AUTOMATIC ANCHOR HANDLING SYSTEM

A thesis submitted to the
Faculty of the Mechanical Engineering Technology Program
of the University of Cincinnati
in partial fulfillment of the
requirements for the degree of

Bachelor of Science

in Mechanical Engineering Technology
at the College of Engineering & Applied Science

by

PARAG PATEL

Bachelor of Science University of Cincinnati

May 2012

Faculty Advisor: JANAK DAVE, PhD

Automatic Anchor Handling System

ACKNOWLEDGEMENTS

I am happy to present this project to my professor, Mr. Janak Dave. I am grateful that Mr. Dave helped me throughout this project, and I have tried my best to succeed at it. I would like to thank all the people who helped me: Mr. Jeff, Mr. Pavel, and Mr. Bud. I would also like to thank my friends for their support.

TABLE OF CONTENTS

Contents

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

Automatic anchor handling devices can be used in methods of dropping and pulling anchor from water. Currently there are few systems in the market but due to the expensive and design of the systems, purchasing one of these systems may not be in a boater's best interest. The purpose of this project was to design an improved and cost efficient anchor handling system. The Automatic Anchor handling system created was an innovative design that used motors to give motion to the pulleys then give motion to the driving rod as well. The designer will demonstrate the functionality of their novel, cost efficient automatic anchor handling system and how to raise the awareness to customers in selecting the more cost effective option.

INTRODUCTION

BACKGROUND

It is clear that one of the most important pieces of equipment on boat is your anchor, and associated anchor winch. A large number of boaters still carry the older generation anchors such as plows (CQR), deltas, claws (Bruce), and danforth types. These boaters may not be fully aware of the benefits of the newer generation type anchors now widely available, which have raised the bar significantly in expectations of anchoring performance.

The common problems with the old generation of anchors are specifically, inconsistent setting performance (often not setting at all), poor holding in soft bottoms, and failure to penetrate in hard substrates. There are type-specific issues also, such as the moving parts of hinged-shank plows, which can cause injury to boater as well as reducing strength; blade shapes designed to furrow through the ground.

These are the functional issues with the old generation designs. The new generation anchors address many of these issues successfully. The failings of the older designs no longer need be tolerated, as the technology of anchors has simply evolved that little bit further.

Cajun anchor is something totally new and different, which is developed for the fishing industry. It is basically a long, heavy metal rod, with an eye to attach a rope at the top end. Some are lightly pointed on the bottom end to help with pushing vertically into soft bottom. In low current, it is simply dropped overboard, using its weight to hold the boat or slow the drift. In this modern period of technology Cajun anchor is the well selected anchor for fishing with small boats.

Due to their weight and length, the anchors are difficult to put into the water as well as taking them out. To make things easier on themselves boaters bought anchor winches to help for free fall and pulling the anchor back to its normal position. An electric anchor winch is, an electrically-powered winch used to raise and lower boat anchors. Boats using an electrical anchor winch can raise a heavier anchor in a variety of situations where using a manual winch would prove to be difficult. These winches are not able to handle a Cajun anchor because the Cajun anchor is long in length and the anchor road is held at a smaller angle.

The purpose of this design is to device an automated Cajun anchor operating system to be able to drop the anchor with require force and pull the anchor back from the water easier.

EXISTING ANCHOR AND ANCHOR WINCH STYLES

ANCHOR STYLE

There are many types of anchors that are available in market. Anchor selection depends on the operation and the surface under the water. Cajun anchor is the most popular style to choose for easy and normal operations. When you anchor, it makes no noise and you need very little scope, which means you can anchor right on the drop and not have to drift back 15 or 20 feet to wait for it to hold. This spear anchor (see. Figure 1), is attractively designed and very strong and easy to throw. The Cajun anchor is constructed of solid stainless shaft with a rounded bottom end so that it penetrates very easily when thrown straight down.

Figure 1 Cajun anchor (1)

This anchor is operated by a manual handling system which effects the user’s body. When you are ready to pull the anchor straight up, the system takes more effort to safely retrieve it.

The next offering for an anchor is called the Grappling anchor (see Figure 2). The grappling anchor is traditional and simple in design. Grappling anchors are used to engage and hold against solid massive seafloor features, such as coral heads, rock outcrops, and crevices or ledges in rock and coral bottoms. Holding power depends on the strength of the grappling device and the seafloor features. Correct pulling angle and the constant tension must be maintained to prevent the anchor from losing its grip and sliding. Grappling anchor rarely have enough fluke area (area of the triangular blade at the end of an arm of an anchor, designed to catch in the ground) to develop much hold in sand, clay, or mud. A grappling anchor is often quite light, and used aboard smaller boats where its weight makes it relatively easy to bring aboard.

Figure 2 Grappling anchor (2)

It is very common for the anchor to unclean on its own rode, or unclean the tines with refuse from the bottom, preventing it from digging in.

ANCHOR WINCH STYLE

The Winch is the tool that helps to drop and pull the anchor into the water. There are different kinds of winches available in market. The selection of winch is depends on the weight of anchor and depth of water. One of the best winch is DeckHand Dh 40(see Figure3).

Figure 3 DeckHand Dh-40 (3)

This winch has a capacity to handle 20-40 pound anchor. It is pre spooled with 100 feet of test rope. Anchor shackle allows for easy changeover from anchor to anchor. Stow and deploy switch integrated into the base of the unit. Corded remote stow and deploy switch allows operation of DeckHand DH-40 from anywhere on the boat. It can automatically raise or lower an anchor at touch of a bottom. Cajun anchor is mainly used for shallow water, where this anchor winch is mainly used for dip water.

Another winch marketed to the high load carrying capacity is the Big Water 45 saltwater winch (see Figure 4). In this winch when the switch control is pressed down, the anchor is released to free-fall to the bottom. After the boat drifts and enough anchor line is let out, pressing the switch “up” locks the winch spool.

Figure 4 Big Water 45 Saltwater Winch (4)

The Push button switch is pre installed on the winch. The housing in this winch is made from lighter wires for simpler and safe operation. This design is small and easy to fix on the rear end of the boat. This anchor winch is often used for large size boats while the Cajun anchor is for small size boats. Because of the boat size this anchor winch is not suitable for cajun anchor.

INTRODUCTION SUMMARY

The preceding research indicates that while each type of anchor and anchor winch has a unique combination of advantages and disadvantages there is not one that specifically outperforms the others in all areas. To create one which fulfills all the criteria of an ideal anchor handling system, I need to find out what the major changes are that the customer requires. To find this out, I did a survey of twenty people, those who own the boat and those who are simply interested in fishing activity. According to my survey results, an ideal anchor handling system would combine the size, weight and system performance of a system with minimum sound and vibration.

CUSTOMER FEEDBACK, FEATURES AND OBJECTIVES

SURVEY ANALYSIS

Based on the QFD results the designer made decisions that impact the final importance. According to Designer Multiplier, some improvements were made which reflected on a Relative Weight. It gives the designer a good idea what the most important decisions have to be achieved to guarantee the complete satisfaction for the design using general important characteristics that the customer were served on.

The twenty boat owners and fishers were participated in the survey. The survey was done based on customer importance and satisfaction with the current product. The purpose of this survey is to help determine to customers' thoughts on the conversion from manual anchor handling to automatic anchor handling product. The survey includes product feature divided by categories for the best exploitation of the future device.

There are three tables of the survey shown below that represents averages of the customer importance and satisfactions based on a scale 1-5 with 5 being most important. Table 2 represents customer feature importance, table 4 represents planned satisfaction and table 3 represents customer current satisfaction.

The most important improvements the designer will focus on are reliability, ease of operation, motor disengagement and low cost of the product, respectably 15-18%. These parameters are recognized as very important components of the design and must be taken for the maximum consideration. So these characteristics should demand better performance. Characteristics such as safety and light weight 8-14% should be more advanced and recognized because these are main components of the product design. Characteristics such as low noise and small design need only 7% improvements to meet designer's requirements to identify and realize that there is good sense of drive among the people and designer.

Table 1 Designer Impact

	Customer importance	Designer's Multiplier	Current Satisfaction	Planned Satisfaction	Improvement ratio	Relative weight %
Safety	4.7	1.2	3.2	5	1.6	14%
Reliability	4.5	1.5	2.8	5	1.8	18%
Motor disengagement	4.9	1.3	3.3	5	1.5	15%
Low noise	3.6	1.1	3.4	4	1.2	7%
Easy of operation	4	1.5	2.9	5	1.7	16%
Low cost	4.4	1.4	3.2	5	1.6	15%
Light weight	2.8	1.5	2.4	3	1.3	8%
Small in design	2.6	1.1	3	5	1.7	7%
Abs. importance	42.0					100%
Rel. importance	100					

PLANNED SATISFACTION

The planned satisfaction was established based on customer importance and satisfaction with the current product. The purpose of this is to help determine to customer's thoughts on the conversion from manual anchor handling system to automatic anchor handling system. There is Tables 2 and 3 of the survey shown below that represent averages of the customer importance and satisfactions based on a scale 1-5 with 5 being the most important.

Applying the quality function deployment method builds the QFD diagram. Customer Importance (Table 2) is qualitative while engineering characteristics are quantitative. It is desirable to have a clear relationship exist between the customer needs and the engineering characteristics. Table 3 represents customer current satisfaction.

Table 2 Customer Importance

Customer Importance	**AVG. %**
Motor Disengagement	4.9
Safety	4.7
Reliability	4.5
Low Cost	4.4
Ease of Operation	4
Low Noise	3.6
Light Weight	2.8
Small in Design	2.6

The current product satisfaction proved surprising in that four of the competitors indicated they did not have an anchor or anchor winch to compare satisfaction with. The results from this section of the survey were not tabulated since no satisfaction correlation could be made (see Table 3).

This helps to explain the results for a cost they would be willing to pay for an automatic Cajun anchor. A majority indicated a willingness to pay in between $200-$500 for a product with these features. See Appendix B for survey results.

Table 3 Current Satisfaction

Current Satisfaction	**AVG. %**
Low Cost	3.4
Motor Disengagement	3.3
Safety	3.2
Low Cost	3.2
Small in Design	3
Easy of Operation	2.9
Reliability	2.8
Light Weight	2.4

ENGINEERING DESIGN CHARACTERISTICS

The customer feedback helped to establish engineering characteristics and their importance the design. The following engineering characteristics (see Table 4) are ranked by importance. A QFD (Quality Function Deployment) was used to help give a weighted value for each. See Appendix C for complete QFD.

Table 4 Engineering Characteristics form QFD

Engineering Characteristics	
Safety	20%
Speed Controller	15%
Clear instruction - efficient setup & less than 15 steps	11%
Battery use	10%
Utilizes "off the self" components	10%
Covered electrical connections	10%
Less than 180 lb	6%
Operation time < 4 min.	5%
Corrosion resistant materials for more than one years	5%
Footprint	4%
Power switch	4%

The safety has effect on multiple customer features. The product should be well inspected on safety base to fulfill customer most important demand.

PRODUCT OBJECTIVES

Product Objectives Conversion from Manual anchor handling system to Automatic anchor handling system.

The product features was developed directly from the survey. The following is a list of product objectives. It involves methods for evaluating the objectives to guarantee that the target of the project is met.

Reliability – (18%)

1.) Reliability of the attachment measured by component life and proper design criteria specified in the following spec sheets:
 -Motor Spec Sheet
 -Speed Controller Spec Sheet
 -Battery Spec Sheet

2.) A factor of safety will be provided to show that structural components of the attachment will not fail under repeated load.

3.) All electrical connections will be soldered and then covered with heat wrap as to assure of no loose connections or bare wires.

Easy of Operation – (16%)

1.) The product will be operated by one person only.
2.) Required less than 15 steps to finish the operation.
3.) Time required to finish operation will be less than 4min.

Motor Disengagement – (15%)

1.) The attachment will include a clutch assembly to control speed.

Low Cost – (15%)

1.) The attachment will cost less than $500 to purchase.

Safety – (14%)

1.) Safety guards covering Cajun anchor and moving parts.
2.) Power switch to disconnect power to the motor when attachment is not being used.

Light weight – (8%)

1.) The total of anchor, attachment and motor will not weigh more than 180 lbs.

Low Noise – (7%)

1.) Noise level will be consistent at lowers than 75 decibels.

Small in Design – (7%)

1.) The storage will not be more than three Sq ft.
2.) The height of storage will not be more than one ft.
3.) The work envelop will not extend more than six ft.

See Appendix D for Product Objectives.

SCHEDULE AND BUDGET

There was a schedule and a budget prepared for the anchor handling system before the design and construction began and after they were completed. The proposed and actual schedules and budget are below.

BUDGET

The budget of preliminary costs is located in Appendix E. The main components and their respective costs are listed below in Table 5. The total cost for anchor handling system is projected to be $198. The labor for assembly is projected to all be done in house and have no out pocket expenses. The actual budget displays how much was actually spend on each component.

Table 5 Major Costs

Description	**Total Cost**
Battery	$100.00
Aluminum material	$40.00
Circuit breaker	$15.00
Connection wire	$10.00
Misc. serviced/parts	$33.00
Total	**$198.00**

Table 6 Budget Comparison

Component	**Forecasted Amount**	**Actual Amount**
12V D.C.Battery	$100.00	$99.95
Motors	N.A.	$81.00
Aluminum material	$40.00	$80.00
Steel plate	N.A.	$12.00
Circuit breaker	$15.00	$11.99
Gears	N.A.	$45.00
Pulley	N.A.	$6.99
Connection wire	$10.00	$12.00
Misc. Services/parts	$33.00	$38.00
Total	$198.00	$386.96

The actual budget was $188.96 over the projected budget, see Table 6. The actual budget was over then projected budget but it was below the customer’s acceptation.

SCHEDULE

The project schedule begins November 23, 2011 with the completion of a weighted objective and proof of design statement. After that key completion dates are as follows as listed in Table 6. The schedule covers twenty-eight weeks with the final assignment, which is the final report, being due on June 1, 2012. The actual schedule in Table 8 depicts the genuine dates that takes were completed on. The testing will be completed few days later than proposed due to unable to find a boat. However, this delay did not directly affect the final project completion. The final project was successfully presented at collage on May 17, 2012.

Table 7 Schedule High Lights

<table>
<tr><td>Parag Patel
Cajun anchor
TASKS</td><td>Dec 11 - 31</td><td>Jan 1 - 31</td><td>Feb 1 - 28</td><td>Mar 1 - 31</td><td>Apr 1 - 30</td></tr>
<tr><td></td><td></td><td>wk1| wk2| wk3| wk4</td><td>wk5|wk6|wk7|wk8|wk9</td><td>wk10|wk11|wk12|wk13</td><td>wk14|wk15|wk16</td></tr>
<tr><td>3D Design</td><td>31</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Part selection</td><td></td><td>2 | | |</td><td></td><td></td><td></td></tr>
<tr><td>Integrate "off the self" components</td><td></td><td>6 | | |</td><td></td><td></td><td></td></tr>
<tr><td>Raw material selection</td><td></td><td>|13 | |</td><td></td><td></td><td></td></tr>
<tr><td>Final container design</td><td></td><td></td><td>4 | | | |</td><td></td><td></td></tr>
<tr><td>Order components</td><td></td><td></td><td></td><td>6 | | |</td><td></td></tr>
<tr><td>Manufacture & Assemble device</td><td></td><td></td><td></td><td>| | |25</td><td></td></tr>
<tr><td>Testing</td><td></td><td></td><td></td><td></td><td>| |27</td></tr>
</table>

Table 8 Actual Schedule

Parag Patel Automatic anchor handling system TASKS	Mar 25 - 31	Apr 1 - 7	Apr 8 - 14	Apr 15 - 21	Apr 22 - 28	Apr 29 - May 5	May 6 - 12	May 13 - 19	May 20 - 26	May 27 - Jun 2	Jun 3 - 9
Manufacture & assemble device	25										
Testing					27				20		
Demo to Advisor							11				4
Demo to Faculty								17			
Oral Report									25		
Final Report										1	

A more complete schedule is located in Appendix F.

DESIGN ALTERNATIVES

AUTOMATIC ANCHOR HANDLING SYSTEM

The first of three design alternatives is called the automatic anchor handling system. This handling system basically works with the help of the motor. The main force required to pull anchor back from the water will be provided by the motor. There will be two linkages available to give moment in vertical direction and to give support to the wire. Wire will be used to lift the anchor. This wire will be engaged with the help of pulley.

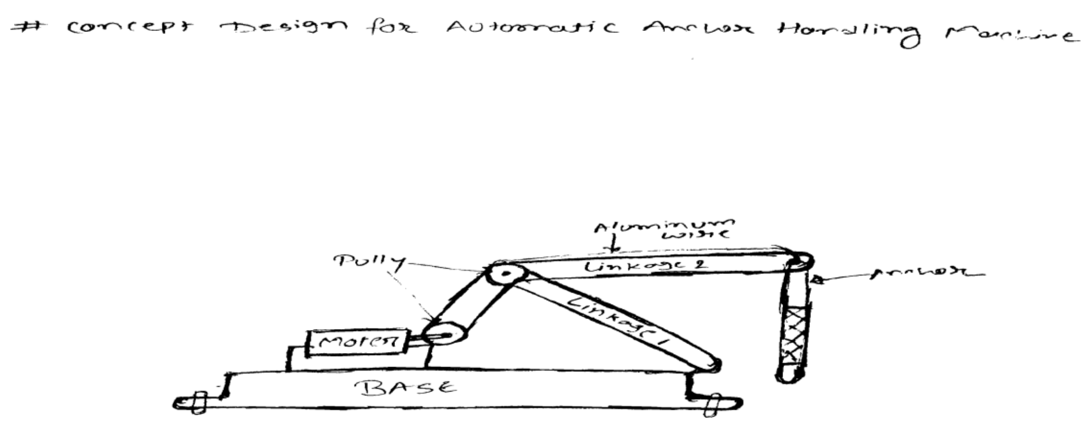


Figure 5 Automatic Anchor Handling System

Advantages

- More efficiency
- Easy of operation
- One man operation
- Low noise
- Safer

Disadvantages

- Long operation time
- Range of movement will be more
- Cost

SIMPLE ANCHOR HANDLING SYSTEM

The next two design alternatives are two configuration of the same idea. This idea combines the benefits of both simple operation and less space requirement. Simple anchor handling system will be operated with help of only one linkage and motor. In this configuration anchor will be attached to the linkage and linkage will be fixed to the base. At the end of the operation one should manually separate anchor from linkage.

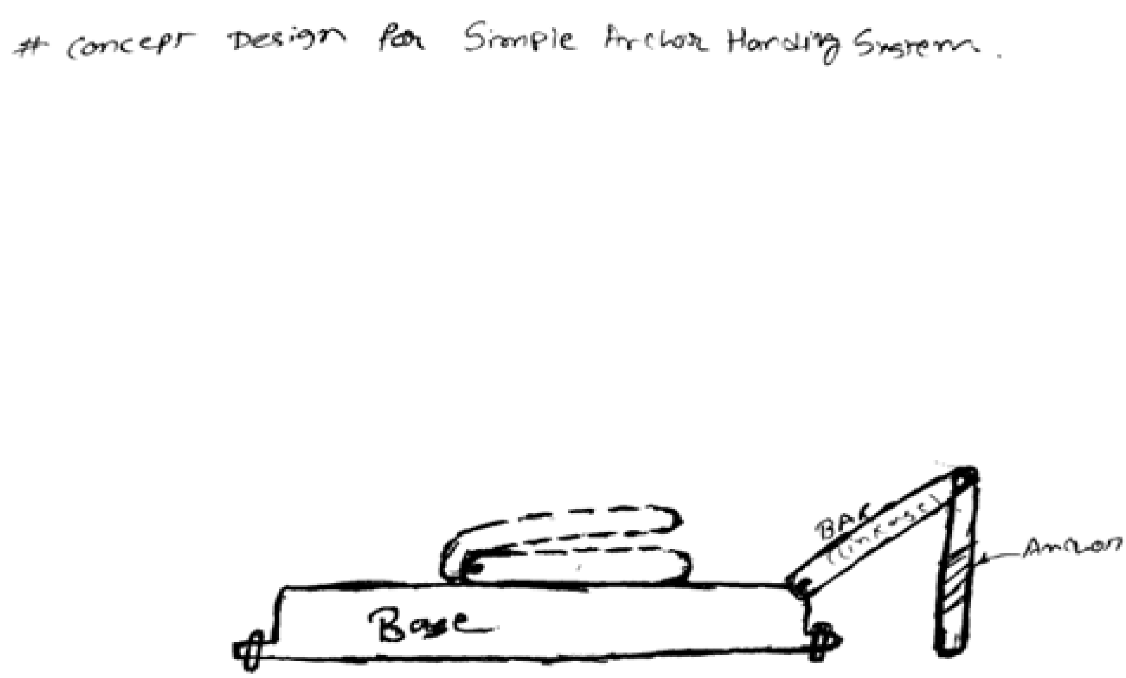


Figure 6 Simple Anchor Handling System

Advantages

- Small operation time
- Small work envelop
- Small in design

Disadvantages

- Low efficiency
- Difficult to handle anchor
- Less safer
- Possibility of damage to linkage

NOSPACE SIMPLE ANCHOR HANDLING SYSTEM

The third design alternative is called no space simple anchor handling system. This handling system doesn't need too much space to fix in the boat. With the help of two linkages, three pulleys and a wire this design will be made. First linkage will be fixed to the base and second linkage will be fixed to it perpendicularly. Wire will be directed with the help of pulleys. Anchor will be fixed at the end of third pulley.

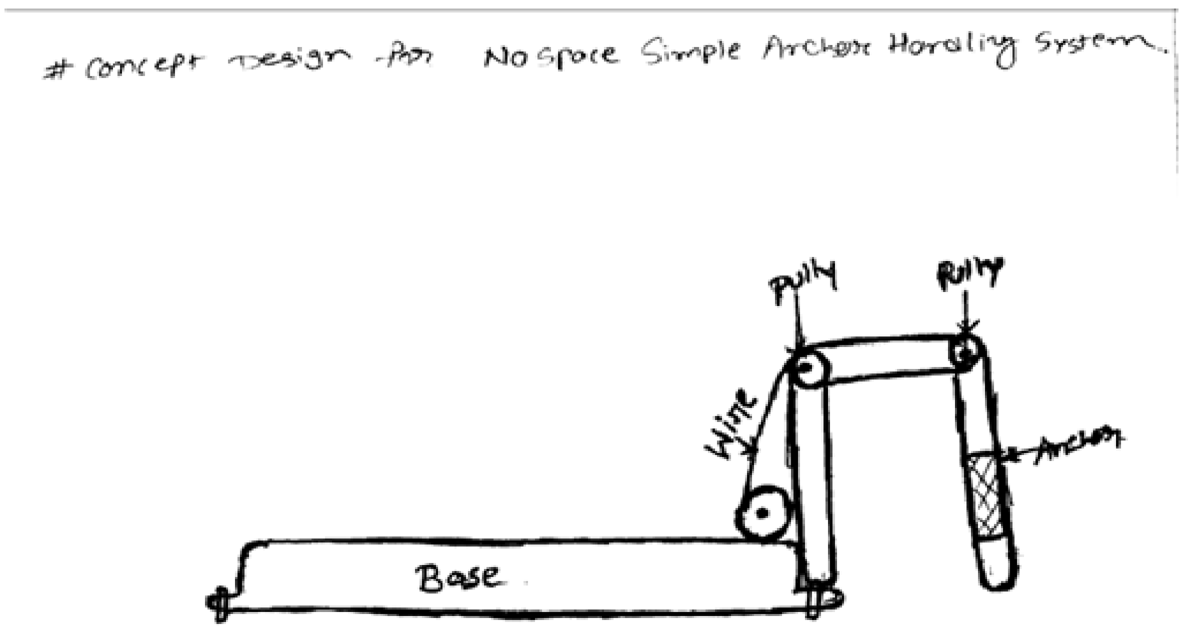


Figure 7 No space Simple Anchor Handling System

Advantages

- Low cost
- Less space require on boat
- Low cycle time

Disadvantages

- Hard to fix design on boat
- Uncomfortable for fisher
- No moving parts
- Possibility of damage to anchor

WEIGHTED DECISION MATRIX

The three design alternatives were compared using a weight decision matrix. Each alternative’s performance was directly compared to a standard anchor handling system for each weighted design criterion and rated on a scale of 0 to 4. The results shown below in Table 7 indicate the automatic anchor handling system to be the best choice.

Table 9 Weighted Decision Matrix

Design Criterion	Weight Factor	Automatic anchor handling		Simple anchor handling		No space simple anchor handling	
		Score	Rating	Score	Rating	Score	Rating
Safety	0.14	4	0.56	2	0.28	2	0.28
Reliability	0.18	3	0.54	2	0.36	2	0.36
Motor disengagement	0.15	4	0.6	4	0.6	3	0.45
Low noise	0.07	2	0.14	2	0.14	2	0.14
Easy of operation	0.16	2	0.32	2	0.32	2	0.32
Law cost	0.15	2	0.3	4	0.6	4	0.6
Light weight	0.08	2	0.16	2	0.16	2	0.16
Small in design	0.07	3	0.21	3	0.21	3	0.21
0= Inadequate, 1=week		Total Rating	2.83	Total Rating	2.67	Total Rating	2.52
2= satisfactory, 3=good							
4= Excellent							

DESIGN

BASE

The base will provide the following functions explained below. The general size of the base was dictated by the size of the linkage. This component will be manufactured with a combination of cutting operation and drill press operations.

1. It will be fully attached to the boat surface to reduce vibrations and to decrease the risk of injuries.
2. It will have ability to carry load of motor, linkages and pulleys.
3. It will have ability to attach motor and pulley on top of it.

MOTOR

The motor will be the main component for this design. The motor selection will be done on the base on force required to operate linkages and load carrying by wire. This component is going to purchase from off self-components. While the calculation will be done the size and power of the motor will be provided.

PULLEY

The total number of pulleys required will be two. This pulley will be same size. This component is going to porches from market. The wire will be passed from the pulley. The main operation of it is to give grip to the wire and make operation smoother. This wire will have a weight of anchor at the end of it. Straightening of the pulley is the most important criteria in selection of it.

LINKAGES

Linkages are aluminum bars that have the capacity of carrying loads of anchor and wire. There will be two linkages used in this design. One will be the main linkage and the other one will be supporting linkage. Supporting linkage will be connected to the base plate and the upper part of it with main linkage.

The primary function of the support linkage is outlined below.

1. Give support to the main linkage.
2. Provide movement to the main linkage.

Main linkage will be manufactured according to the need. A hole will be drilled at the end of the linkage to attach with supporting linkage. A pulley can then be attached. At the front part of it, the cut off section will be provided for passing wire from it.

BELT

The polymer compound belt will be used to connect the pulleys. To make sure the belt doesn’t slip on the pulley, the timing belt will be used. The size of the belt will be selected once the assembly of the linkages and pulleys will be done.

The final design can be seen in Appendix K.

FABRICATION

For the designing process of the Anchor handling system certain components required fabrication in order to function properly within the system. The different methods of fabrication include welding, drilling, sawing and forming.

First I worked to construct the base.

Figure 8 Wood base

The figure above displays 1” thick wood sheet which is used for mountain the device which is include of main arm, supporting arm, pulleys and gears.

Figure 9 Center punch operations

The figure above displays the use of center punch to make punch marks in the wood sheet through each of the seven, 1/4-inch diameter holes. After this, now proceed to drill the seven ¼-inch diameter holes which were center-punched in the sheet in above step.

Figure 10 Drilling operation

The figure above displays the wood sheet while drilling operation was conducted. 3-inch diameter hole was operated on the sheet with help of hole saw. This hole was used to pass the bottom part of the supporting arm.

Figure 11 Welding operations on pulley

The figure above displays the welding operation was done to the aluminum rod. Aluminum rod was attached to two round plates. At the end of this welding operation this part will known as a main pulley where the nylon rope will takes place and gears will attach to pulley.

Figure 12 Motor

The motor shown above is the component which is used to rotate pulley. A gear with 1" pitch diameter is attached to the motor. Welding on end of the gear is needed to give permanent holding with the pulley.

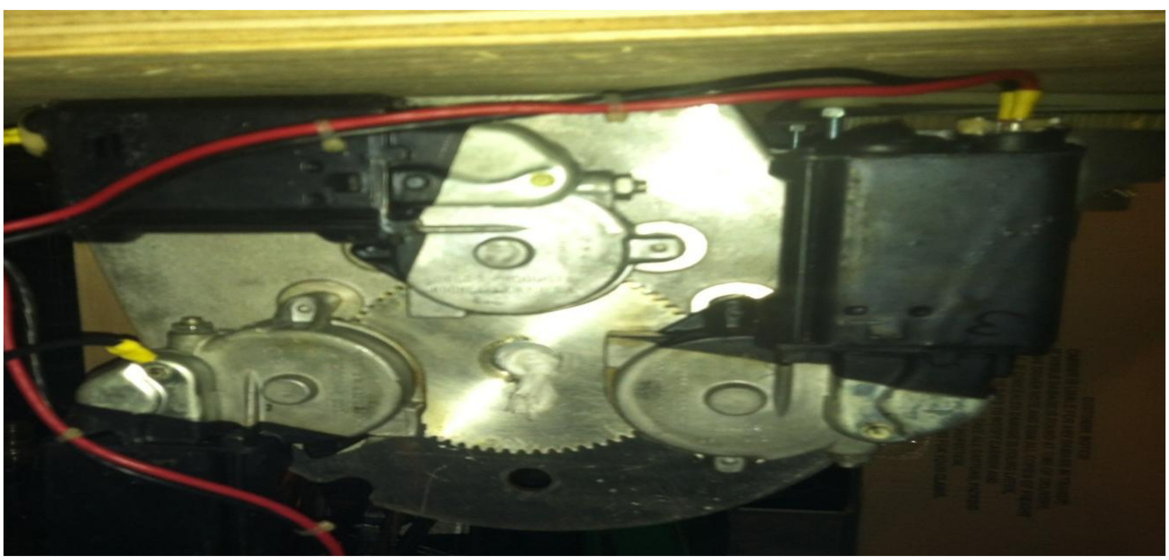


Figure 13 Motor attached to the pulley

The figure above displays the motor after the required fabrication is completed. Each of the gear was now attached to the pulley. All three 1” diameter gears are attached to the 3” pitch diameter gear.

After all fabrication work done arm assembly takes place.

Figure 14 Arm assembly

Arm assembly was contained two arms, one is main arm and the other is supporting arm. Main arm is used to lift and drop the anchor. This arm is made from aluminum. Supporting arm is basically support the main arm. There is a hole in this arm from top to the bottom. The main purpose of this hole is to run rope from it to the pulley. This arm is also made from aluminum.

Figure 15 Belt connection

Timing belt was connected to the two pulleys. The main operation of this timing belt is to transfer rotary motion from pulley to the driving rod. This driving rod helps move pulley backward and forward, which help rope to distribute equally on pulley rod.

TESTING

Unfortunately the device has not yet been tested. I was not successful to find a boat on time to do practical of my project.

The load carrying capacity of the device was tested by lifting the weight. Based on this result, I found that Anchor handling device is able to lift 30-40 lbs easily. An anchor was drop from the 15ft of height to the ground and lift back. This result shows that, device successfully accomplish its main operation.

This device addresses many of the issues successfully. With the help of this device one can easily drop an anchor and pull it back from water. This device completed all the customer’s requirements too.

CONCLUSION

The anchor handling system was designed sufficiently powerful enough for Cajun anchor. The goal of coast not more than $500.00 was exceeded and the weight of the device was 60 lbs which successfully accomplish customer's requirement.

Being able to drop an anchor and pull it back from the water by use of only one switch saves lots of manual work. By using the anchor handling system, a boater can finished the operation in very less amount of time.

This Anchor Handling System has proven to be an inexpensive and efficient method for dropping and pulling back an anchor from the water.

REFERENCES

1. **Parker, Jay.** *Boat owner.* cincinnati, Octtober 10, 2011.
2. new generation boat anchors. *petersmith.net.nz.* [Online] [Cited: October 12, 2011.] http://www.petersmith.net.nz/boat-anchors/new-gen-boat-anchors-explained.php.
3. **D.H.PASCOE & Co., Inc.** boat battery basics. *yachtsurvey.com.* [Online] [Cited: September 12, 2011.] http://www.yachtsurvey.com/boat_battery_basics.htm.
4. Anchor line. *iboats.com.* [Online] [Cited: September 12, 2011.] http://www.iboats.com/Anchor-Lines/dm/cart_id.818530136--session_id.737675655--view_id.217391.
5.*http://www.onlinemetals.com/merchant.cfm?pid=1072&step=4&showunits=inches&id=298&top_cat=60.* [Online]
6. *http://asm.matweb.com/search/SpecificMaterial.asp?bassnum=MA6061t6.* [Online]

APPENDIX A – RESEARCH

Interview with customer, Oct 10, 2011
Jay Parker, boat owner, 1029 Asbury Road, Cincinnati, OH, 45255
Phone # (513)505-2741
•Has enough space to store his Cajun anchor and motor in side of boat.
•It is difficult to carry Cajun anchor because of more weight and bigger size.
•Anchor hurts hands when trying to lift and throw.
•It won’t be easy to pull anchor back from water.
•Plan to get product which can automatically lift and drop of anchor in water.
•Plan to setup the device at the rear end of the boat.
•Hopefully not use to much heavy material to keep weight low and keep it easy to operate.

<table>
<tr>
<td>
http://www.iboats.com/Minn-Kota-DeckHand-Dh-40-Electric-Anchor-System/dm/cart_id.818530136--session_id.630063087--view_id.38839
10/10/2011 Electric Anchor Winch iboats.com

DeckHand Dh-40 Electric Anchor Winch - Minn Kota

20- to 40-pound anchor capacity (anchor not included).
Pre-spooled with 100 feet of 800-lb test rope.
Universal davit can be mounted at base of DeckHand™ or in remote position on boat deck; stows anchor horizontally to eliminate anchor swing.
Anchor shackle allows for easy changeover from anchor to anchor.
Stow and deploy switch integrated into the base of the unit.
Corded remote stow and deploy switch (sold separately) allows operation of DH-40 from anywhere on the boat.
Compatible with MKA-16-02 quick release bracket – ideal for easy removal for boat cover clearance or clearing the deck during non-use (requires holes to be drilled in top plate of quick release bracket).
12-volt battery operation.

</td>
<td>
Easy to fit at rear end of the boat.
More weight carrying capacity.
Tolerable cost $237.00
Automatically raise or lower your anchor at the touch of a button.
One person operation
Remote operation
</td>
</tr>
</table>

 It is not often that something totally new and different is developed for the fishing industry. Cajun anchor is shaped like a spear. When you need very little scope, which means you can anchor right on the drop and don’t have to drift back 15 to 20 feet to set the anchor. •3’- Kayaks/canoes •4’- Canoe to 15’ •5’- 15’ to 20’ •6’- 20’ to 25’	Easy to handle the anchor. Easy to clean the anchor. Less weight. No maintenance cost. Low product cost. Simple to operate Safe to use and store

http://www.overtons.com/modperl/product/details.cgi?i=99723&pdesc=TRAC_Big_Water_45_Saltwater_Winch&aID=602A1&merchID=4006 10/10/2011 overtons.com  TRAC® Big Water 45 Saltwater Winch Item # 99723 •When the switch control of this winch is pressed down, the anchor is released to free-fall to the bottom. •After the boat drifts and enough anchor line is let out, pressing the switch "up" locks the winch spool. •Push-button switch comes pre-installed on winch housing with lighter wires for simpler and safer operation. •Includes 100' braided anchor rope, anchor chain, automatic resetting circuit breaker, and assembly hardware. •Winch measures 10" x 8-1/2" x 6-1/2". Anchor not included.	When the switch control of this winch is pressed down, the anchor is released to free-fall to the bottom. 316 stainless steel hardware 3-step corrosion protection Includes 100' braided rope This winch cost $299.99

http://www.iboats.com/Grappling-Anchor/dm/cart_id.547085070--session_id.943195334--view_id.56674
10/28/2011 Grappling Anchor
Iboat.com

Grappling Anchor

- More holding power per pound.
- The Grappling Anchor is great for all small boats including dinghies, inflatable, canoes and PWC.
- The ability to quickly fold and unfold in seconds and stow in a very small compartment makes the Grappling Anchor a good choice.
- Galvanized iron.

Weight	5lb
Price	$15.96

Low Cost, $15.96
Manufactured from Aluminum
Light weight
Easy to operate
Manual handling

APPENDIX B – SURVEY RESULTS

Cajun Anchor
CUSTOMER SURVEY

The purpose of this survey is to help determine to customers' thoughts on the conversion from manual handling to automatic handling for Cajun anchor. This survey is done to determine what product features should be significant to get the higher results for functionality of the device.

How important is each feature to you for the design of a new Cajun anchor handling device?
Please circle the appropriate answer. 1 = low importance 5 = high importance

							AVG
Safety	1	2(1)	3	4(3)	5(16)	N/A	4.7
Reliability	1	2	3(1)	4(8)	5(11)	N/A	4.5
Motor disengagement	1	2	3	4(3)	5(17)	N/A	4.9
Low Noise	1(2)	2(1)	3(5)	4(7)	5(5)	N/A	3.6
Ease of operation	1(1)	2	3(4)	4(9)	5(6)	N/A	4.0
Low Cost	1	2	3(3)	4(7)	5(10)	N/A	4.4
Light weight	1(1)	2(7)	3(9)	4(2)	5(1)	N/A	2.8
Small in design	1(7)	2(1)	3(6)	4(2)	5(3)	N/A(1)	2.6

How satisfied are you with the current manual Cajun anchor?
Please circle the appropriate answer. 1 = very <u>UN</u>satisfied 5 = very satisfied

							AVG
Safety	1(5)	2(1)	3(2)	4(9)	5(3)	N/A	3.2
Reliability	1(4)	2(4)	3(7)	4(2)	5(3)	N/A	2.8
Motor disengagement	1(3)	2(2)	3(5)	4(6)	5(4)	N/A	3.3
Low Noise	1(2)	2(2)	3(6)	4(6)	5(4)	N/A	3.4
Ease of operation	1(5)	2	3(9)	4(5)	5(1)	N/A	2.9
Low Cost	1(3)	2	3(7)	4(2)	5(6)	N/A(2)	3.2
Light weight	1(6)	2(5)	3(6)	4(2)	5(1)	N/A	2.4
Small in design	1(3)	2(3)	3(6)	4(3)	5(3)	N/A(2)	3.0

How much would you be willing to pay for this product?

\$200-\$500(12)	\$500-\$1000(6)	\$1000-\$1500(2)	\$1500-\$2000(0)
60%	30%	10%	0%

Thank you for your time.

APPENDIX C – QUALITY FUNCTION DEPLOYMENT

Parag Patel Cajun Anchor 9 = Strong 3 = Moderate 1 = Weak	Covered electrical connections	Operation time < 4min.	Footprint	Material	Utilizes "off the shelf" components	Safety Factor	Speed controller	Battery use	Power switch	Less than 180lbs	Clear instruction - efficient set-up and operation, less than 15 steps	Customer importance	Designer's Multiplier	Current Satisfaction	Planned Satisfaction	Improvement ratio	Modified Importance	Relative weight	Relative weight %
Safety	9			1	1	9	3	3	3	3	9	4.7	1.2	3.2	5	1.6	8.8	0.14	14%
Reliability	9					9	9	3			1	4.5	1.5	2.8	5	1.8	12.1	0.18	18%
Motor disengagement	1	1	3		1	9	9	3	1		3	4.9	1.3	3.3	5	1.5	9.7	0.15	15%
Low noise				1	3	3	3	9				3.6	1.1	3.4	4	1.2	4.7	0.07	7%
Easy of operation		9			9	9	3	1	3		9	4	1.5	2.9	5	1.7	10.3	0.16	16%
Low cost	1		1	3	9		3	3	1	3		4.4	1.4	3.2	5	1.6	9.6	0.15	15%
Light wieght			1	9		3		3	1	9		2.8	1.5	2.4	3	1.3	5.3	0.08	8%
Small in design			9	1		1	1	1	1	3	3	2.6	1.1	3	5	1.7	4.8	0.07	7%
Abs. importance	3.18	1.58	1.33	1.45	3.26	6.17	4.61	2.97	1.33	1.79	3.49	31.2					65.2	1.0	
Rel. importance	0.10	0.05	0.04	0.05	0.10	0.20	0.15	0.10	0.04	0.06	0.11	1.00							

APPENDIX D WEIGHTED PRODUCT OBJECTIVES

Product Objectives

Automatic handling for Cajun anchor

The following is a list of product objectives and how they will be obtained or measured to ensure that the goal of the project was met. The product objectives will focus on an automatic handling for Cajun anchor.

Reliability – (18%)

1.) Reliability of the attachment measured by component life and proper design criteria specified in the following spec sheets:
  - -Motor Spec Sheet
  - -Speed Controller Spec Sheet
  - -Battery Spec Sheet

2.) A factor of safety will be provided to show that structural components of the attachment will not fail under repeated load.

3.) All electrical connections will be soldered and then covered with heat wrap as to assure of no loose connections or bare wires.

Easy of Operation – (16%)

4.) The product will be operated by one person only.
5.) Required less than 15 steps to finish the operation.
6.) Time required to finish operation will be less than 4min.

Motor Disengagement – (15%)

2.) The attachment will include a clutch assembly to control speed.

Low Cost – (15%)

2.) The attachment will cost less than $500 to purchase.

Safety – (14%)

3.) Safety guards covering Cajun anchor and moving parts.
4.) Power switch to disconnect power to the motor when attachment is not being used.

Light weight – (8%)

2.) The total of anchor, attachment and motor will not weigh more than 180 lbs.

Low Noise – (7%)

2.) Noise level will be consistent at lowers than 25 decibels.

Small in Design – (7%)

4.) The storage will not be more than three Sq ft.
5.) The height of storage will not be more than one ft.
6.) The work envelop will not extend more than six ft.

APPENDIX E – BUDGET

PRELIMINARY BUDGETS

Component	Forecasted Amount	Actual Amount
12V D.C.Battery	$100.00	$99.95
Motors	N.A.	$81.00
Aluminum material	$40.00	$80.00
Steel plate	N.A.	$12.00
Circuit breaker	$15.00	$11.99
Gears	N.A.	$45.00
Pulley	N.A.	$6.99
Connection wire	$10.00	$12.00
Misc. Services/parts	$33.00	$38.00
Total	$198.00	$386.96

APPENDIX F – PROJECT SCHEDULE

Parag Patel
Cajun anchor

TASKS	Nov 20-26	Nov 27 - Dec 3	Dec 4 - 10	Dec 11 - 17	Dec 18 - 24	Dec 25 - 31	Jan 1 - 7	Jan 8 - 14	Jan 15 - 21	Jan 22 - 28	Jan 29 - Feb 4	Feb 5 - 11	Feb 12 - 18	Feb 19 - 25	Feb 26 - Mar 3	Mar 4 - 10	Mar 11 - 17	Mar 18 - 24	Mar 25 - 31	Apr 1 - 7	Apr 8 - 14	Apr 15 - 21	Apr 22 - 28	Apr 29 - May 5	May 6 - 12	May 13 - 19	May 20 - 26	May 27 - Jun 2	Jun 3 - 9
Proof of Design to advisor	23																												
Concept sketches to advisor	23																												
Choose best concept		2																											
Four bar linkage design				14																									
Preliminary Container Design(1-5)																													
1) Preliminary drawing for Manufacture container housing				16																									
2) Component/parts selection							2																						
3) Integrate "off the shelf" components into preliminary design							6																						
4) Raw materials selesction								13																					
5) Design user interface										27																			
Design Freeze											30																		
Final Container Design											4																		
Oral Report															2														
Order Components																6													
Winter Report																9													
Manufacture & assemble device																			25										
Testing																							27						
Demo to Advisor																									11				
Demo to Faculty																										18			
Oral Report																											25		
Final Report																												1	

APPENDIX G- CALCULATION

WIRE & LINKAGE CALCULATION

$T = m \times g$

T= Tension in wire
m= Mass of the anchor
g= Gravitational force

= 4.535×9.81

= 44.48 N

$T/A = 90 \times 10^6$

A= Area of wire

A= T/ (90×10^6)

= $\frac{44.48}{90} \times 10^{-6}$

A= 4.94×10^{-7}

$A = \pi r^2$

$r = radius$

$r = \sqrt{(\frac{44.48}{90\pi})} \times 10^{-6}$

= $\sqrt{1.573 \times 10^{-7}}$

$r = 3.96 \times 10^{-4}$

$d = 2r$

= 2× 3.96×10^{-4}

= 7.93×10^{-4}

= 0.7932 mm

According to American wire gauge, the diameter d is related to the gauge number n by

$d = 0.127 \times 92^{[\frac{36-n}{39}]}$

The number of gauge for the required wire = 22 gauge.

$\tau = rFsin\theta$

$\tau = Tourq$
r= length of linkage1
F= force acting on linkage
$\theta = angle\ between\ linkage\ and\ anchor$

$\tau = 0.3048 \times 9.81 \times 4.53 \times sin90$

$\tau = 12.10\ N.m$

$\tau = rFsin\theta$

$\tau = Tourq\ on\ pulley$

$\tau = 0.3048 \times 9.81 \times 4.53 \times sin45$

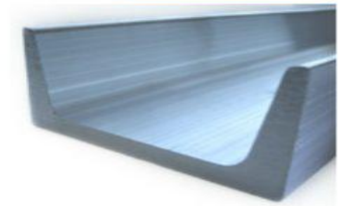
$\tau = 11.52\ N.m$

APPENDIX H: PURCHASED COMPONENTS

Home >ALUMINUM CHANNEL >6061-T6 STRUCTURAL (AM STD) CHANNEL

PRINT THIS PAGE

Extruded American Standard Aluminum Bare Channel 6061 T6



Instructions for "standard-size" pieces.
Click on the arrow in the drop down box below to view available "standard-cut" sizes. If you see the size you want, click on it to select it then enter the quantity you wish to order in the "Add" Box. Select Size:

- Random Length (10"-12") - $16.15
- One Ft. (12") Length - $17.94
- Two Ft. (24") Length - $34.45
- Three Ft. (36") Length - $48.45
- Four Ft. (48") Length - $57.42
- Five Ft. (60") Length - $68.18
- Six Ft. (72") Length - $79.67
- Seven Ft. (84") Length - $90.43
- Eight Ft. (96" Length) - $100.48

Add 1 To My Shopping Basket.
Click the Add button to add "standard-cut" items to shopping basket. You will still have an opportunity to change or cancel your order.

- OR -

Custom Cuts
All cuts are guaranteed to be +.125" -0" (+1/8" -0")

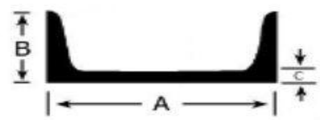
Length - Inch: 1

Pieces: 1

Your Price / Piece: $ 1.98

Add Custom Cut

Please note that custom cuts of less than 1 inch will be priced at the 1 full inch price.



Weight/lineal foot: 2.894 pounds

MTR's are available on this item

Dimensions	
Dim. Name	**Value**
Base	6"
Legs	0.2"
Wall	1.92"
Additional Information	
Inner Corner Radius	0.3
Leg Corner Radius	0.12
Slope	1:6
Technical Information	

This material meets the following specs:
AMS-QQA 200/8

(5)

Steel Pulley

Steel Pulley

Share

Like | Sign Up to see what your friends like.

Standard:	ISO, GB
Productivity:	500T/month
Payment Terms:	L/C
Trademark:	Sinma
Deformation Temperature:	Warm Forging
Molding Style:	Forging

Contact Now

Add to Basket | Add to Product Favorites

Product Description

Cast Steel Pulley Specifications:
1) Diameter: 180mm to 3, 100mm
2) Manufacture: Casting, forging or hot-press
3) Produce according to customers' drawings

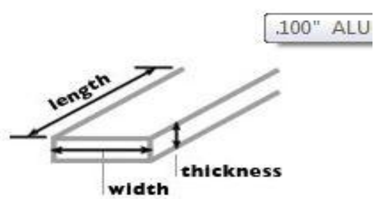
Aluminum Bare Sheet 6061 T6

Instructions for "standard-cut" sizes.
Click on the arrow in the drop down box below to view the available "standard-cut" sizes. If you see the size you want, click on it to select it, then enter the quantity you wish to order in the "Add" Box.
Shipping is calculated automatically based on the items in your basket.

Select Size:
- 12 inches x 12 inches - $11.66
- 12 inches x 24 inches - $22.52
- 12 inches x 36 inches - $28.96
- 12 inches x 48 inches - $36.20
- 24 inches x 24 inches - $36.20
- 24 inches x 36 inches - $53.09
- 24 inches x 48 inches - $69.18
- 36 inches x 36 inches - $77.82
- 36 inches x 48 inches - $98.94

Add 1 To My Shopping Basket.
Click the Add button to add "standard-cut" items to your shopping basket. You will still have an opportunity to change or cancel your order.

- OR -



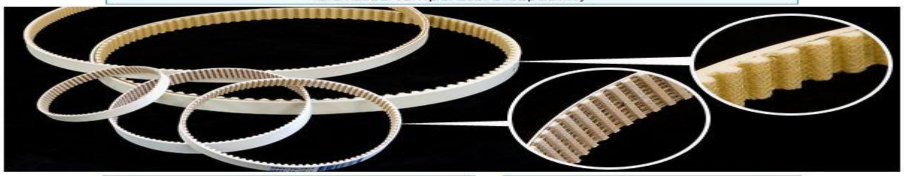
Weight/square foot: 1.4112 pounds

MTR's are available on this item

Dimensions	
Dimension Name	Value
Thickness	0.1"

Tolerances		
Dim. Name	Plus	Minus
Thickness	0.006"	0.006"

Description
.200" (XL) Pitch, 25 Teeth, 1/4" wide Low Dust TruMotion Timng Belt with elevated temperature capability



Product Details	
Part Number	A26R 3-025025
Unit	Inch
Belt Type	Single Sided
Pitch	.200" (XL)
No. Of Grooves	25
Belt Width	1/4"
Material	Polymer Compound
Tension Member	Fiberglass
Pitch Length	5"

Price Information	
Quantity	Price
1 to 24	$4.92
25 to 99	$3.19
100 and up	$2.42
Availability	Out of Stock
Sell Unit	Each
Quantity	

ADD TO CART

ADD TO RFQ

CAD Models / Catalog Pages	
Specs from printed catalog	PDF
PTC PartsLink	3D CAD Models

For Breaks Not Shown & Out Of Stock Items

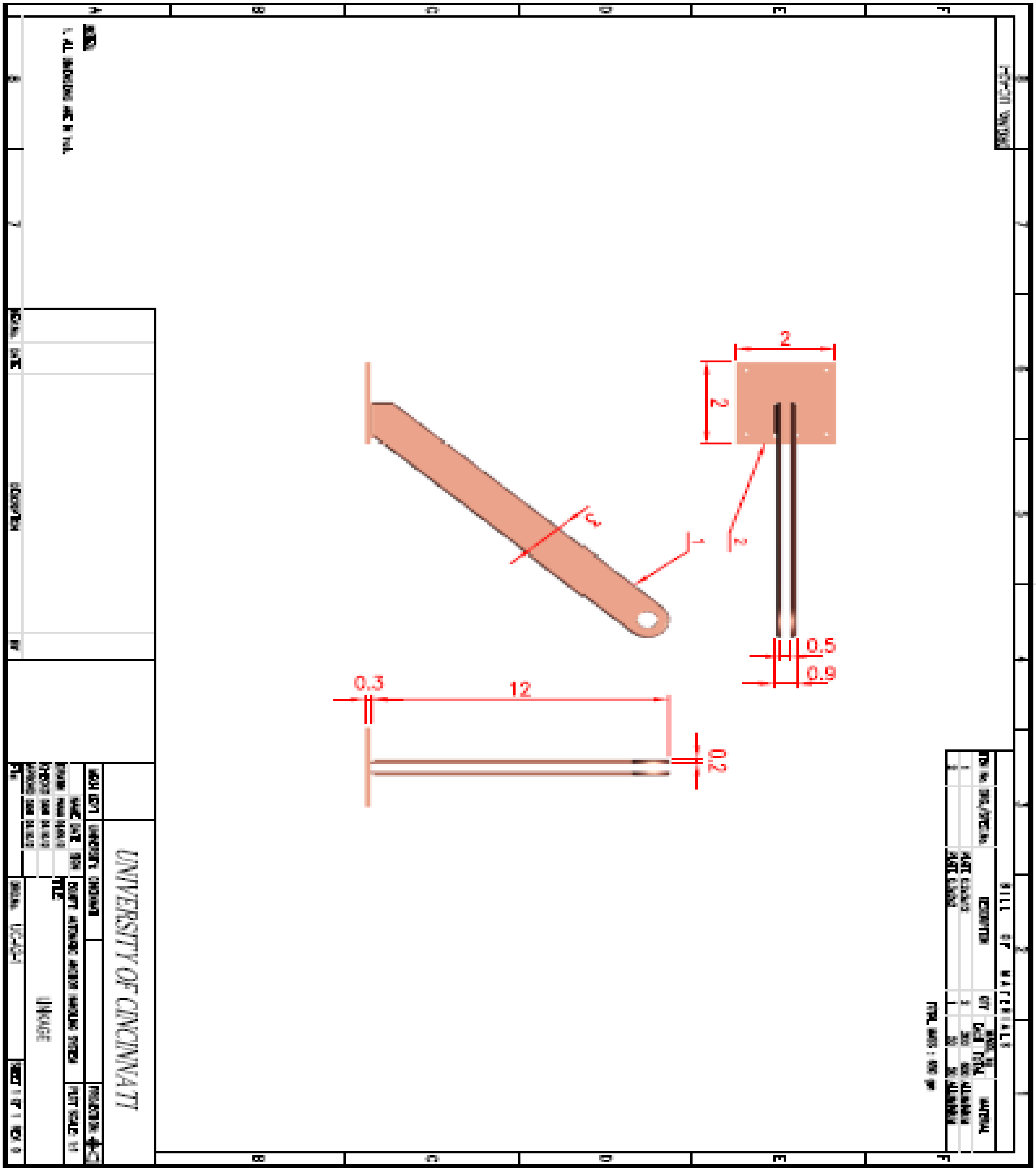
Please call or email our sales department for delivery schedule and higher price breaks.

Phone: (800) 819-8900X491 Fax: (516) 326-8827 Email: support@sdp-si.com

APPENDIX I: BILL OF MATERIALS

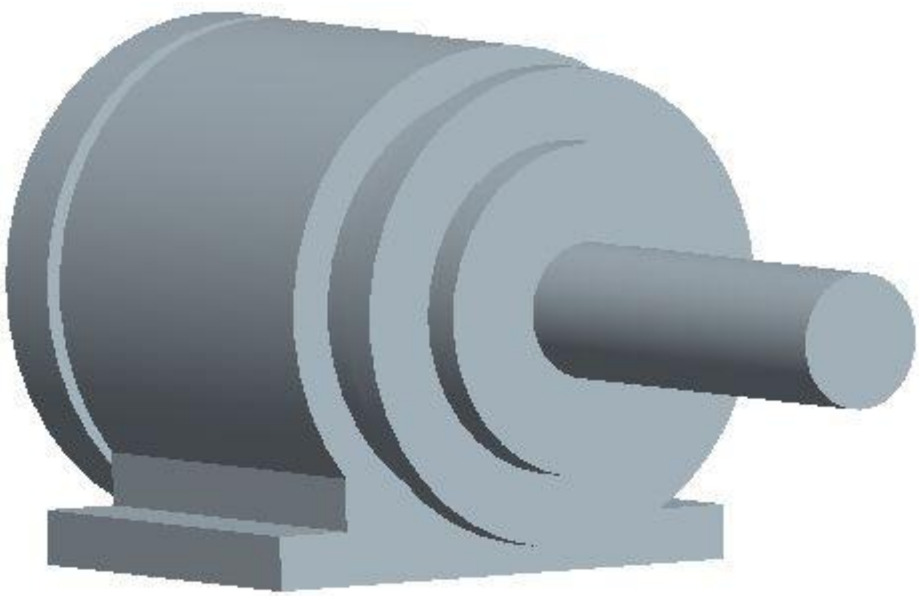
Qty.	Part Name	Vender	Material	Remarks
1	Motor	Northern tool	Steel	Buy
1	Motor Base		Aluminum	Make
1	Base Plate	Online Metals	Aluminum	Buy
2	Linkage	Online Metals	Aluminum	Make
1	Belt	Advance auto parts	Polymer	Buy
2	Pulley	globalxfunds	Steel	Buy
75ft	Nylon rope	Home depot	Nylon	Buy
30	Socket Head Cap Screw	Home depot	Steel	Buy
1	12v D.C. Battery	Battery Pulse	----------	Buy
1	Pulley	Online Metals	Steel	Make
1Pk	Quick disconnector	Auto zone	-----------	Buy
1	3” pitch diameter gear	ebay	Steel	Buy
3	1” pitch diameter gears	ebay	steel	Buy

APPENDIX J: DETAIL DRAWING

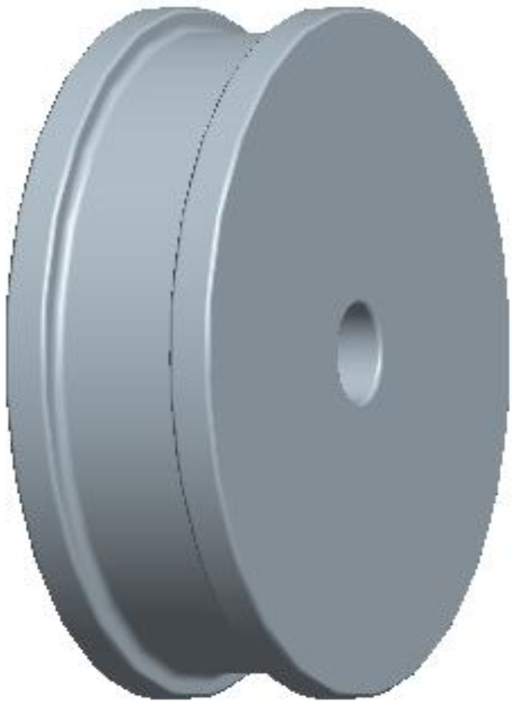


APPENDIX K: DESIGN OF PARTS

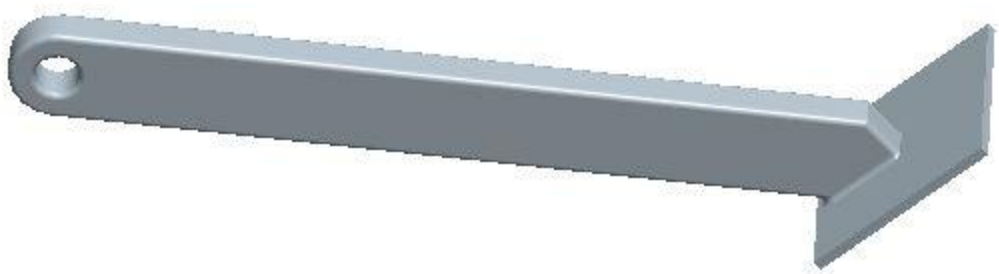
Base



Motor



Pulley



Supporting linkage

Main linkage

Belt

APPENDIX L: 3D MODEL