2
12	spacer	DELRIN	4
13	top plate rev A	6061 ALUMINUM	1
14	railing holder	6061 ALUMINUM	10
15	verticle pipe	6061 ALUMINUM	10
16	horizontal rail 1	6061 ALUMINUM	2
17	rail stopper	6061 ALUMINUM	10
18	horizontal rail 2	6061 ALUMINUM	2
19	horizontal rail 3	6061 ALUMINUM	1
20	98848A033	THREADED ROD	1
21	6470K54	MOTOR	1
22	coupling	AISI 304	1
23	91845A330	NUT	8

Figure 16 Bill of Material

TESTING

Testing Methods:

Dry Testing: these test will test the platform when the boat is not placed in a body of water.

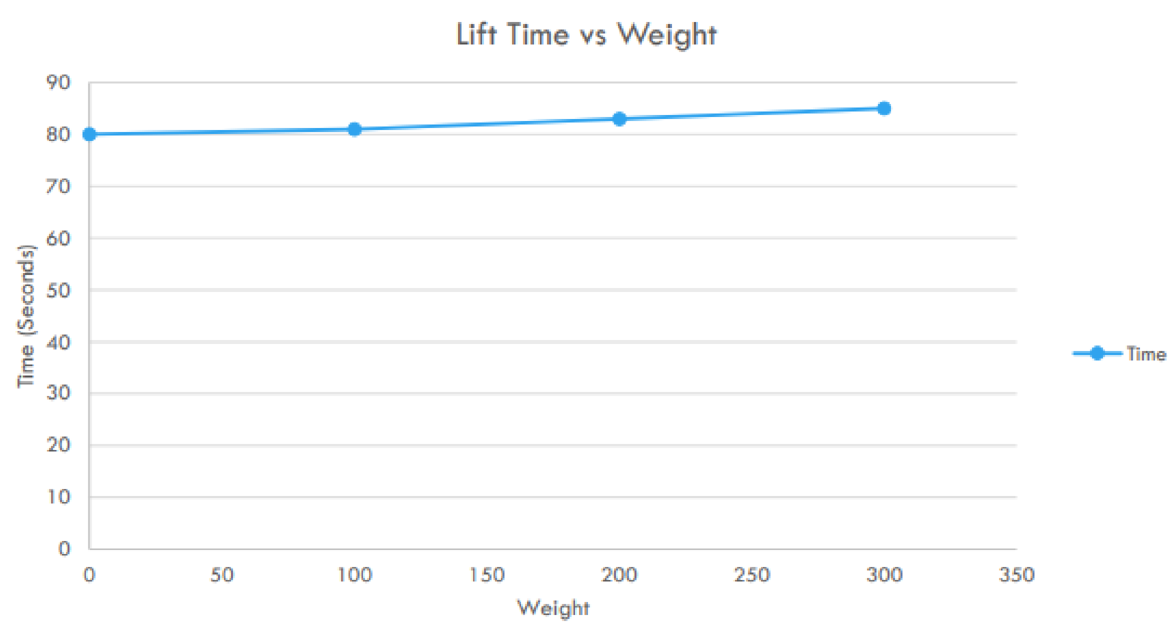
- Make sure the platform can hold the intended weight
- Rise time of platform

Wet testing: This will test the platform when the boat is placed in a body of water.

- Ballast of boat
- Rise time of platform

Results:

Table 5 Testing Results



In testing there was a slight increase in time as weight increases. With a constant torque motor at 58 RPM there should be no variance in time theoretically. In Appendix F there are calculations showing how height of lift can be accounted for time.

Stability Issues were seen while raising the platform. This is caused by the bearings being able to slide forward and backward depending on how weight is shifted on the platform. Tighter tolerances and additional stability control is lacking.

Height after testing has proven to be too much. A reduction in height would increase time of lift as well better stability. The height achieved from the lift causes swaying and the user becomes unstable.

FUTURE DESIGN IMPROVEMENTS:

This platform that was created is an innovative design that went over well with active bow fisherman. The platform performed great in the time of lift and height of lift, however, the height achieved is too much for the platform. A redesign is needed of the double scissor to possibly a single scissor to allow for small lift and less weight. The motor will also be able to be reduced due to less force on it. Stability is an issue due to not tight enough tolerances. A change in the design as well to possibly 2 threaded rods would compensate for this problem.

PROJECT MANAGEMENT

BUDGET, PROPOSED/ACTUAL

Charles Schmidt
Trenton Hartmann

Project budget

CATEGORY	ESTIMATED	ACTUAL	OVER/UNDER
Materials	1,200.00	1,580.51	-380.51
Tools	100.00	0.00	100.00
Motor	850.00	1,031.52	-181.52
cooler	100.00	80.00	20.00
pumps w/ hoses	150.00	24.99	125.01
batteries	100.00	104.00	-4.00
Boat maintenance	400.00	600.00	-200.00
Total Expenses	2,900.00	3,421.02	-521.02

Figure 17 Project Budget

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The budget was more expensive than originally expected. There were issues met with the boat that wouldn’t affect the expenses of the platform. There was also some angle needed to shim the platform into the boat.

SCHEDULE, PROPOSED /ACTUAL

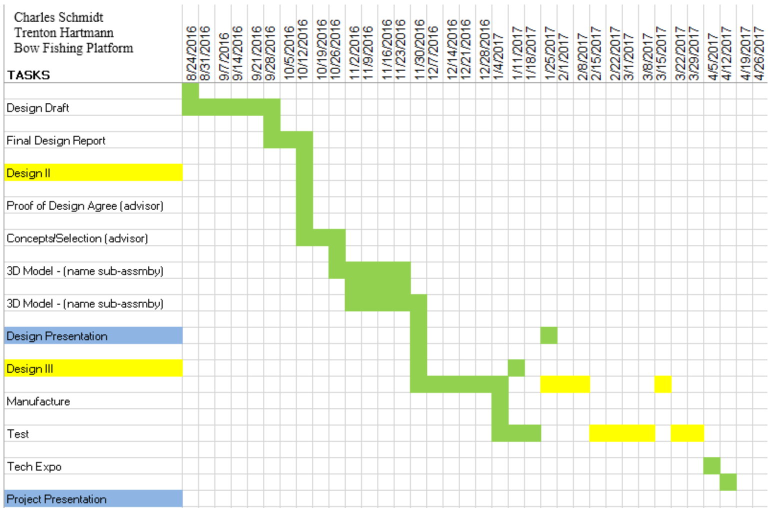

Figure 18 Schedule

The schedule was planned out well. The schedule worked well due to the amount of machines that General Tool Company had readily available. The time to manufacture will need to be changed depending on the lathe and machine work found in Appendix H

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APPENDIX A - RESEARCH

The Platform that is purchasable with the Tracker Grizzly 1860 shows how the bolt on platform is utilized for attaching a platform to the hull of the boat. It has a nice console and railings for safety.

EDGE Bowfishing has a stowaway platform that can be folded up for normal fishing. The tied down is a simple bungie tie down underneath the frame to anchor to the boat. The platform features: non slip titan decking; lightweight Aluminum construction; folds for easy storage; adjustable legs; wheel kits; LED light kits; safety rails; universal seat mounts. The dimensions are 36” Long X 36” Wide (Tapers to 24”) X 8” to 21” Height. (4)

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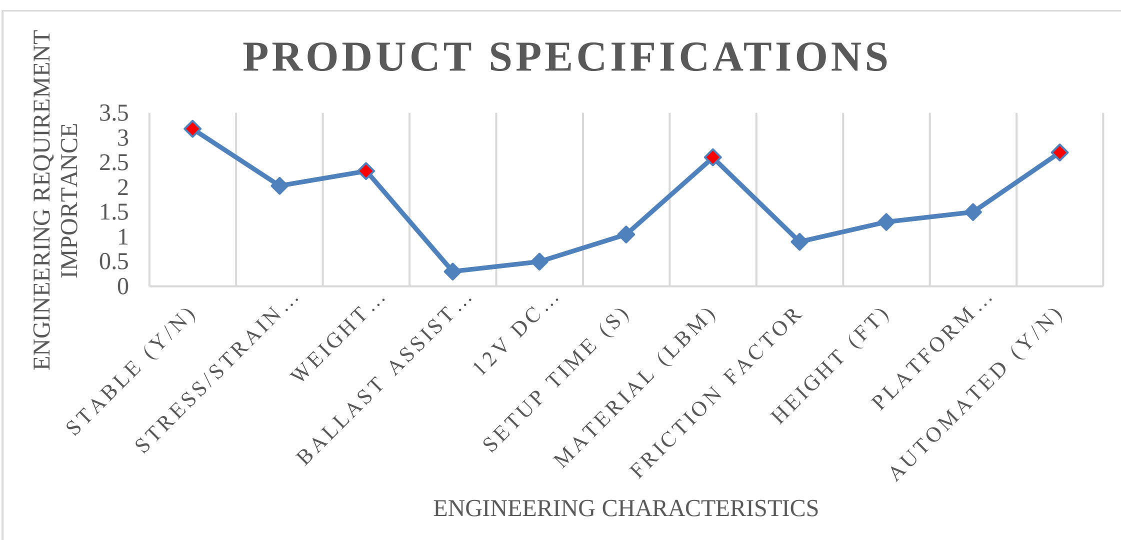
APPENDIX B – QUALITY FUNCTION DEPLOYMENT

			Engineering Requirements (units)														Customer Satisfaction Rating (0.00 - 1.00)			
		Importance wt.	Stable (Y/N)	Stress/Strain Force (lb*ft^	weight Capacity (lbs)	Ballast assist (lb*ft)	12V DC Battery (Y/N)	Setup Time (s)	Material (lbm)	Friction Factor	Height (ft)	Platform Area (ft^2)	Automated (Y/N)							
	Customer Requirements		1	2	3	4	5	6	7	8	9	10	11	12	13	14	CP	A	B	C
1	Doesn't shift while using	0.10	9		3				1		1	3						1	0.4	
2	Stays in upright position	0.20	9	9	9				3		3	3						1	0.8	
3	Can hold multiple people	0.03	1	9	9	3			3			9						1	0	
4	Setup is quick	0.05					3	9			1		9					0.1	1	
5	Weather/Rust resistance	0.20							9									1	0	
6	Battery Powered	0.05					9						9					0	0	
7	Sway Compensation	0.05	9			9					3	1						1	0	
8	Automated	0.20					1	3					9					0	0	
9	Non-slip Surface	0.10								9		1						0.7	1	
10	Step up to platform	0.03									9							0.4	0.2	
	Total Importance	1.00	28	18	21	12	13	12	16	9	17	17	27							
	Engineering requirement importance		3.18	2.03	2.33	0.3	0.5	1.05	2.6	0.9	1.3	1.5	2.7							
Performance	Current Product																			
	competitor A		Y	N/A	575	N	Y	N/A	250	Low	1	16	N							
	competitor B		N	N/A	250	N	N	60	20	high	2	4	N							
	competitor C																			
	New Product Targets		Y		600	Y	Y	30	100	High	2	9	Y							

Interaction Matrix

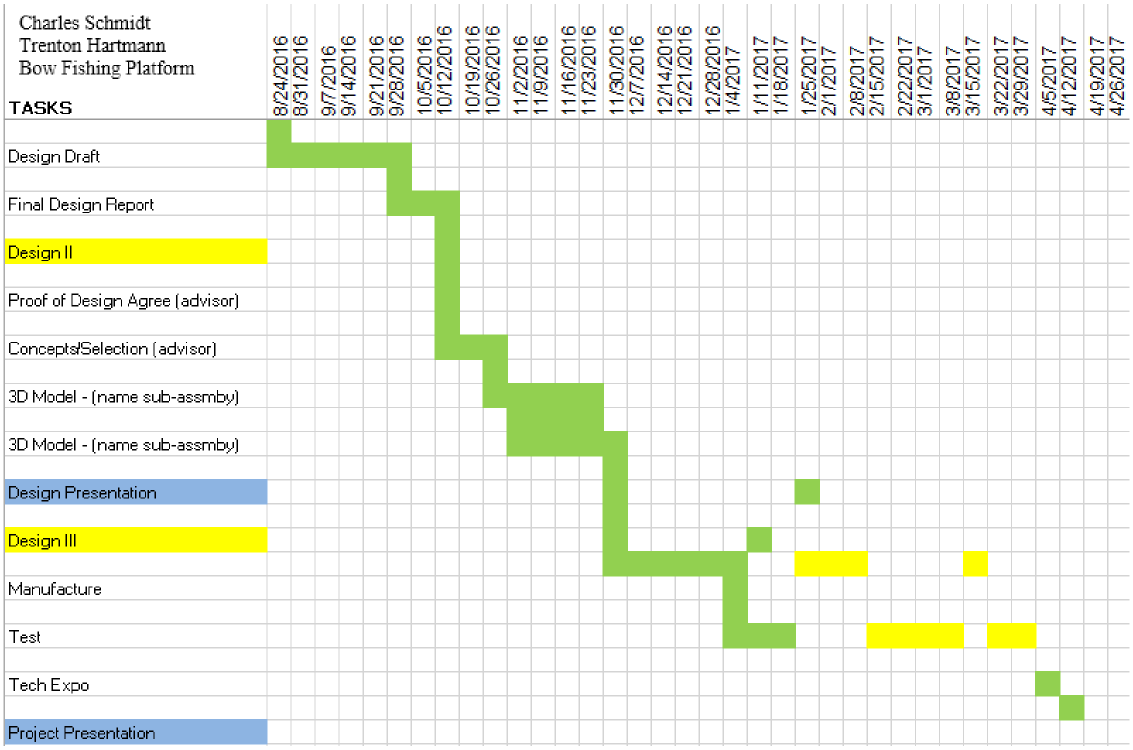
Engineering Requirements	Engineering Requirements	Stable (Y/N)	Stress/Strain Force (lb*ft^2)	weight Capacity (lbs)	Ballast assist (lb*ft)	12V DC Battery (Y/N)	Setup Time (s)	Material (lbm)	Friction Factor	Height (ft)	Platform Area (ft^2)	Automated (Y/N)	0	0	0
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
Stable (Y/N)	1		9	9	9			3		-3	3				
Stress/Strain Force (lb*ft^2)	2			9				3		1	9				
weight Capacity (lbs)	3				-3			1			9				
Ballast assist (lb*ft)	4					9	1	1		3	3				
12V DC Battery (Y/N)	5						9					9			
Setup Time (s)	6									1		9			
Material (lbm)	7									1	3				
Friction Factor	8														
Height (ft)	9											1			
Platform Area (ft^2)	10														
Automated (Y/N)	11														
0	12														
0	13														
0	14														



APPENDIX C - OBJECTIVES

- **Durability**
  - The platform is built to be strong to allow for people to be standing on it over a decently long period of time. Should not wear over time.
- **Functionality**
  - The platform will raise and lower on command as preferred by the user with no issues.
- **Price**
  - Product should be designed using standard material sizes to reduce cost. Try to eliminate special purpose parts because it will increase the price dramatically due to the material processes.
- **Weight Capacity**
  - The weight capacity will be set at 600 lbs.
- **Weight**
  - Product will be light weight to allow for more carrying capacity on the boat
- **Setup Time**
  - Platform should be setup in a timely manner. To get the safety components set up and from the platform to rise to its peak, it should take minimal time.
- **Reliability**
  - Product should be able to perform time and time again. Should be able to satisfy customer requirements and specifications at a consistent rate for a long period of time.
- **Noncorrosive**
  - Product will be interacting with water being attached to a boat. Should be made with rust resistant materials.
- **Safety**
  - Product should be built rigidly and should have railings as it will be elevated from the surface of the boat.
- **Ballast Compensator**
  - Keep boat balanced in the water when the product is in use. Would compensate for the weight of the user and weight of the product.

APPENDIX D - SCHEDULE



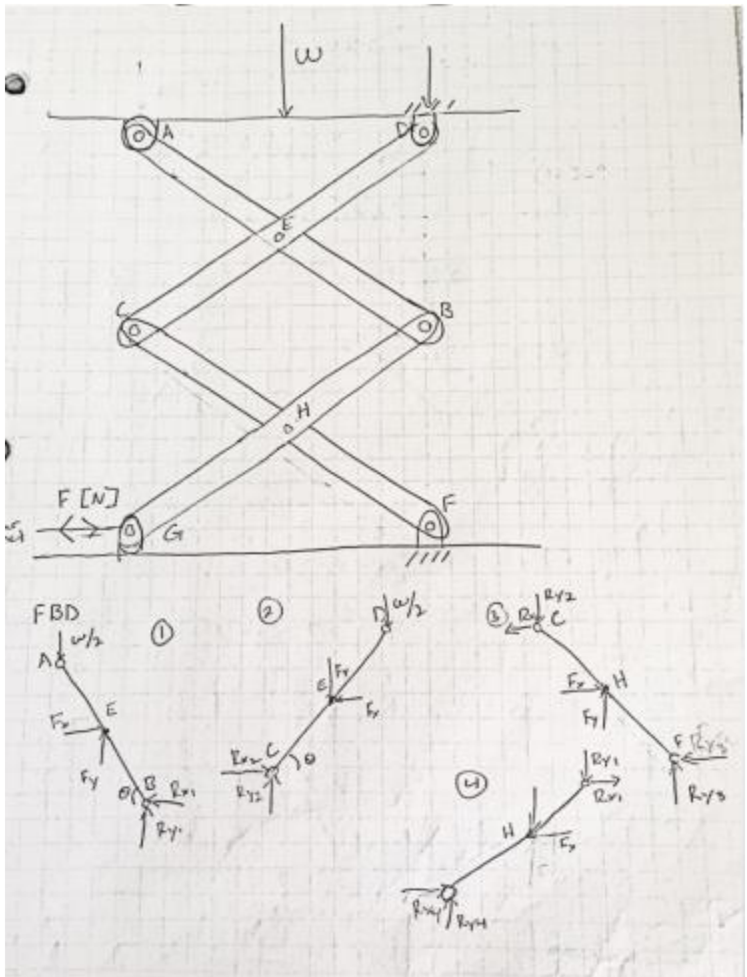
APPENDIX E - BUDGET

Charles Schmidt
Trenton Hartmann

Project budget

CATEGORY	ESTIMATED	ACTUAL	OVER/UNDER
Materials	1,200.00	1,580.51	-380.51
Tools	100.00	0.00	100.00
Motor	850.00	1,031.52	-181.52
cooler	100.00	80.00	20.00
pumps w/ hoses	150.00	24.99	125.01
batteries	100.00	104.00	-4.00
Boat maintenance	400.00	600.00	-200.00
Total Expenses	2,900.00	3,421.02	-521.02

APPENDIX F – PROOF OF DESIGN



Equation A: $\sum MB = \frac{w}{2} 2L(\cos(\theta)) - Fx(Lsin(\theta)) - Fy\big(Lcos(\theta)\big) = 0$

Equation B: $\sum Fx = Fx1 - Rx1 = 0$

Equation C: $\sum Fx = Fy1 + Ry1 - \frac{w}{2} = 0$

Equation D: $\sum MC = -\frac{w}{2} 2L(\cos(\theta) + Fx(Lsin(\theta)) - Fy\big(Lcos(\theta)\big) = 0$

Equation E: $\sum Fx = Rx2 - Fx1 = 0$

Equation F: $\sum Fy = Ry2 - Fy1 - \frac{w}{2} = 0$

Equation G:

$$\sum MF = -(Ry2)2L(\cos(\theta)) - (Rx2)2L(\sin(\theta) - Fx(Lsin(\theta)) - Fy\big(Lcos(\theta)\big) = 0$$

Equation H: $\sum Fx = -Rx2 + Fx2 + Rx3 = 0$

Equation I: $\sum Fy = -Ry2 + Fy2 + Ry3 = 0$

Equation J:

$$\sum MG = (Ry1)2L(\cos(\theta)) + (Rx1)2L(\sin(\theta) - Fx(Lsin(\theta)) + Fy\big(Lcos(\theta)\big) = 0$$

Equation K: $\sum Fx = Rx1 - Fx2 - Rx4 = 0$

Equation L: $\sum Fy = -Ry1 + Fy2 + Ry4 = 0$

12 equations: 12 unknowns

Solve for Unknowns using the weight of the platform being 600 lbs

Force on screw = P = 2(Rx4)

Screw then needs to hold that weight with it being a ½ diameter 304 stainless steel threaded rod.

As = tensile stress area = $\frac{\pi}{4} - [0.5 - (\frac{.9382}{13})]^2$ = 0.144
St = tensile strength in psi = 70,000 for 304 stainless steel
P = St x As
P < the force the screw can hold.

Torqued needed to turn rod
K = torque coefficient which is the coarse threaded rod. = 0.25
D = nominal diameter
P = Tensile load

$$T = \frac{(KDP)}{12}$$

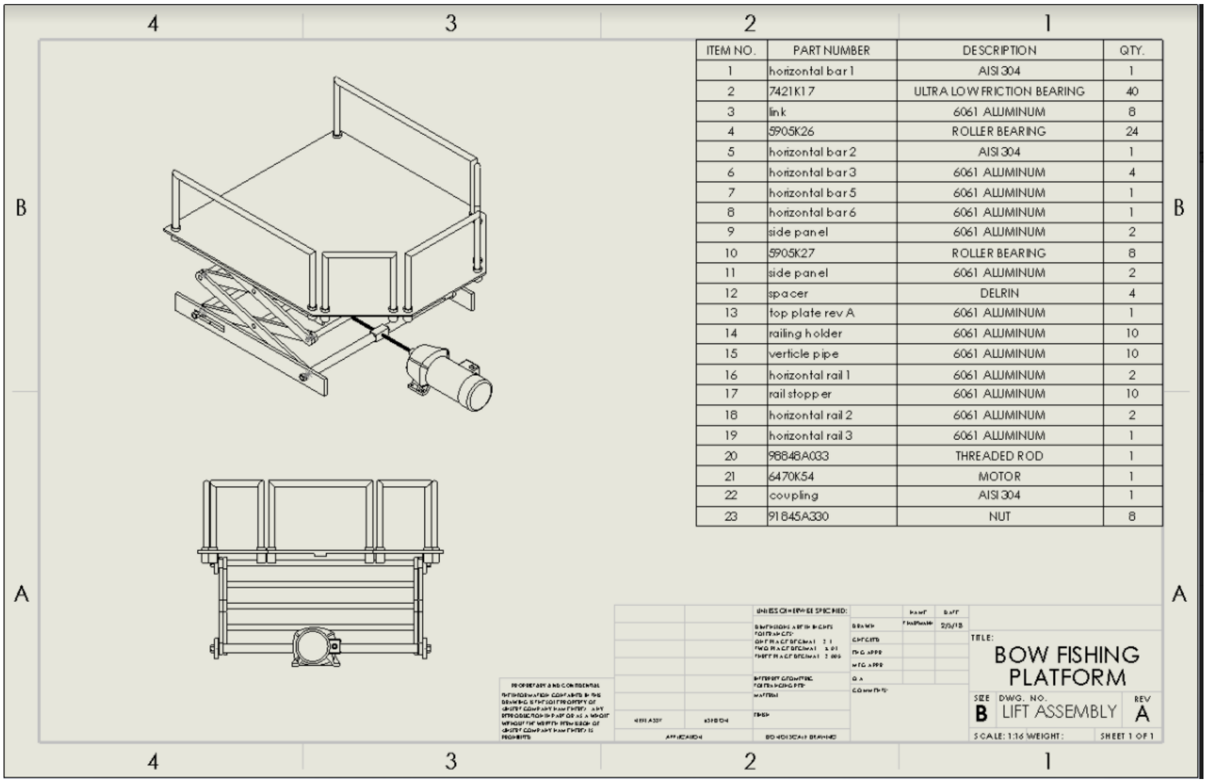
T = 23 ft.*lbs.

Motor selection is a 90V 5 A DC moter at ½ hp 58 RPM and 40 ft.*lbs. of torque

Time to raise lift

6 inches of translation multiplied by 13 threads per inch divided by 84 RPMS * 60 seconds in a minute = 84 s to raise lift

APPENDIX G – DRAWINGS



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	horizontal bar 1	AISI 304	1
2	7421K17	ULTRA LOW FRICTION BEARING	40
3	link	6061 ALUMINUM	8
4	5905K26	ROLLER BEARING	24
5	horizontal bar 2	AISI 304	1
6	horizontal bar 3	6061 ALUMINUM	4
7	horizontal bar 5	6061 ALUMINUM	1
8	horizontal bar 6	6061 ALUMINUM	1
9	side panel	6061 ALUMINUM	2
10	5905K27	ROLLER BEARING	8
11	side panel	6061 ALUMINUM	2
12	spacer	DELRIN	4
13	top plate rev A	6061 ALUMINUM	1
14	railing holder	6061 ALUMINUM	10
15	verticle pipe	6061 ALUMINUM	10
16	horizontal rail 1	6061 ALUMINUM	2
17	rail stopper	6061 ALUMINUM	10
18	horizontal rail 2	6061 ALUMINUM	2
19	horizontal rail 3	6061 ALUMINUM	1
20	98848A033	THREADED ROD	1
21	6470K54	MOTOR	1
22	coupling	AISI 304	1
23	91845A330	NUT	8

Figure 19 Full Assembly

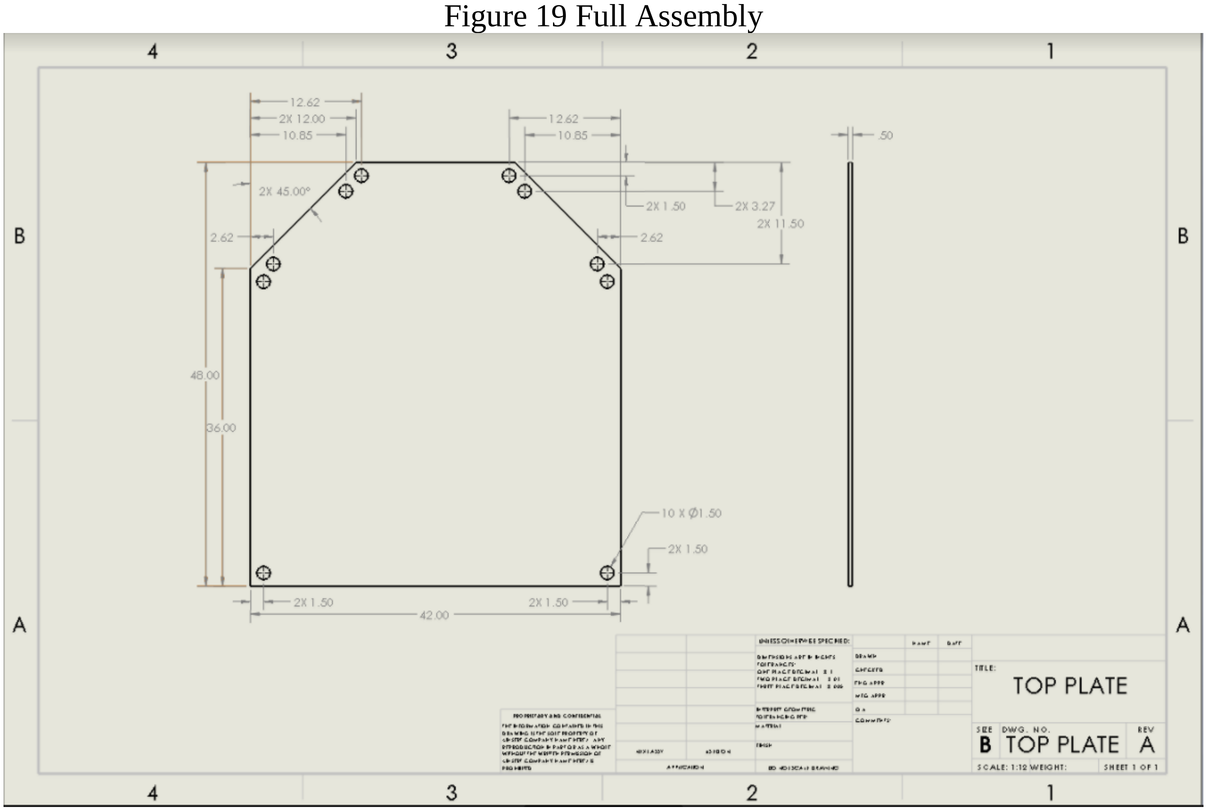


Figure 20 Top Plate

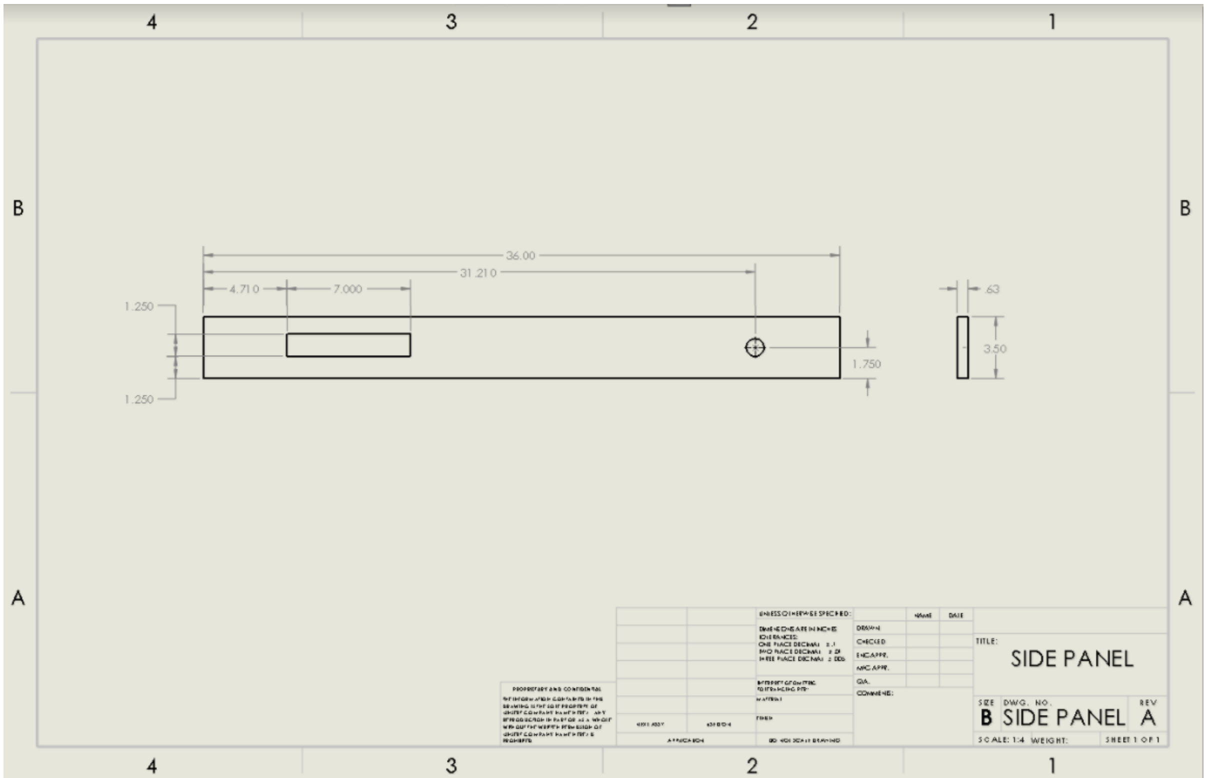


Figure 21 Side Panel

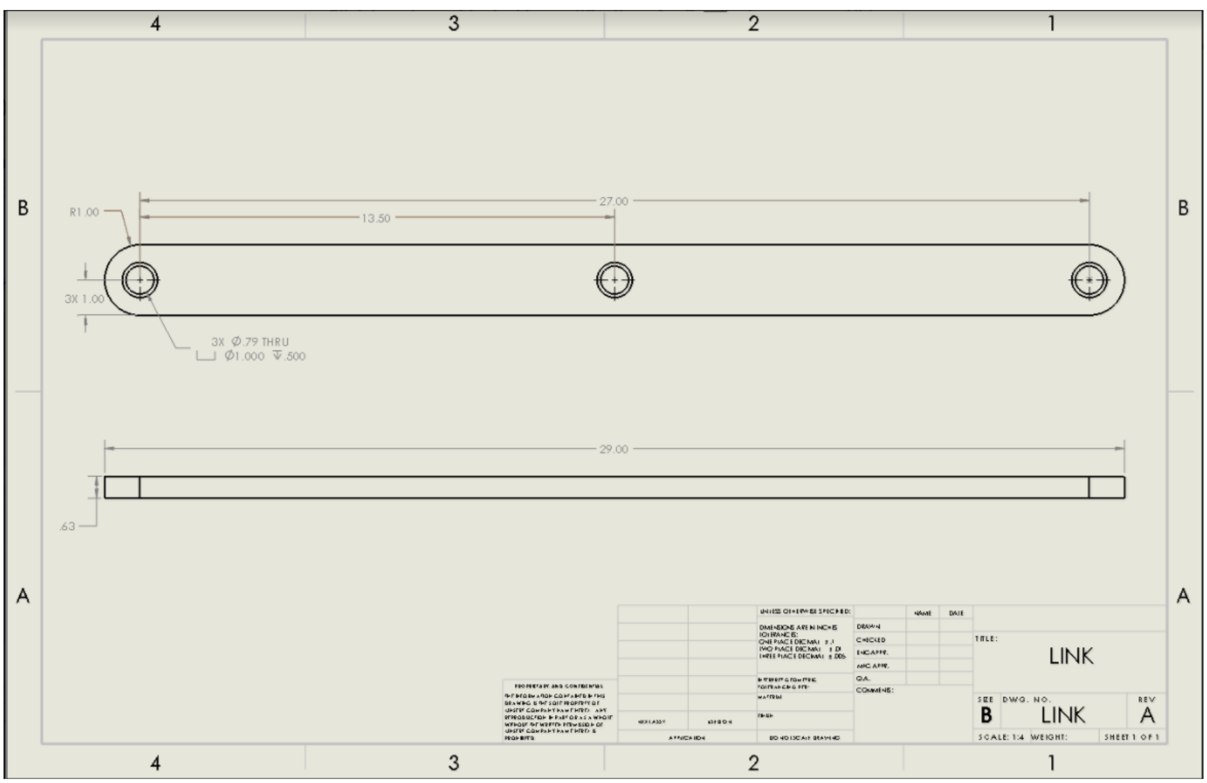


Figure 22 Link

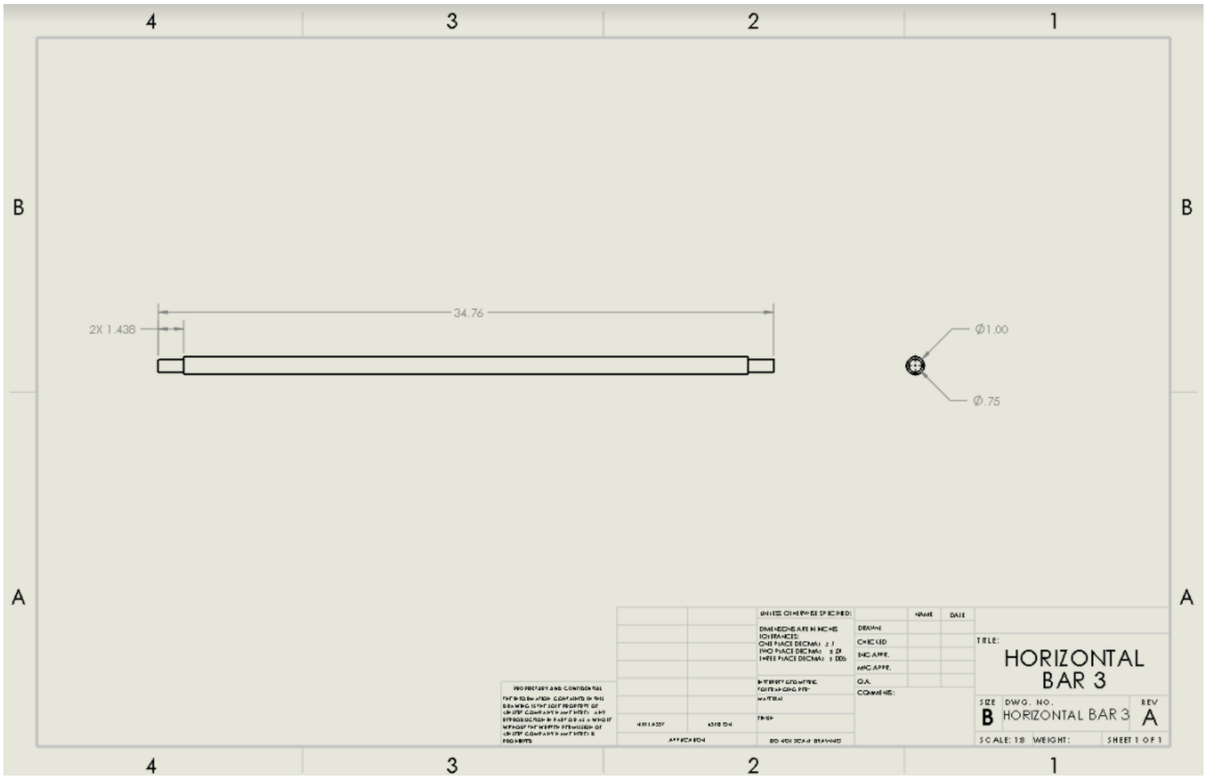


Figure 23 Horizontal Cross Member

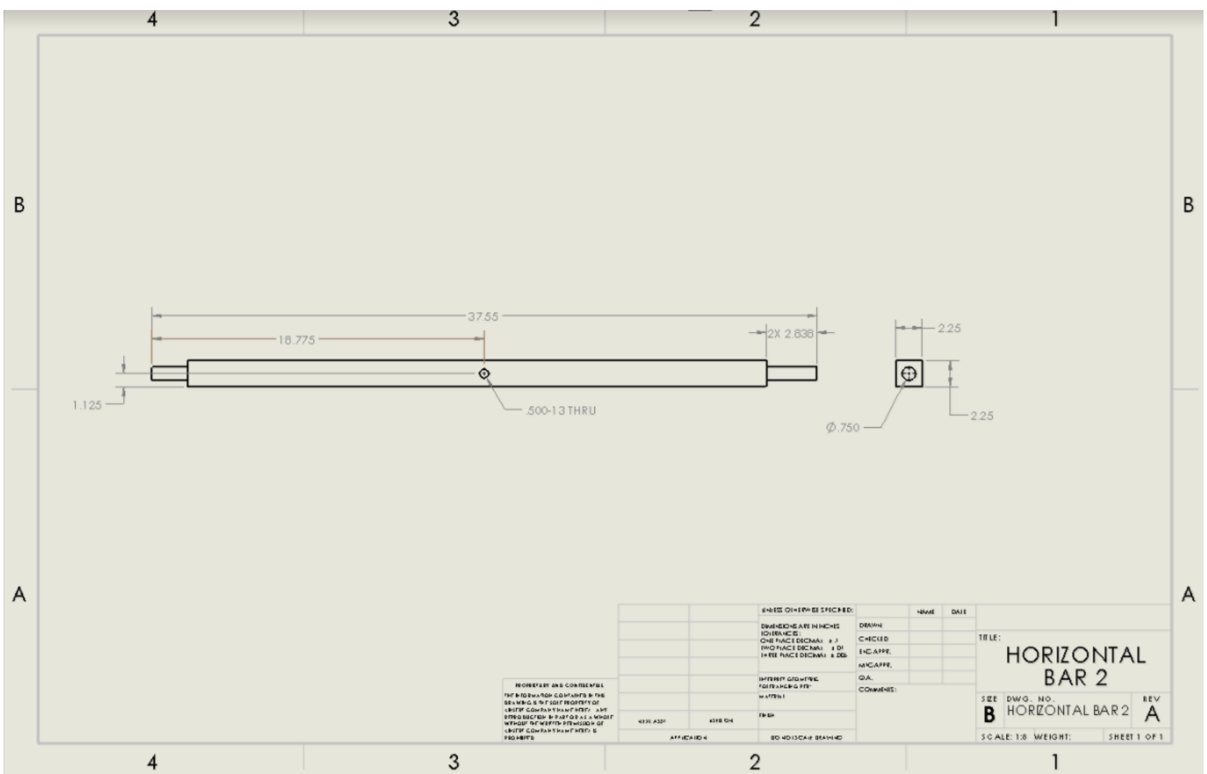


Figure 24 Horizontal Screw Driven Member

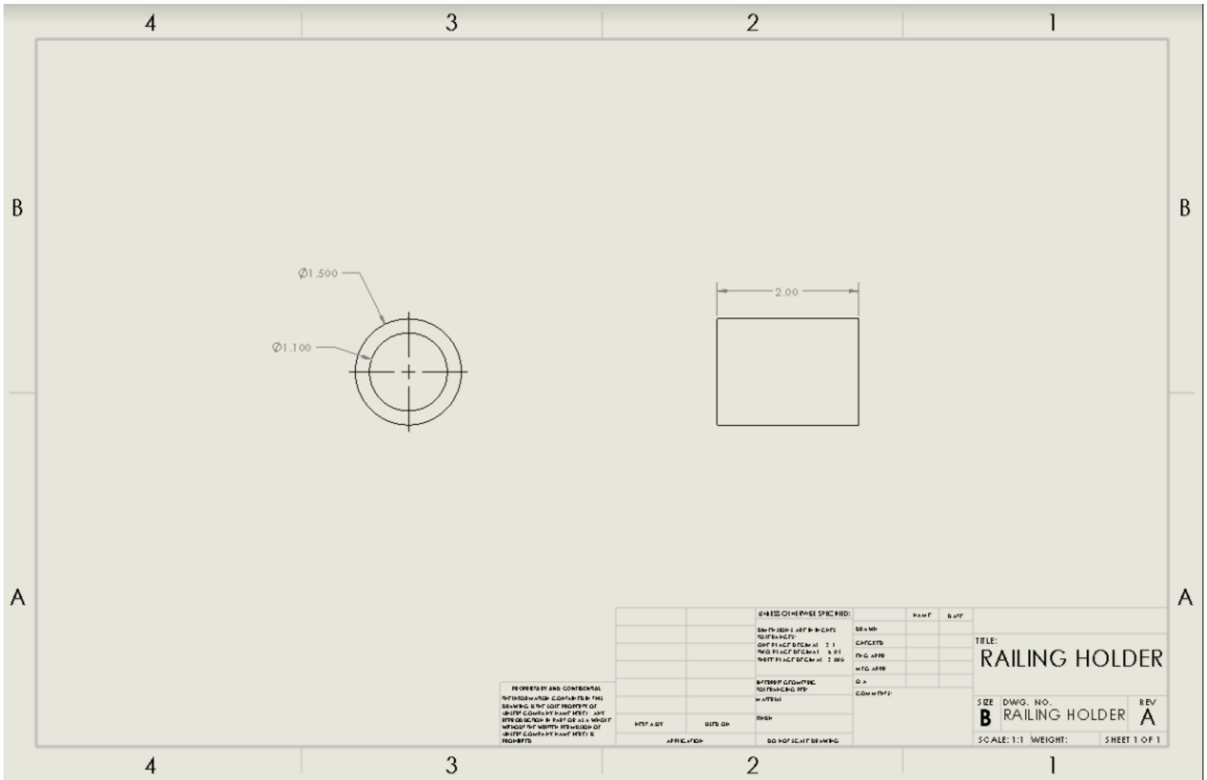


Figure 25 Railing Holder

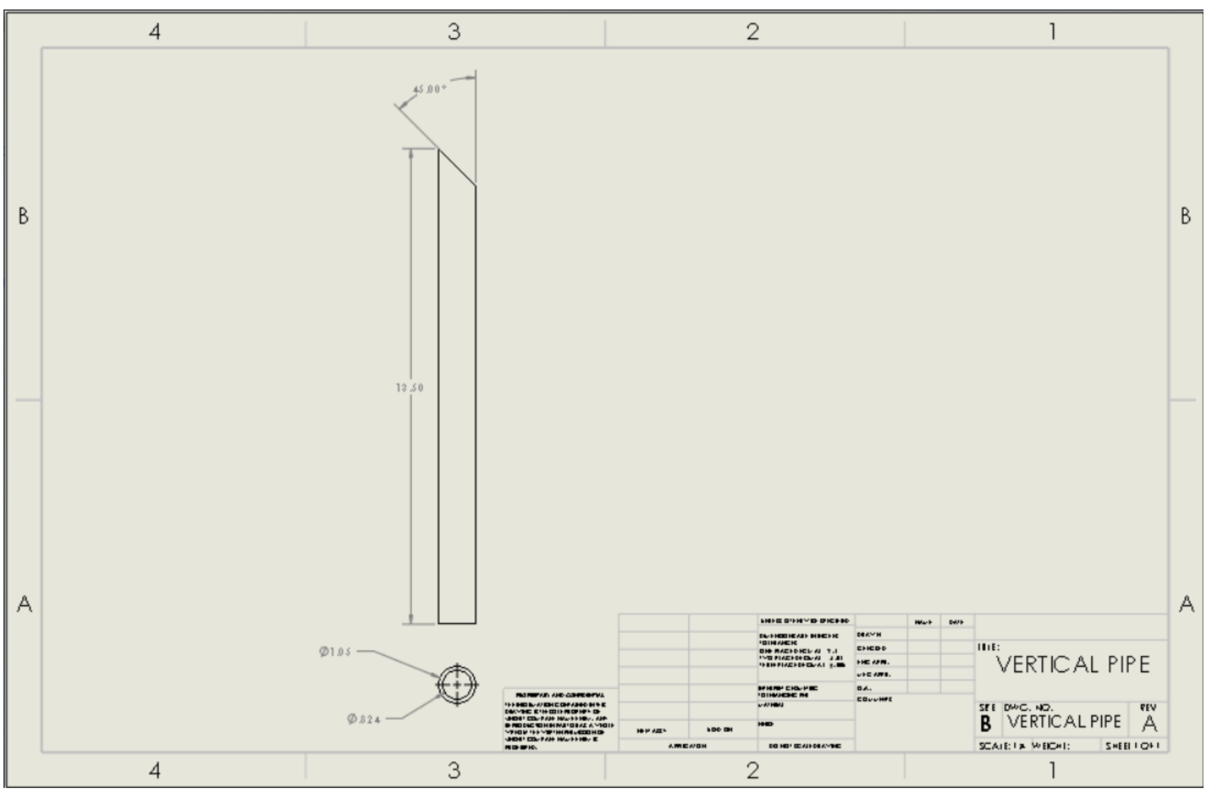


Figure 26 Vertical Pipe

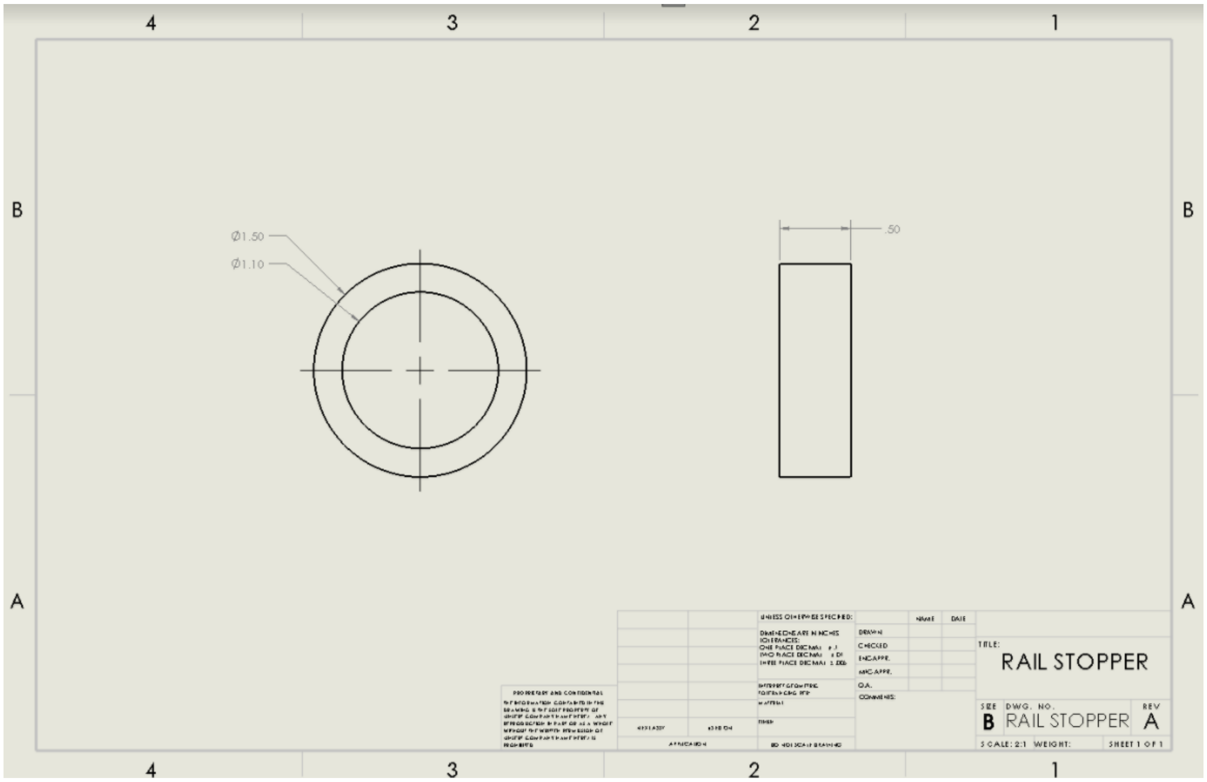


Figure 27 Rail Stopper.

APPENDIX H – MANUFACTURING AND ASSEMBLY

Machining:

Figure 28 Lathe Work

The above parts all are being machined on a manual lathe. This involved turning, facing, threading and cutting off parts to length.

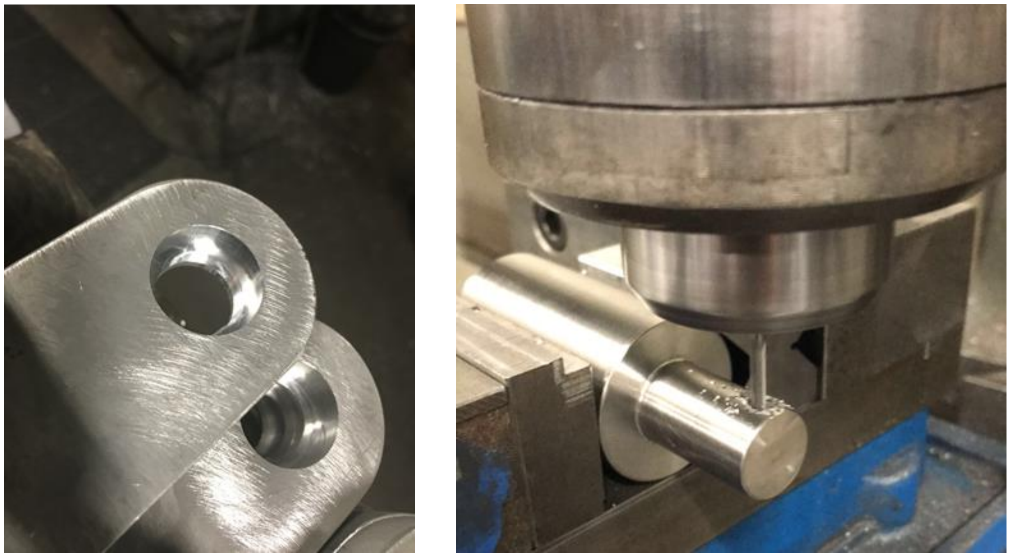


Figure 29 Milling

The above parts required milling work all done on a manual Bridgeport. Figure 29 shows a counter bore hole for a bearing to be press fit inside. This was done by interpolating the hole with an end mill. Figure 29 also shows the coupling adapter piece being milled for a key way slot.

Figure 30 Water Jet

Fabrication:

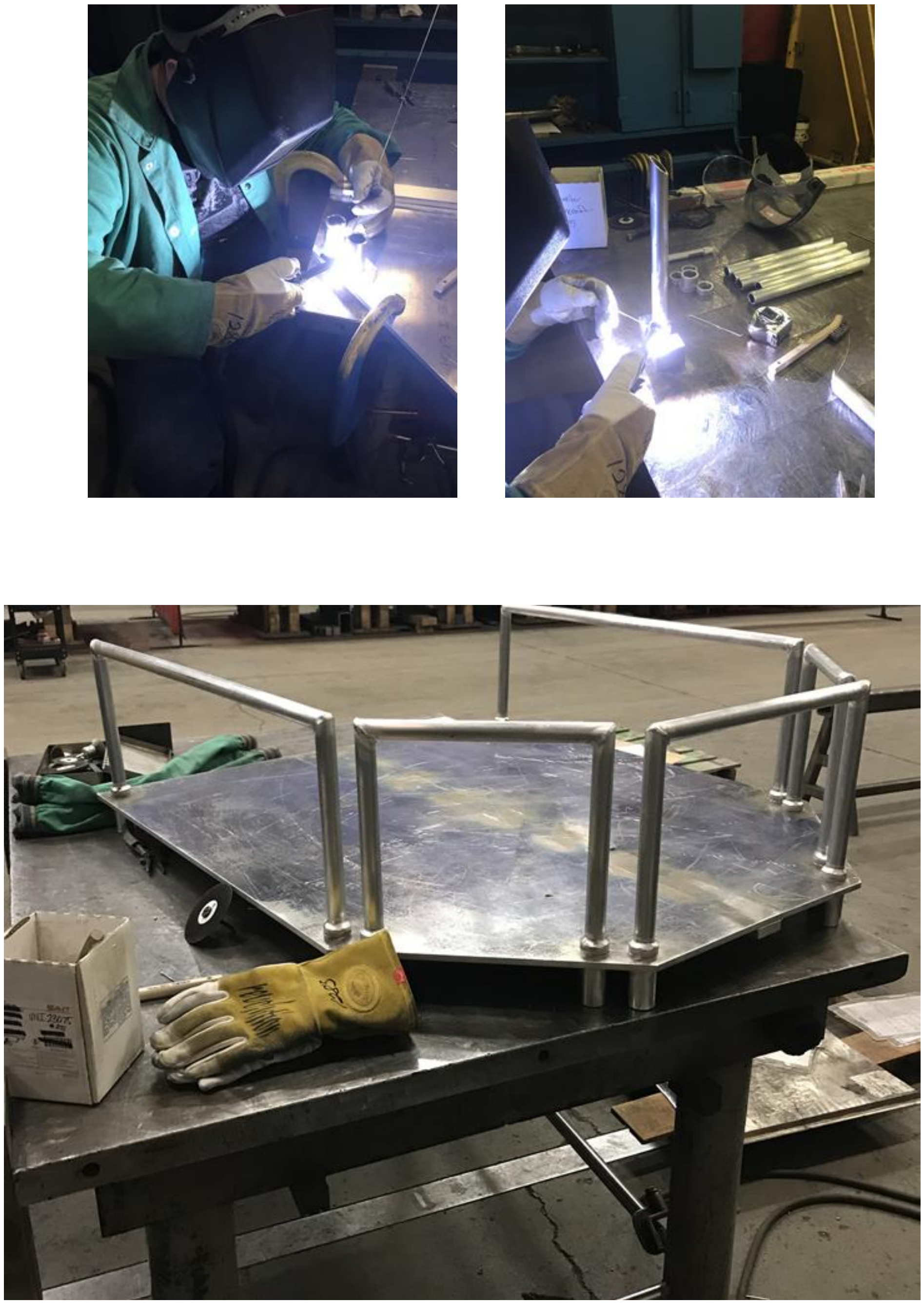


Figure 31 Welding

All the fabrication of the platform was saw cuts and aluminum welding. Fitting up the railings in the holes before welding them was needed to allow for them to be easily removable.

Assembly:

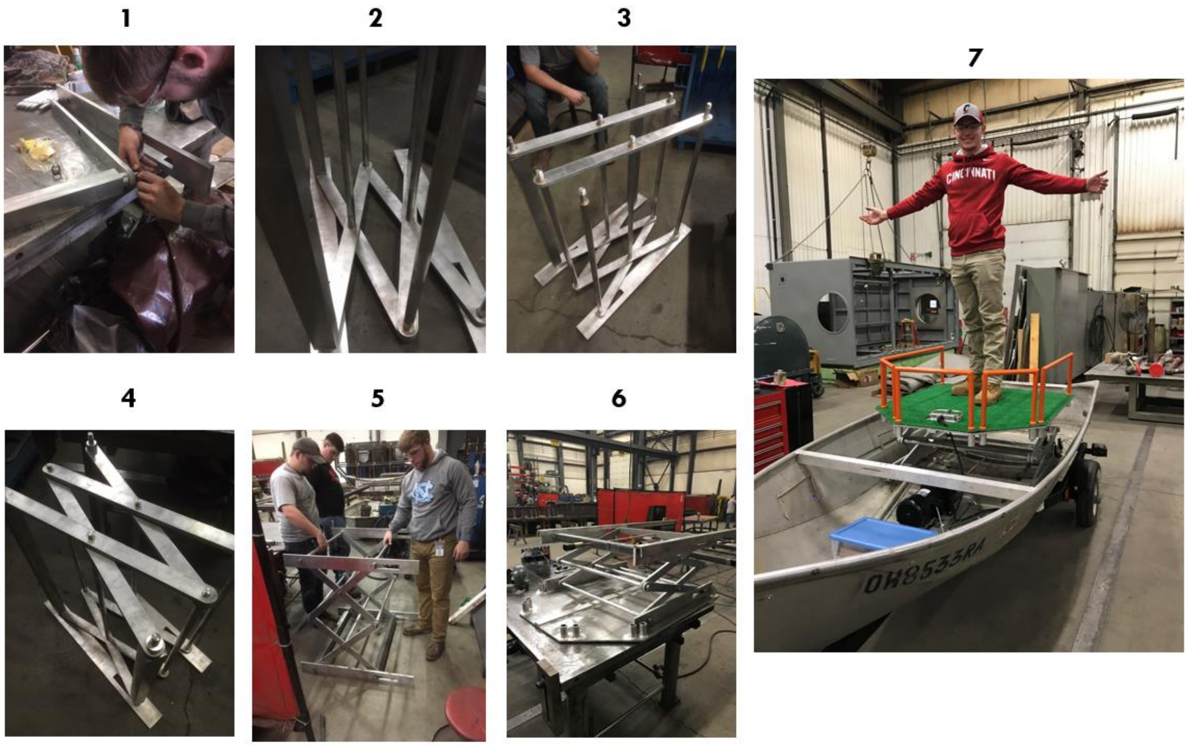


Figure 32 Assembly

Figure 32 shows the process of how the platform got assembled. You had to start with assembling one side at a time from the bottom of the lift to the top. Once the first side was fully assembled, the platform was sat on its side to assemble the other side. When this was complete, the top plate was welded on and the whole platform was put in the boat and welded firmly inside. Attaching the motor and all the electronics was the last step to make are lift fully functional.