Team Two

Project Proposal and Feasibility Study

Engineering 339

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Abstract

The goal of our project is to design and build a device to capture Common Merganser ducks for medical treatment of a parasite that causes ‘swimmer’s itch.’ The preliminary design consists of four poles that are set up in the lake. A net is connected to each pole creating an enclosed area. This net is initially underwater, but after using a wireless solenoid to trigger a mechanical pulley device, the net rises vertically and traps the ducks.

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1. Introduction

The Common Merganser duck serves as a host for the parasite that causes schistosome cercarial dermatitis, also known as 'swimmer's itch.' It has been proven by SICon, L.L.C that treating the ducks with medicine that kills the parasites will help control 'swimmer's itch' in northern Michigan lakes. Currently, the state of Michigan is treating the problem of 'swimmer's itch' primarily by depositing chemicals into the lakes. The long-term effects of controlling the problem in this way are unknown.

2. Problem Definition

The purpose of our senior design project is to design and construct a device to trap Common Merganser ducks for medical treatment and research of 'swimmer's itch'. Once the ducks are treated, they will be released back into the environment unharmed. This proves to be an effective way of controlling 'swimmer's itch' because it targets the parasite which is the primary cause of the skin reaction. This project is in conjunction with SICon, L.L.C., which is focused on the control, education, and research of 'swimmer's itch'. This company is owned by Harvey Blankespoor, a former biology professor of Hope College, and Ron Reimenk, a Hudsonville High School teacher.

3. Project Objectives

3.1. Course Requirements

- The team shall work efficiently together
- One focus of the project shall be to learn about engineering project design and production in a real world scenario
- One focus of the project shall be to learn about the practice of engineering from a Christian perspective
- The team shall complete all course requirements according to a team schedule, as well as the course schedule

3.2. Physical Requirements

3.2.1. Weight

- The weight shall be minimal in order to ensure portability of the trap
- The duck trap shall be heavy enough to ensure stability

3.2.2. Size

- The size shall be as small as possible in order to ensure portability of the trap
- The trap shall be no larger than 25 feet by 25 feet in order to assure the ducks will not be able to begin flight

3.2.3. Material

- All materials shall be durable in order for the trap to withstand usage in the lakes
- All materials shall be waterproof
- All electrical devices shall be wireless

3.2.4. Setup

- The entire duck trap shall be setup by a maximum of two people
- The setup time shall be no more than 15 minutes
- Once the trap is released, the trap shall be able to reset with minimal work and time
- The trap will be set up in two feet of water maximum with a sandy lake bottom

3.2.5. Performance

- The trap shall trap the ducks that dive
- The trap shall not harm the ducks
- The trap shall be activated by a remote trigger
- The duck trap shall be adjustable for multiple environments and situations

4. Alternative Solutions

The first alternative is to anchor four poles in the sand around the dock as seen in figure one.

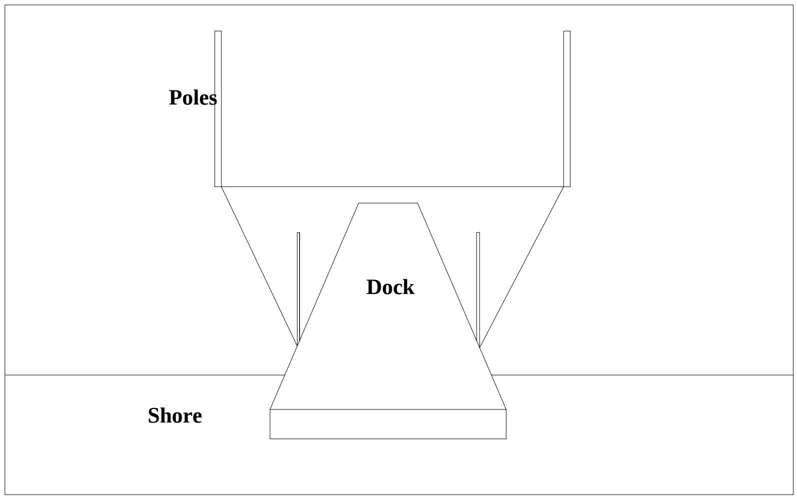


Figure One: Alternative One – Dock and Trap Layout

The net is attached to the poles and rests unseen under the water. Lead weights are attached to the bottom of the net in order to keep it at the bottom of the lake. When the ducks are positioned within the trap, a remote control device triggers the net to rise vertically and traps the ducks in a confined area. The net slides up and down along each pole with a device consisting of wheels that roll vertically inside the pole. A diagram of this device can be seen in figure two.

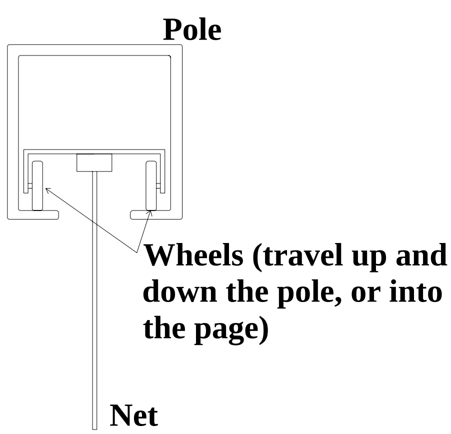


Figure Two: Alternative One – Wheel Device Top View

Design alternative two is similar to alternative one, with four poles placed around the dock. However, the poles are in a wider area, as seen in figure three.

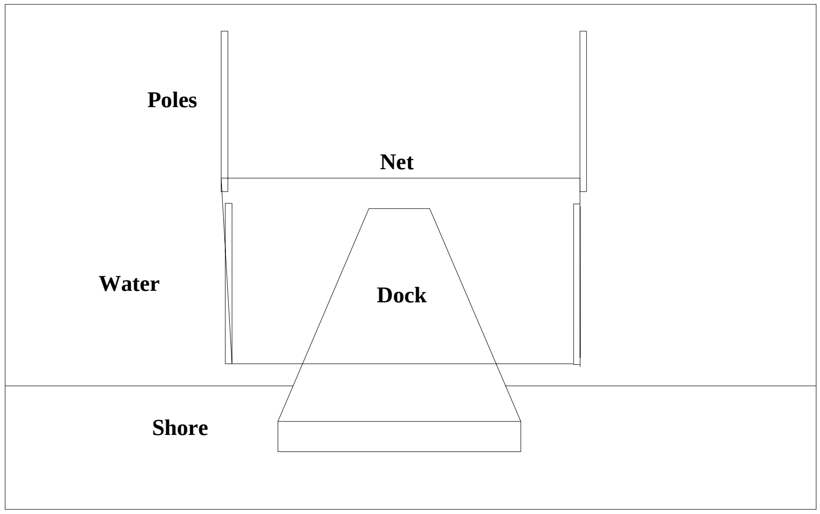


Figure Three: Alternative Two – Dock and Trap Layout

The basic function of alternative two is the same as alternative one, except that it is more versatile because it can be used in multiple locations in the lake. This is beneficial because the ducks learn the locations of the traps.

Alternative three consists of a box resting at the bottom of the lake. It contains four retractable arms or linkages that are attached to a net. The net is outside of the box. When the trap is triggered, the arms shoot out of the box at an angle via the corners. When the box is in the final position, the nets and poles will trap the ducks in a confined area.

Alternative four is a box that is floated and position in the water. The weight required for the box to sink is achieved when the box fills with water. When the box is in position at the bottom of the lake, four retractable poles, as seen in figure four, extend the poles into position.

The net is attached to each pole. When the ducks are positioned inside the nets, a remote control device triggers the net to rise and trap the ducks. The arms will have the ability to move in and out and up and down, in order to make adjustments to the area or environment in which the ducks are trapped.

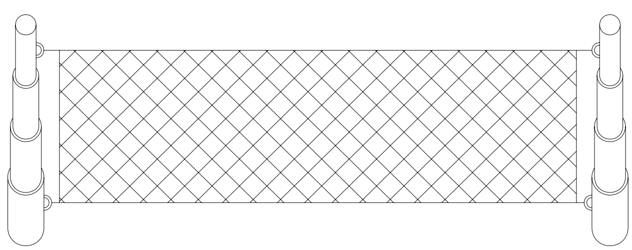


Figure Four: Alternative Four – Retractable Poles with Net

Design alternative five consists of four retractable poles positioned in a square near the dock similar to figure three. The poles will be anchored to the bottom of the lake. A square net is attached to each pole and is positioned on the bottom of the lake with a few lead weights in the center of the net. Prior to the trap being triggered, the net is unseen under the water of the lake. When the ducks are within the trap area, the poles are triggered and move upward, similar to figure four.

The final design alternative consists of a box that rests on the dock and holds a spring-loaded net. At the push of the button, the net springs out similar to a ‘jack-in-the-box’, encompassing the dock. The net will sink to the bottom in order to prevent the ducks from escaping.

One alternative to aid in triggering the trap is using air pumps. When the trap is triggered, the air pumps release enough pressure to push the poles up. However, when reviewing this alternative more closely, we felt it would introduce possibilities for failure. For example, if water leaked into the air pump apparatus, the operators would have to let the air pump apparatus dry completely before being able to reuse the trap.

Another alternative to aid in triggering the tap includes wireless solenoids. When used in conjunction with a mechanical device, they would produce enough force to aid in pulling the nets out of the water.

5. Preliminary Design

Our preliminary design is a combination of many of the design alternatives. As shown in figure five, it consists of four poles secured into the bottom of the lake with augers.

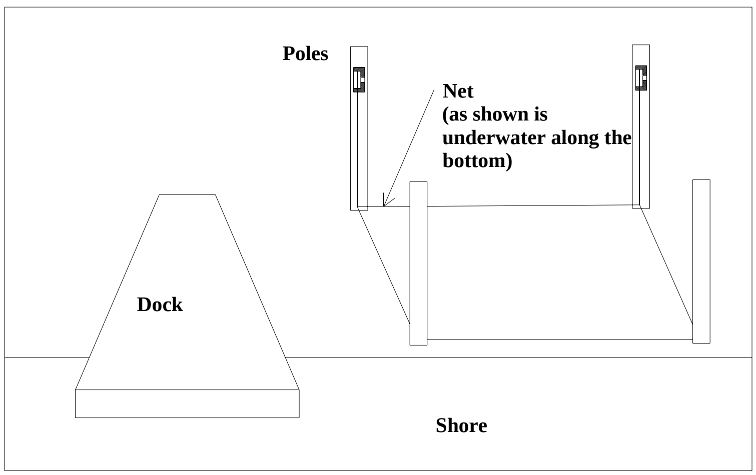


Figure Five: Initial Setup of Preliminary Design

Each pole has its own mechanical device consisting of two pulleys and a spring to raise the net vertically out of the water. The bottom of the net is attached to a lead-lined cable which is used to sink the net to the bottom of the lake. Each pole has a cable connected to the corners of the nets. This cable is connected to a three inch diameter pulley located in the top of the pole. The three inch pulley is fixed to a one inch pulley. A second cable is fixed to this pulley and to a tension spring inside the pole. When the net is underwater, the spring is fully extended and the cable is wound around the one inch pulley. A wireless transmitter will be used to trigger a solenoid, which is used to release the spring and allow it to compress. Compressing the spring will wind up the cable attached to the net and pull the net up out of the water. The force to pull the net up out of the water is approximately 50 pounds-force. By using a spring that stretches an additional 24 inches from its original length, the pulleys will revolve nine times and the net will travel up seven feet. Once the net has traveled seven feet it will lock into place to prevent it from sagging in the middle as the spring relaxes or from being pulled down by the ducks. This mechanism is shown in figure six.

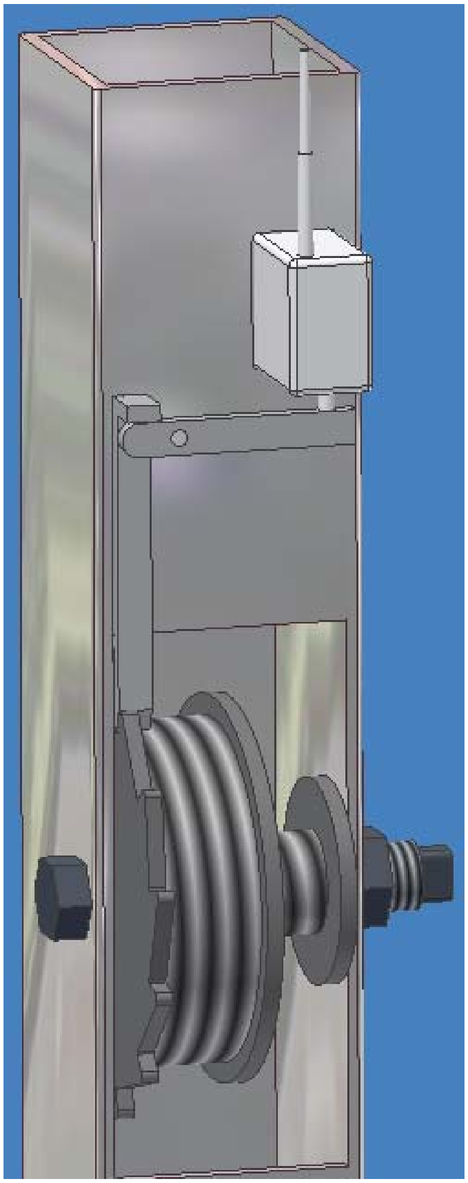


Figure Six: Preliminary Design – Top of Pole

The trigger and locking mechanisms will be controlled by a tooth gear and locking pin on the larger pulley. The locking pin will only permit the pulley to rotate in the direction of lowering the net into the water when it is in place. This allows the user to easily set the trap by pulling the net down without worrying about it springing up in the process. Figure seven shows the trap after being triggered.

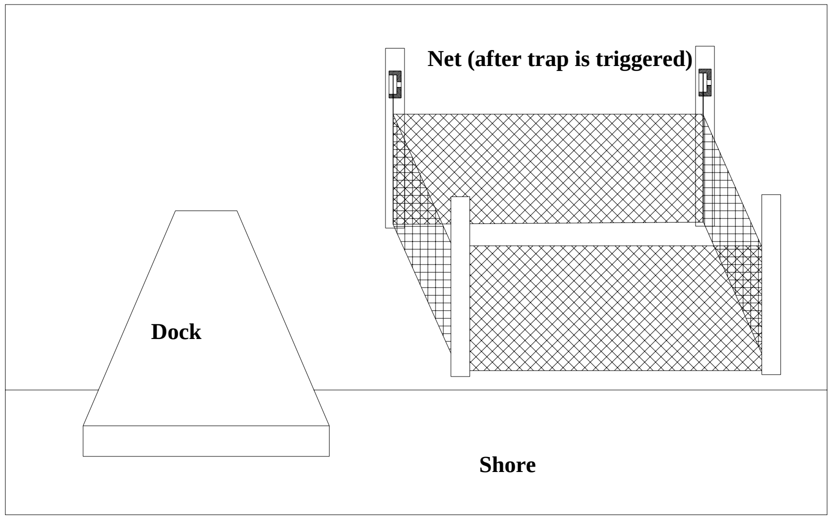


Figure Seven: Final Setup of Preliminary Design

To trigger the trap, a wireless transmitter will send a signal to a four-channel receiver, which will in turn send a signal to four solenoids on each of the poles. The solenoids will extend out, pushing down on a lever arm which will pull the locking pin out of the gear and allow the larger pulley to spin freely. The lever arm is used to convert the small force from the solenoid into a large enough force to overcome the friction on the locking pin. Figure eight shows the electrical block diagram.

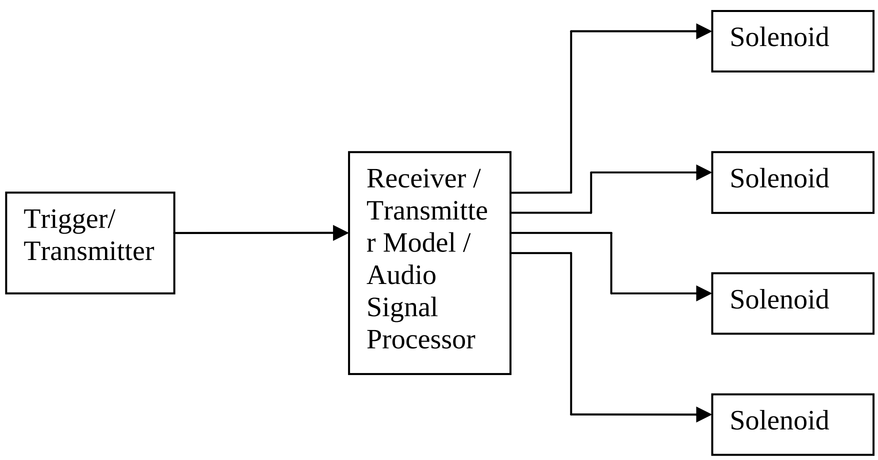


Figure Eight: Electrical Block Diagram

The trigger serves as a signal transmitter. It sends out a digital signal to the receiver which has a multi-channel output. The receiver sends out a wireless signal to each solenoid simultaneously and triggers the solenoid.

6. Feasibility Study

After meeting with our contacts from SICon, L.L.C., we discovered their ideas for designs are similar to our own ideas. Their ideas were helpful; however modifications needed be made in order to produce an efficient design to trap Common Merganser ducks. Modifications that needed be made to the design include more versatility, less error, and remote activation. After analyzing our preliminary designs, we found that our greatest obstacle in this project will be finding an electrical and mechanical mechanism to push the net out of the water at a quick enough speed in order to trap the ducks. After discussing further details with contacts of SICon, L.L.C, we found that the maximum amount of force to pull the net vertically through the water is approximately fifty pounds-force. Another idea we have gained from meeting with SICon, L.L.C. is to mount an audio device that would play the call of young ducks to attract mother ducks and their broods in the area of the trap. Therefore, an audio signal receiver might need to be incorporated into out transmitter device.

On a financial note, SICon, L.L.C. has offered us an additional $600.00 to fund our project. We feel that this additional amount of funding will greatly ensures our financial feasibility. Also, there is a possibility of utilizing some material in the engineering metal shop and purchasing aluminum poles at cost value through Gensink Steel.

In our industrial consultation with Chuck Spoelhoff, we discovered that we had already covered most of the questionable areas of our design. However, Mr. Spoelhoff did encourage us to use bungee cords, which were investigated prior to the consultation instead of springs for reasons such as reduced cost and water resistance. The electrical component of our design was also more clearly defined during the industrial consultation.

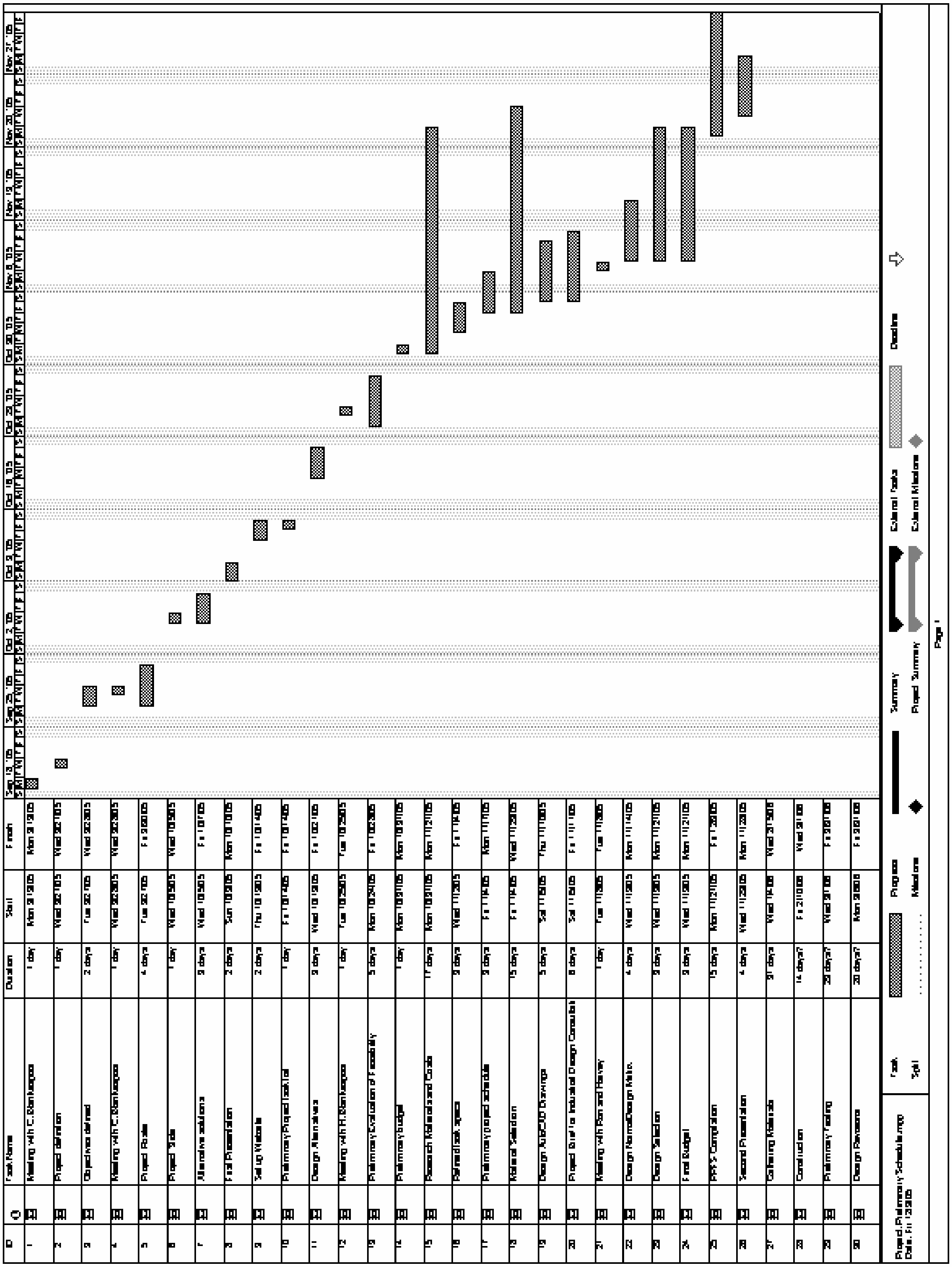
7. Christian Perspective

As students in a Christian engineering program, we find it important that our faith be reflected in our senior design project. When designing our project, we considered many design norms and the impacts they had. First, the design norm of transparency is important to us because we want to be completely honest with our customers, SICon, L.L.C. Next, trust influenced our design. We think it is important that our final prototype be a dependable design that captures the Common Merganser ducks. Also, it is important that the materials we use are good quality in order to ensure that prototype can be used for multiple years. And finally, caring and stewardship played a large part in our design. It is important to care for those affected by ‘swimmer’s itch’ and help them to enjoy God’s creation safely. Also, the trap is environmentally safe because the ducks and the environment will not be harmed in the process. It also prevents the State of Michigan from pouring multiple chemicals into the lakes to try to control the problem.

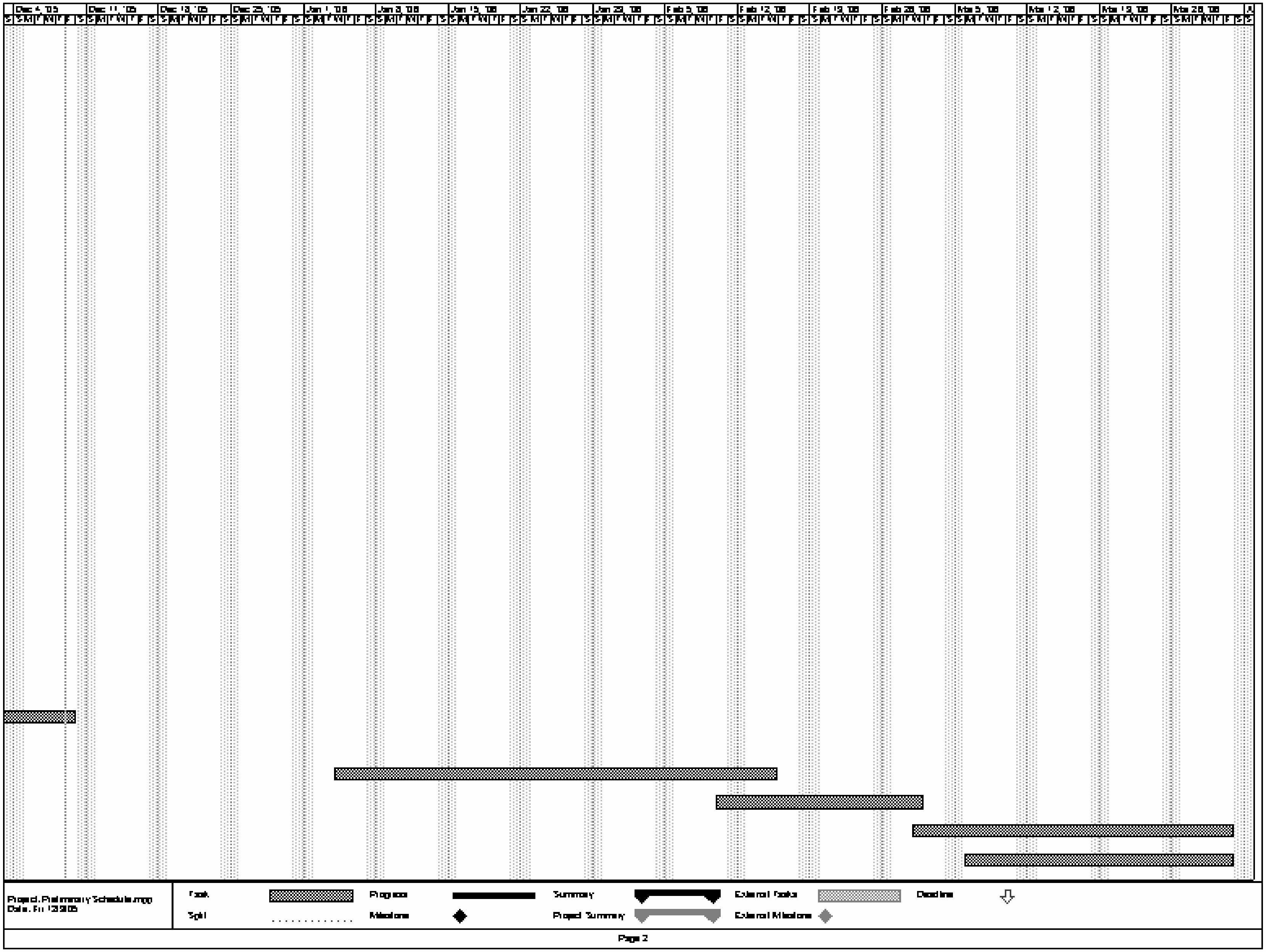
8. Project Task List

Task Description:			Duration (hrs)	Start	Finish
Administration and project setup			79.5		
X	Project definition		1	9/20/05	9/21/05
X	Objectives defined		1.5	9/27/05	9/28/05
X	Project Poster		2	9/27/05	9/30/05
X	Project Slide		1	10/4/05	10/5/05
X	Alternative solutions		3	10/5/05	10/7/05
X	Project task list		3	10/14/05	10/17/05
X	Preliminary Project website		3	10/13/05	10/14/05
X	Preliminary Evaluation of Feasibility		2	10/24/05	10/28/05
X	Preliminary budget		2	10/31/05	10/31/05
X	Refined task specs		3	11/2/05	11/4/05
X	Project Brief for Industrial Design Consultation		3	11/5/05	11/11/05
X	Preliminary project schedule		4	11/4/05	11/7/05
X	PPFS Compilation		50	11/21/05	12/9/05
Presentations			21.5		
X	First Presentation		1.5	10/9/05	10/12/05
X	Second Presentation		3	11/28/05	12/5/05
	Third Presentation		2		
	Forth Presentation		2		
	Fifth Presentation		3		
	Final Presentation		10		
Preliminary Design Analysis			12		
X	Material selection		3	11/4/05	1/21/05
	Design decision				
X		Design Norms	2		11/14/05
X		Decision matrix	2		11/14/05
	Preliminary design selection				
X		Design selection feasibility	3		11/21/05
X		Final Design Budget	2		11/21/05
Prototyping			102		
X	Researching Materials / Costs		15	10/31/05	11/21/05
	Gathering materials		2	1/4/05	2/15/05
	Construction		40		
	Testing		30		
	Redesign		15		
	Reconstruction		15		
Continuous Tasks (estimated overall hours required)			81		
X	Updating websites		20		
X	Monthly budget reports		12		
X	Individual journal entry		34		
X	Communication with Prof. Blankespoore		15		
TOTAL HOURS ON PROJECT:			**194**		

9. Schedule



ID
Task Name
Duration
Start
Finish
1 Meeting with C. Bonkoapon 1 day
2 Project definition 1 day
3 Objectives defined 2 days
4 Meeting with C. Bonkoapon 1 day
5 Project Goals 4 days
6 Project Site 1 day
7 Alternative solutions 3 days
8 First Presentation 2 days
9 Set up Website 2 days
10 Preliminary Project task list 1 day
11 Design Alternatives 3 days
12 Meeting with H. Bonkoapon 1 day
13 Preliminary Evaluation of Feasibility 5 days
14 Preliminary budget 1 day
15 Research Materials and Costs 17 days
16 Refined task specs 3 days
17 Preliminary project schedule 3 days
18 Material Selection 15 days
19 Design AutoCAD Drawings 5 days
20 Project Brief for Industrial Design Consultant 6 days
21 Meeting with Ron and Harvey 1 day
22 Design Normal/Design Matrix 4 days
23 Design Selection 9 days
24 Final Budget 9 days
25 PPFS Compilation 15 days
26 Second Presentation 4 days
27 Gathering Materials 31 days
28 Construction 14 days?
29 Preliminary Testing 23 days?
30 Design Revisions 20 days?
Project: Preliminary Schedule.mpp
Task
Split
Progress
Milestone
Summary
Project Summary
External Tasks
External Milestone
Deadline
Page 1


Dec 4, '05
Dec 11, '05
Dec 18, '05
Dec 25, '05
Jan 1, '06
Jan 8, '06
Jan 15, '06
Jan 22, '06
Jan 29, '06
Feb 5, '06
Feb 12, '06
Feb 19, '06
Feb 26, '06
Mar 5, '06
Mar 12, '06
Mar 19, '06
Mar 26, '06
Project: Preliminary Schedule.mpp
Task
Split
Progress
Milestone
Summary
Project Summary
External Tasks
External Milestone
Deadline
Page 2

10. Material Selection and Budget

Note: The final cost reflects the plans for a best case scenario preliminary design.

Team Two Budget			
Product	**Source**	**Quantity**	**Total Cost**
Aluminum Poles	Gensink	4	$150.00
Augers	Marina Shop - Holland	4	$0.00
Bungee Cords	Home Depot	4	$15.00
Transmitters & Receiver	Smart Home	1	$112.00
Wireless Solenoids	Ledex and Dormeyer Products	4	$120.00
Pulleys	shop	4	$0.00
Gears	McMaster Carr	4	$40.00
Net	www.nylonnets.com	1	$100.00
Cable	Home Depot	2	$20.00
Lead-Lined Cable	Professor Blankespoor	1	$0.00
Total			**$557.00**

We chose aluminum poles because it is important that our design is lightweight and portable. We identified in our design criteria that no more than two people should be needed to set up the trap; this will be accomplished by keeping the poles lightweight. Also, aluminum is resistant to rust, so they will be more resistant to corrosion than different materials such as steel. Another important part of the trap pole design is that they will not look any different than dock poles. Most dock poles are aluminum, so using aluminum poles instead another material such as PVC pipes provides a better disguised trap.

We are planning on utilizing the augers that are used in the current trapping system, which would eliminate the cost of new augers. However, if this cannot be done, we will be purchasing new augers from a marine shop in Holland. SICon, L.L.C. used this vendor in the past and were satisfied with their service and purchase. SICon, L.L.C. has identified that their current trap has had a lot of success using augers to anchor their poles in the bottom of the lake. Because we have a possibility of obtaining augers for no cost and their past success, we have decided that augers will be the best choice for our duck trap design.

We are currently planning on using bungee cords in the mechanical device of our design. The reason we have chosen bungee cords is because they are less expensive and provide the same results as an extension spring. Also, it has the added benefit of having no metal parts which increases the resistance to corrosion from the lake environment. Also, they are easier to find and replace and also less expensive if maintenance needs to be performed in the future. If, after testing during interim, we find that we are not satisfied with the performance of the bungee cords we have chosen, we are planning on using extension springs and have located the needed spring to replace the bungee cord. Five extension springs are available from McMaster-Carr for approximately $40.00.

The pulleys required in our mechanical device are very specific to our needs in this project. Because they would need to be specially made and are not commonly found on the market, we have decided to construct them ourselves in the metal shop using various size pipes and sheet metal. An added benefit to this is that the material in the metal shop is available to our team for no additional cost. This also helps keep the final cost of our project down.

We have decided on attaching a gear to our pulley system in order to control the movement of the pulley. This allows us to have remote activation of the trap. Also, the gear system allows us to stop the net when it reaches its maximum point in order to aid in the prevention of sagging of the net. We have researched gears that are available online at McMaster Carr.

The net that will be utilized in the design will be purchased from Nylon Nets. This is a company that specializes in all types of nets and has been specifically chosen by our customer because of previous satisfaction. Our customer, SICon, L.L.C, has suggested that we use a heavier net than was used in the past because the net will no longer be visible. Also, using a heavier net will prevent the ducks from tearing it, which has happened in the past. Currently, SICon, L.L.C. has specified a double-salvage gill net of the heaviest strength. Purchasing a heavier net will not increase our cost significantly. SICon, L.L.C. has offered to pay for the net entirely, since it is an essential part of the trap.

A simple cable has been identified for use in raising the net vertically because it will not stretch under tension. Cable is also very inexpensive, easily available at most hardware and home improvement stores, and is also available with corrosion-resistant coatings.

Currently, we have a lead-lined cable that was donated by SICon, L.L.C. This cable will be strung along the bottom of the net and fixed to each pole. This is done to assure that the bottom of the net remains tight and rests at the bottom of the lake.

We are currently planning on using a transmitter that is manufactured by Linear Corporation and distributed by Smart Home. The model is the handheld long-range transmitter, number 7426. Figure nine displays a picture of the transmitter.

Figure Nine: Linear Corporation Transmitter

The reason we chose this transmitter is because it can be operated during various weather conditions. It is also powered by a 9 volt alkaline battery which is available at home improvement stores as well as food and drug stores. It is lightweight which satisfies our design requirement that the trap as a whole be lightweight and portable. Also, it comes with its own receiver. The total cost of the transmitter and receiver is within our budget. It also has 30 second transmission cycles and amperage of 20 milliamps.

We are also currently planning on using wireless solenoids. The solenoids are available from Ledex and Dormeyer Products. A picture of the solenoid can be seen in figure ten.

Figure Ten: Tubular Wireless Solenoids

After discussing our project with a representative from the company, reasons for choosing this specific model of solenoids were easily identified. The chosen solenoids require the same amount of power that will be output from the selected receiver. These solenoids have a moderate force output of approximately 22 pounds-force. The push and pull engagement is well-suited to lock and latch operations. Also, the solenoids have a two inch stroke which is applicable for our design. The solenoids have a long-lasting life of at least 25 million actuations which is ideal for our situation because we want to provide SICon, L.L.C. with a design that will not require a lot of maintenance and will last a long time.

11.References

Professor Harvey Blankespoor –SICon L.L.C

Ron Reimenk – SICon L.L.C

Professor Ned Nielsen

Professor Curt Blankespoor