

# ENT 498: Senior Design Project

## Miami University

Robotic X-Ray Plate Holder Final Report

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Submission Date: 5/8/2020

## **Executive Summary**

Our group is creating a robotic x-ray plate holder for The Wilds so that they can x-ray the legs of giraffes while they are standing and non-sedated. The Wilds reached out to Zane State College for this project due to their old x-ray plate holder wearing out. The old x-ray plate holder was created by Adam Davis who is the head of animal management and came to us for this project. There are many requirements for a project like this since it deals with live animals. The x-ray plate holder will need to be quiet, slow moving, lower and raise from the ground up to 48 inches, extend arm at least 12 inches, withstand a warm and humid atmosphere, and be easily movable in case the animal lashes out. Our goal is to complete this project so that The Wilds has a reliable x-ray plate holder that they can easily and effectively use.

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Robotic X-Ray Plate Holder



Figure 1

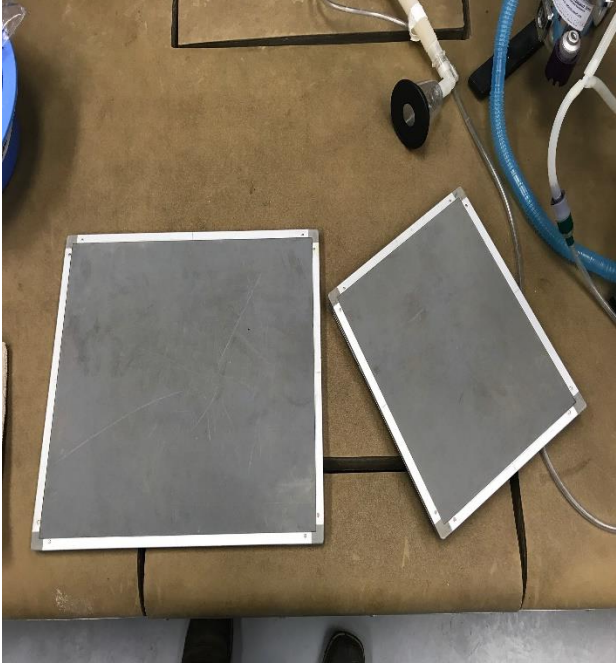


Figure 2



Figure 3



Figure 4

Robotic X-Ray Plate Holder



Figure 5



Figure 6



Figure 7

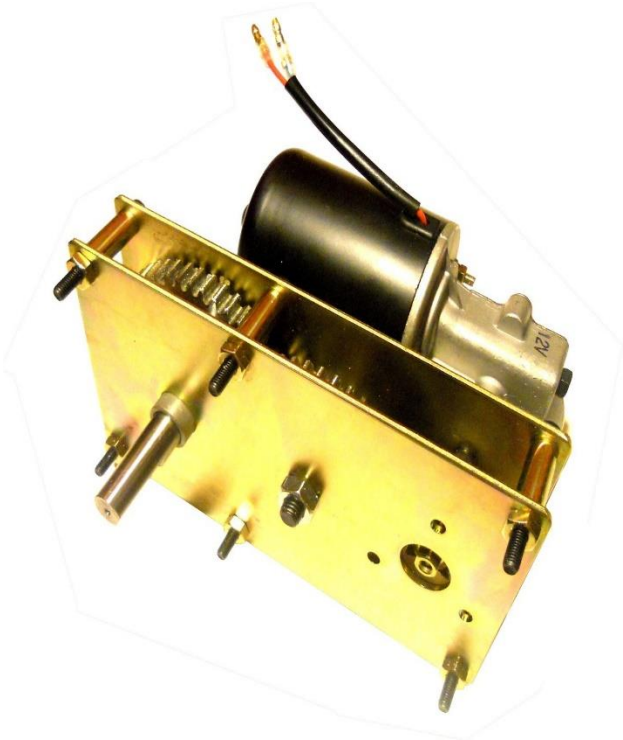


Figure 8

# Robotic X-Ray Plate Holder

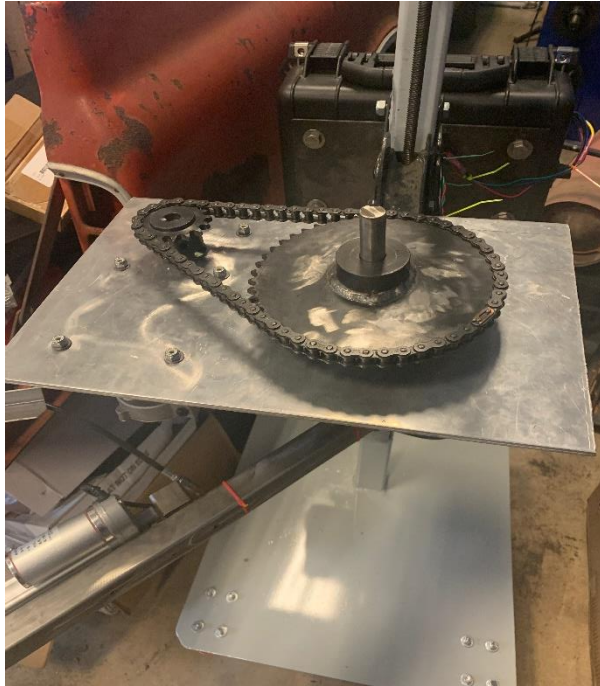


Figure 9



Figure 10



Figure 11

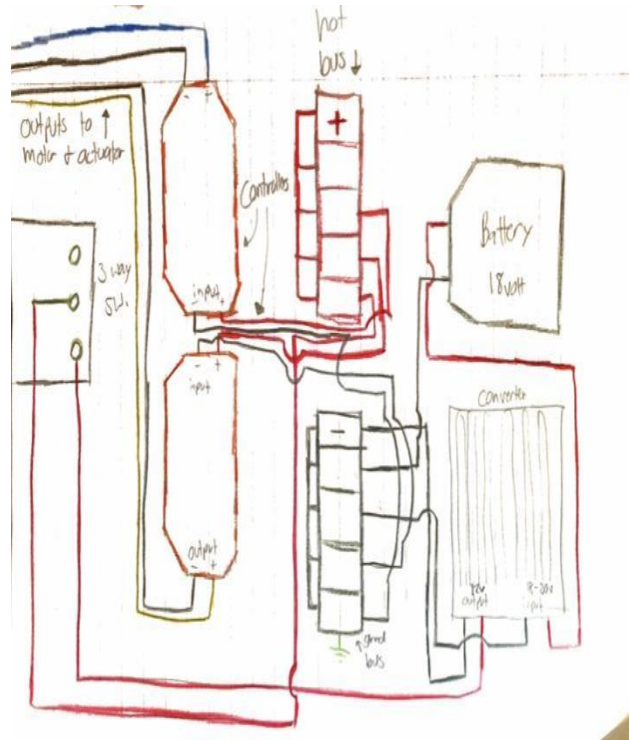


Figure 12

# Robotic X-Ray Plate Holder

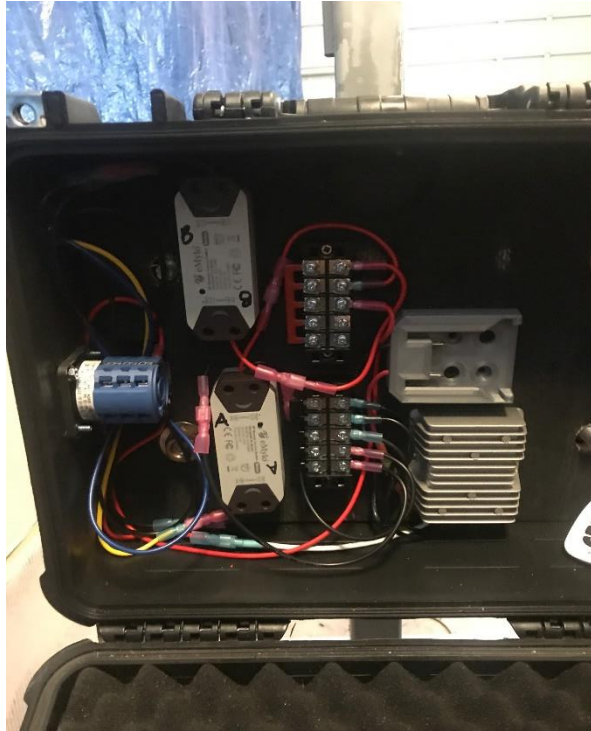


Figure 13

| Mode | Task Name                                   | Duration | Start        | Finish       |
|------|---|----------|--------------|--------------|
| 1    | Senior Project - Robotic X-Ray Plate Holder | 175 days | Mon 8/26/19  | Fri 4/24/20  |
| 2    | Project Tasks                               | 175 days | Mon 8/26/19  | Fri 4/24/20  |
| 3    | Start Project                               | 1 day    | Mon 8/26/19  | Mon 8/26/19  |
| 4    | Project Finished                            | 1 day    | Fri 4/24/20  | Fri 4/24/20  |
| 5    | Research Project                            | 30 days  | Mon 8/26/19  | Fri 10/4/19  |
| 6    | Project Proposal                            | 8 days   | Thu 10/10/19 | Sun 10/20/19 |
| 7    | Project Approval                            | 5 days   | Mon 10/21/19 | Fri 10/25/19 |
| 8    | Final Oral Presentation                     | 1 day    | Fri 4/24/20  | Fri 4/24/20  |
| 9    | Planning                                    | 37 days  | Thu 10/3/19  | Fri 11/22/19 |
| 10   | Design                                      | 27 days  | Thu 10/3/19  | Fri 11/8/19  |
| 11   | Order Parts                                 | 11 days  | Fri 11/8/19  | Fri 11/22/19 |
| 12   | Fabrication/Construction                    | 78 days  | Thu 10/17/19 | Mon 2/3/20   |
| 13   | Mechanical                                  | 40 days  | Thu 10/17/19 | Wed 12/11/19 |
| 14   | Arm Design                                  | 17 days  | Thu 10/17/19 | Fri 11/8/19  |
| 15   | DC Motor                                    | 11 days  | Fri 11/8/19  | Fri 11/22/19 |
| 16   | Clamp Design                                | 14 days  | Fri 11/22/19 | Wed 12/11/19 |
| 17   | Electrical                                  | 39 days  | Wed 12/11/19 | Mon 2/3/20   |
| 18   | Install Dry Box                             | 7 days   | Wed 12/11/19 | Thu 12/19/19 |
| 19   | Mount Battery                               | 6 days   | Thu 12/19/19 | Thu 12/26/19 |
| 20   | Run Wires Through Trough                    | 5 days   | Thu 12/26/19 | Wed 1/1/20   |
| 21   | RC Control Programming                      | 24 days  | Wed 1/1/20   | Mon 2/3/20   |
| 22   | Testing                                     | 46 days  | Mon 2/3/20   | Mon 4/6/20   |
| 23   | Troubleshooting                             | 34 days  | Mon 2/3/20   | Thu 3/19/20  |
| 24   | Safety Checks                               | 7 days   | Thu 3/19/20  | Fri 3/27/20  |
| 25   | Multiple Simulations                        | 7 days   | Thu 3/19/20  | Fri 3/27/20  |
| 26   | Test On Giraffe                             | 7 days   | Fri 3/27/20  | Mon 4/6/20   |

Figure 14

| Task Mode | Task Name                                   | Duration | Start        | Finish       |
|-----------|---|----------|--------------|--------------|
| 1         | Senior Project - Robotic X-Ray Plate Holder | 189 days | Mon 8/26/19  | Thu 5/14/20  |
| 2         | Project Tasks                               | 180 days | Mon 8/26/19  | Fri 5/1/20   |
| 3         | Start Project                               | 1 day    | Mon 8/26/19  | Mon 8/26/19  |
| 4         | Project Finished                            | 1 day    | Fri 4/24/20  | Fri 4/24/20  |
| 5         | Research Project                            | 30 days  | Mon 8/26/19  | Fri 10/4/19  |
| 6         | Project Proposal                            | 8 days   | Thu 10/10/19 | Sun 10/20/19 |
| 7         | Project Approval                            | 5 days   | Mon 10/21/19 | Fri 10/25/19 |
| 8         | Final Oral Presentation (YouTube Video)     | 8 days   | Wed 4/22/20  | Fri 5/1/20   |
| 9         | Planning                                    | 141 days | Thu 10/3/19  | Thu 4/16/20  |
| 10        | Design                                      | 86 days  | Thu 10/3/19  | Thu 1/30/20  |
| 11        | Order Parts                                 | 56 days  | Thu 1/30/20  | Thu 4/16/20  |
| 12        | Fabrication/Construction                    | 36 days  | Thu 3/5/20   | Thu 4/23/20  |
| 13        | Mechanical                                  | 36 days  | Thu 3/5/20   | Thu 4/23/20  |
| 14        | Arm   | 36 days  | Thu 3/5/20   | Thu 4/23/20  |
| 15        | Motor                                       | 21 days  | Thu 3/26/20  | Thu 4/23/20  |
| 16        | Clamp                                       | 31 days  | Thu 3/12/20  | Thu 4/23/20  |
| 17        | Electrical                                  | 11 days  | Thu 4/9/20   | Thu 4/23/20  |
| 18        | Install Dry Box                             | 6 days   | Thu 4/16/20  | Thu 4/23/20  |
| 19        | Mount Battery                               | 6 days   | Thu 4/16/20  | Thu 4/23/20  |
| 20        | Run Wires Through Trough                    | 6 days   | Thu 4/16/20  | Thu 4/23/20  |
| 21        | RC Control Programming                      | 11 days  | Thu 4/9/20   | Thu 4/23/20  |
| 22        | Testing                                     | 16 days  | Thu 4/23/20  | Thu 5/14/20  |
| 23        | Troubleshooting                             | 16 days  | Thu 4/23/20  | Thu 5/14/20  |
| 24        | Safety Checks                               | 16 days  | Thu 4/23/20  | Thu 5/14/20  |
| 25        | Multiple Simulations                        | 11 days  | Thu 4/30/20  | Thu 5/14/20  |
| 26        | Test On Giraffe                             | 1 day?   | tbd          | tbd          |

Figure 15

## **Scope and Methodology**

### ***Introduction to The Wilds***

The land that The Wilds is based on used to be coal mine lands. According to [6] after 200 years of coal mining, Ohio extracted over 3.6 billion tons of coal. This resulted in 450,000 acres of land that were surface mined for coal and 119,000 acres of land that was in desperate need for land reclamation efforts. In the Surface Mining Control and Reclamation Act, the United States Congress required national standards for coal mining and land reclamation. The birth of The Wilds began in 1984 when The International Center for the Preservation of Wild Animals received a gift of approximately 9,154 acres of land from the Central Ohio Coal Company as seen in [3]. The Wilds now make major efforts to reclaim these tainted lands such as prairies, forests, wetlands, and streams as seen in [9].

Today The Wilds is one of the largest animal conservation centers in North America with over 9,000 acres of land that serve as open range habitats for rare and endangered species around the world. With around 28 different species of animals The Wilds offers public tours as well as private, and specialty tours and those include things such as ziplining, horseback riding, and fishing.

### ***Project Scope***

Adam Davis [1] who is our contact and head of animal management for The Wilds, insisted that they needed to be able to x-ray the legs of giraffes while they were standing and non-sedated, and they had very good reasoning. Due to a giraffe being so tall and them being such skittish animals they tend to fight the sedation and could be killed from a fall at such great heights. Not only is the life of the animal saved from a non-sedation process, but getting x-ray images of a giraffe that is non sedated and who is cooperating is a great representation of The Wilds' goals by having as little intrusion on the animal's life as possible.

Adam let us know exactly what he wanted from the new x-ray plate holder. Which gave us a clearly defined scope for the project. Since the giraffes live in the open, and free-range habitats, they are not as accustomed to people as giraffes at zoos may be. Adam requested that the plate holder be slow moving and quiet that way it would not spook the giraffes. It also needs to be controlled from a distance so that no person has to be exposed to radiation during the imaging process or risk being kicked by the giraffe when operating it. The x-ray plate holder also must be durable in case it is knocked around by a giraffe that lashes out, and must be ruggedized since it will be in a barn where the environment is similar to that of the giraffe's homeland which is high temperatures and high humidity. It also needs to be portable or have easy assembly and disassembly so that it can fit through doorways and possibly taken out in the field as well.

Our task was to rebuild/recreate Adam's old x-ray plate holder that he put together himself with the help of the Zane State IDEA lab (figure 1). The plates that are held by the robotic x-ray plate holder are made of radiographic film. They have two sizes of plates that they use on the giraffes, the larger plates are 18x15", while the small plates are 13x11" (figure 2). Adam's design had an old IV stand as his base and he used a 35lb barbell plate as his counterweight for the arm. He used 2 U-bolts to loosen and tighten the arm to the upright of the IV stand for the purpose of lowering and raising the arm. He had a small



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servo motor with a chain and sprockets to rotate the arm. He used a linear actuator for the extension of the arm, and spring-loaded clamps were tied to the end of the arm to hold the x-ray plate. The extension and rotation were wirelessly controlled using RC. Adam let us know a few problems with his design that he wanted us to improve on. Whenever they raised up the arm to its max height the entire assembly was prone to tipping over because of how weak the upright of the IV stand was. Another big issue was drift from the rotating servo motor. Whenever they stopped inputting a rotation signal with the RC remote the arm of the plate holder would still move slightly due to motor drift. This is especially a huge problem since the drift of the arm could potentially bump the giraffe and cause the animal to be under a large amount of distress. The casters for the IV stand were also an issue. An IV stand is designed to be indoors, so the casters seized up due to being in such a harsh environment. Lastly, the x-ray plate holder was not working due to cheap parts being put on it. The Wild's deserves an x-ray plate holder that can last them years to come.

This project tested our engineering skills from several different aspects. Research, balancing the allotted budget, electrical sizing, mechanical sizing, and safety were all aspects we took into consideration when designing our x-ray plate holder robot. Understanding how the portable x-ray machine worked was a big part of starting the project. We used [8] to get a better understanding of the machine we were working with. After finding out how the machine worked, we then downloaded the manual for the MiniXray HF100+ from [5] as another source of information and to assist in designing a suitable robot.

### *Implementation*

Our original plan was to modify a hydraulic lift cart so that we could mount the robotic arm to it without having to worry about an unstable base. This idea of a lift cart was soon revised due to cost. A hydraulic lift cart that both met our requirements and fit our height requirements was impossible to find at stores or online without a huge shipping fee. We then decided to create our own base by modifying the design of a mower jack. To build the cart we started with a piece of 2'x3' 3/16" [2,10] thick steel (figure 3). We found the exact center and welded in a piece of 2.5" square tubing. From there, we added the upright made of 2" square tubing that slid directly into the 2.5" square tubing. On the 2" upright, we welded two tabs with holes for the linear screw thread to slide in. We attached our aluminum motor assembly to the upright with a custom bracket that rises and lowers with the screw thread. For wheels we drilled and bolted in a caster on each corner, 1.25" from the edges (figure 4). Once all the welding was done, we laid paint (figure 5) and did the final assembly. From this lifting mechanism we were easily able to mount our dry box to one side so that our wires coming out of the enclosure move with the actuator and motor controllers on the opposite side (figure 6). With the arm assembly we devised we mounted a 12V wirelessly controlled motor to drive a chain (figure 7) and sprocket that would rotate an assembly that housed an extension that the clamp plate design would attach to. We then got generic weights for the mounting plate, square tubing, and the cold rolled round stock that we would be using for the extend and clamp for devising the actuator size. After finding that figure we then added the weight of the shaft and the tubing that houses the extension tubing and the actuator for a total theoretical rotating assembly weight.

Once a rough design, sketch, and parts list were made we next addressed the mechanical parts of our design. Several design modifications will be addressed for proper operation of our robot. The first included adding a mounting plate to the top of the lift to give us a place to mount the motor, gearbox, and

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rotating arm. We purchased a 28" x 16" x 1/4" aluminum plate and had them bend a 6" lip on the end for mounting to the lift. We also purchased the material for the arm and shaft at that time. After researching several types of motors to drive our rotating assembly, we called Makermotor to see if they had what we were looking for. We were able to find [4] that had a locking gearbox (figure 8).

The gearbox helped us ensure that there was no drift on the arm when operating or stopping it. We were also assured by the mechanical engineer that the motor is quiet enough to not startle the giraffes. With only needing 180 degrees of rotation, 5 rpm was still too fast to rotate our robot arm. The motor did come with a PWM controller that would allow us to control the speed; however, by doing that we would have a dramatic drop off in our torque output for the motor when using the controller to slow down the motor. To drop our speed and increase our torque output, we decided to use a drive chain and 2 sprockets to create a mechanical ratio of 3 that would drive our rotational arm. This would drop our max speed to 1.66 rpm and bump our maximum rated torque output up by a ratio of 3 to 195 ft lbs of rated torque. Additionally, the PWM controller can be used to slow down the arm even further, while still maintaining the necessary torque we needed.

The mechanical ratio consisted of a 4016T-drive sprocket and a 4048T driven sprocket on the shaft for the rotational arm, which is driven by #40 roller chain (figure 9). With 48 teeth on the driven sprocket and 16 teeth on the motor gearbox sprocket, our final ratio would be 3 to 1. Both sprockets were a two-piece design where the bore could be inserted and welded for final assembly based on the necessary bore. We purchased three sprockets and bores at the tractor supply company in Zanesville, Ohio. The drive sprocket is a 5/8" bore for the motor gearbox shaft and the driven sprocket is a 3/4" bore for the rotational arm shaft. The rotational shaft for the arm did require a keyway milled for the driven sprocket to attach properly. Once the shaft was machined and slip fitted for the driven sprocket, bearing design came into play. With the help of Zanesville Bearing, we were able to order a 2 bolt flange and 4 bolt flange to support the weight of the arm and provide smooth stable motion and have offsetting bolt patterns for the ease of mounting to the lift plate (figure 10).

The arm fabrication and actuator selection were the next mechanical tasks necessary. The arm consisted of 1 1/4" SS square tubing 36" in length. The square tubing was drilled at one end to 13/16" for the 3/4" SS shaft to pass through flush and be welded on both sides and tied together with multiple pass MIG welds. We found a 12V actuator with 18" of stroke and a 300N push/pull force. The actuator required the arm to be drilled and tapped for the mounting hole (12mm-24tpi). After mounting the actuator, we found it did not extend straight due to its mechanical shape and the mounting position. We used washers welded to the arm to shim the actuator square with the arm to provide the straight linear actuation we needed.

The last mechanical task was to fabricate a tool that could hold the plate and attach to the actuator. We devised using a C clamp welded to the key stock and then welded to a 5/8" split collar that would slip fit over the actuator shaft and tighten down. We made 2 different styles of clamps, one for horizontal mounting and one for vertical mounting (figure 11).

Next, we addressed the electrical capabilities and requirements that our robot would need. We looked into dry boxes for electronic components storage and figured [7] would suit us best for our budget. A sketch of the wiring diagram can be seen in figure 12. See figure 13 for a picture of our dry box which

## Robotic X-Ray Plate Holder

houses our electrical components. Supplying enough power was our first obstacle. We decided upon the idea of using a 18V tool battery and converting it to 12V as our supply power to ensure enough amp-hours were present, allow easy charging, and ease of maintenance. During our meeting with The Wilds, easy breakdown and safety were also requirements that needed to be addressed. The use of electrical disconnects throughout the design would allow easy breakdown for storage or mobile use and the disconnect will come unplugged before the wire will pull apart in the event of an animal becoming spooked and getting wrapped up in the robot. The last design choice was to use RC wireless controllers for our actuator and DC motor to actuate the rotating assembly and the extension actuator. The biggest factors for using RC were avoiding programming issues, never becoming outdated, inexpensive, and ease of maintenance for replacement. The RC controllers that we found are eMylo RF motor controllers. These controllers resist interference and come with very powerful remotes.

### *Timeline*

For the timeline of our project, a lot of our dates were changed due to COVID-19. The old timeline is pictured in figure 14 while the new timeline is pictured in figure 15. At the beginning of our timeline, we have four main level tasks that we worked through. We had the project task stage that encompassed all our previous goals, such as starting and researching the project, writing our proposal, and getting the approval to start designing and working on this project. None of these dates were changed due to the pandemic. A date that did change however was the date that we wanted to finish the project, and the date of our final oral presentation. The rest of our dates were changed mostly due to COVID-19. For the planning phase of the project, we had our dates to design the plate holder and to order parts. We did not start to order parts until later than expected because The Wilds had a hard time getting access to the funds for us. We got the approval to start ordering parts from The Wilds around Christmas break. We did not start our fabrication and construction until March. For this main task we have two subgroups, mechanical work and electrical work. For the mechanical work portion of the project we have the fabrication of the arm that will be holding the x-ray plate, and the installation of our motor we are going to use, and the clamp that will hold the x-ray plate. As for electrical work we did, we had to install a dry box to put most of our main electrical components in. We also had to install the battery, run wires, and program the RC controls that we are using to control the arm. The testing stage of our project got pushed back due to the fabrication starting later because of the downtime we had. For the testing stage, we are taking our time making sure that the project is going to be fully safe when used to hold the x-ray plate beside the giraffe. We are troubleshooting any issues, doing some safety checks, and finally some simulations will be occurring. Because of the coronavirus, we have not been able to set a date on when we will be able to use the project on a giraffe. We are hoping to be able to get a video of them operating it after we are done with the Senior Project Class.

### *Cost*

For our budget, we were given \$1000 by The Wilds as a maximum. Later in the Fall semester, we were told about a scholarship that we could apply for. Not long after we applied, we received \$500 from the Armin Fleck scholarship. The funds from the scholarship are being used to save some money for The Wilds, and since The Wilds is non-profit, we were very happy about this. The total cost of our parts that we have bought for the project is \$906 as seen below (Table 1).

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The parts that were used to build the X-Ray Plate Holder are in the cost table. Everything that was bought with a credit card or with cash will be what the scholarship is paying for. We had to buy 10 feet of chain, a master link, two offset links, and some flange bearings. We also had to buy the plate for the arm and motor to mount onto, and some stainless-steel tubing. We have a 5-rpm motor with a gearbox and the pulse width modulation controller. Also, some drive sprockets, and the extension arm with supports. We had to get some wireless controllers, a 12V actuator, and a 12V lawn and garden battery. We have some stuff that was donated to us, like some collars and C clamps. The Wilds bought the rest of the stuff, which would be the metal for the base and upright of our plate holder, the casters, and the miscellaneous parts such as the dry box, wires, terminal blocks, and battery mount. The parts list brings us to a total of \$906.10.

Robotic X-Ray Plate Holder

**Costs**

| <b>Item</b>  | <b>Purchase date</b> | <b>Total with tax (\$)</b>  | <b>Supplier</b>    | <b>Payment Method</b> |
|--|----------------------|-----------------------------|--------------------|-----------------------|
| 10' box of roller chain, 1 master link, and 2 offset links   | 4/21/2020            | 71.46                       | Goss Supply        | Credit card           |
| 4 bolt flange bearing  | 4/15/2020            | 21.13                       | Zanesville Bearing | Cash                  |
| 2 bolt flange bearing  |                      | 17.79                       |                    |                       |
|  |                      | 38.92 Subtotal<br>2.82 Tax  |                    |                       |
|  |                      | 41.74 Total                 |                    |                       |
| 16" x 28" x 1/4" aluminum plate with bend  | 4/3/2020             | 76.45                       | Goodman Steel      | Credit card           |
| 1 1/4" SS square tubing  |                      | 30.47                       |                    |                       |
| 3/4" diameter SS shaft 12" in length   |                      | 9.05                        |                    |                       |
|  |                      | 115.97 Subtotal<br>8.41 Tax |                    |                       |
|  |                      | 124.38 Total                |                    |                       |
| 5 rpm 12V motor with locking gearbox and PWM controller  | 2/5/2020             | 205.00                      | Maker Motor        | Credit Card           |
| <b>Drive Sprockets</b><br>40 Chain<br>Driven sprocket 48 tooth with a welded bore 3/4" diameter  | 2/17/2020            | Donation                    | Tractor Supply     | Donation              |
| 40 Chain<br>Drive sprocket 16 tooth with a welded bore 5/8"  |                      |                             |                    |                       |
| <b>Extension arm and supports</b><br>1/2" diameter SS rod 36" length (Extension arm)<br>Qty 2 of 4" length SS pipes with .505 inside diameter (Clamp supports) | 4/20/2020            | 28.52                       | Goodman Steel      | Credit Card           |

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|   |           |          |              |             |
|---|-----------|----------|--------------|-------------|
| Wireless 12V controllers  |           | 23.58    | Amazon       | Credit Card |
| 12V actuator  | 2/6/2020  | 49.03    | Walmart      | Credit Card |
| Lawn and garden 12V battery   | 4/3/2020  | 25.39    | Advance auto | Credit card |
| <b>Miscellaneous Clamp Necessities</b><br><br>Qty 2 of 1/2" SS set collars and 1 5/8" set collar for actuation link<br><br>Qty 2 C clamps | 4/20/2020 | Donation |              | Donation    |
| Metal for base and upright  | 4/13/2020 | 150      |              | The Wilds   |
| Casters   | 3/15/2020 | 40       |              | The Wilds   |
| Dry box, wires, switch, terminal blocks, bolts, battery mount, and all other miscellaneous parts  | 4/8/2020  | 147      |              | The Wilds   |
| Total   |           | 906.10   |              |             |

**Table 1**

### ***Conclusion***

In conclusion, our project is complete except for the testing. As of now we do not have any time or date as of when we will be able to watch The Wilds test out the plate holder. We are still keeping in contact with Adam Davis, but with Covid-19 still ongoing, there is not much more we can do at this point. We are excited to see how much potential this project has and to see it in action whenever we are able to transport it to The Wilds and get it tested on a giraffe.

## **References**

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**Meeting Journal**  
**Department of Engineering Technology**  
**ENT 497/498 - Senior Design Project**  
**Project Title: X ray plate robot**

|                 |                                   |
|-----------------|-----------------------------------|
| <b>Advisor:</b> | <b>Present</b><br><b>Mert Bal</b> |
| <b>Student:</b> | <b>Ryan Duty</b>                  |
| <b>Student:</b> | <b>Landon Campbe</b>              |
| <b>Student:</b> | <b>Austin William</b>             |
| <b>Student:</b> | <b>Kyle Moss</b>                  |

|                          |          |
|--------------------------|----------|
| <b>Meeting Date:</b>     | 2-6-2020 |
| <b>Meeting Location:</b> | Room 210 |

**Topics Discussed**

Over the break, our team met twice to collaborate on parts and go over finalized design with Adam from the Wilds. However, after presenting our design idea to Adam(the Wilds employee) we were informed the winch motor would be too loud and the hydraulic lift cart was too big for their liking. We compromised using a reversible rotisserie motor that will be geared down( with an insulated box to dampen noise) to rotate the assembly and making the rolling cart smaller and with an upright with holes drilled in it for vertical adjustment. This week we ordered parts: rotisserie motor, gears, actuator, and reversing controllers. We have recieved the gears, the motor will be here on 2-12, and the actuator won't arrive until between 2-15 and 2-17. This weekend we will be heading to knowltons steel to pick up the tubing for the arm and the rotation shaft.

**Responsibilities/ Actions Taken**



|   |
|---|
| <b>Next Meeting Date:</b> <b>2/13/2020</b> <b>Location</b> ZSC College Hall |
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**Meeting Journal**  
**Department of Engineering Technology**  
**ENT 497/498 - Senior Design Project**  
**Project Title: X Ray Plate Holder/The Wilds**

|                 |                         |
|-----------------|-------------------------|
|                 | <b>Present</b>          |
| <b>Advisor:</b> | <b>Mert Bal</b>         |
| <b>Student:</b> | <b>Ryan Duty</b>        |
| <b>Student:</b> | <b>Landon Campbe II</b> |
| <b>Student:</b> | <b>Austin Williams</b>  |
| <b>Student:</b> | <b>Kyle Moss</b>        |

|                          |           |
|--------------------------|-----------|
| <b>Meeting Date:</b>     | 2-13-2020 |
| <b>Meeting Location:</b> | Room 210  |

**Topics Discussed**

We met on 2/6 and after class that day, we all went down to talk to the IDEA lab to talk to the manager there, Chip. We needed to know some information and he was telling us about a place that may donate some parts for our project. We need to get a little more clarification on this and tell Chip what we would like to ask for. The team talked about meeting on Monday to start welding some of the steel together to make the base of the x ray plate holder. We will input the results of this meeting in next weeks journal.

**Responsibilities/ Actions Taken**      Talked to Chip Clark, manager of the IDEA lab. Planning on meeting Monday, 2/17.

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| <b>Next Meeting Date:</b> <b>2/17/2020</b> <b>Location</b> ZSC College Hall |
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|                 |                        |
|-----------------|------------------------|
|                 | <b>Present</b>         |
| <b>Advisor:</b> | [ ]                    |
| <b>Student:</b> | <b>Kyle Moss</b>       |
| <b>Student:</b> | <b>Landon Campbell</b> |
| <b>Student:</b> | <b>Austin Williams</b> |
| <b>Student:</b> | <b>Ryan Duty</b>       |

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|--------------------------|------------------|
| <b>Meeting Date:</b>     | 2/20/2020        |
| <b>Meeting Location:</b> | College Hall ZSC |

**Topics Discussed**

Started on the support base for the x-ray plate holder. We met on Monday to start welding but the slide we ordered for the vertical adjustment of the arm was too thick to slide over the vertical upright. So we took pictures Monday for the group project and Landon finished most of the base up. We are waiting on the caster wheels from Adam to finish up. We wired up the motor, controller, actuator, and wireless relay on a DC power supply at Ryan's work for testing.

**Responsibilities/ Actions Taken**

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| <b>Next Meeting Date:</b> 2/27/2020 | <b>Location:</b> Zane State College Hall |
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**Meeting Journal**  
**Department of Engineering Technology**  
**ENT 497/498 - Senior Design Project**  
**Project Title: X ray plate robot**

|                 |                       |
|-----------------|-----------------------|
|                 | <b>Present</b>        |
| <b>Advisor:</b> | <b>Mert Bal</b>       |
| <b>Student:</b> | <b>Ryan Duty</b>      |
| <b>Student:</b> | <b>Landon Campbe</b>  |
| <b>Student:</b> | <b>Austin William</b> |
| <b>Student:</b> | <b>Kyle Moss</b>      |

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|--------------------------|-----------|
| <b>Meeting Date:</b>     | 2-27-2020 |
| <b>Meeting Location:</b> | Room 210  |

**Topics Discussed**

Still waiting on parts order from Adam for base of plate holder. Ordered gears with weld on bore, reordering shaft because bearing would not fit over it.

**Responsibilities/ Actions Taken**

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|---------------------------|-----------------|----------------------------------|
| <b>Next Meeting Date:</b> | <b>3/5/2020</b> | <b>Location</b> ZSC College Hall |
|---------------------------|-----------------|----------------------------------|



**Meeting Journal**  
**Department of Engineering Technology**  
**ENT 497/498 - Senior Design Project**  
**Project Title: Robotic X-Ray Plate Holder**

|                 |                       |
|-----------------|-----------------------|
|                 | <b>Present</b>        |
| <b>Advisor:</b> | <b>Mert Bal</b>       |
| <b>Student:</b> | <b>Ryan Duty</b>      |
| <b>Student:</b> | <b>Landon Campbe</b>  |
| <b>Student:</b> | <b>Austin William</b> |
| <b>Student:</b> | <b>Kyle Moss</b>      |

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|--------------------------|----------|
| <b>Meeting Date:</b>     | 2-6-2020 |
| <b>Meeting Location:</b> | Room 210 |

**Topics Discussed**

Final parts(bearings and sprockets) arrived for the rotating arm and sprockets have bores installed and welded and have been fitted to the motor and shaft; however, a keyway will need cut for the rotating shaft to attach to the sprocket still. Assembly, mounting, and wiring for the rotation and extension will begin next week.

**Responsibilities/ Actions Taken**

The sprockets and bearings arrived Tuesday, the bores were welded to the sprocket

Tuesday night. Keystock was cut and fitted for the sprockets. The shaft that we ordered that was not accuround has been returned for accuround round stock and bearings slide on now. Assembly of the arm and shaft will begin this weekend. A 1/4" Key way will need cut in the shaft for sprocket keyway. Assembly of the arm to the rotating shaft can be completed once the key is cut.

**Next Meeting Date:** 3/5/2020 **Location:** Room 210





**Meeting Journal**  
**Department of Engineering Technology**  
**ENT 497/498 - Senior Design Project**  
**Project Title: Robotic X-Ray Plate Holder**

|                 |                        |
|-----------------|------------------------|
|                 | <b>Present</b>         |
| <b>Advisor:</b> | <b>Mert Bal</b>        |
| <b>Student:</b> | <b>Ryan Duty</b>       |
| <b>Student:</b> | <b>Landon Campbell</b> |
| <b>Student:</b> | <b>Austin Williams</b> |
| <b>Student:</b> | <b>Kyle Moss</b>       |

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|--------------------------|----------|
| <b>Meeting Date:</b>     | #####    |
| <b>Meeting Location:</b> | Room 210 |

**Topics Discussed**

Worked more on getting the project assembled and are waiting on some parts still.

**Responsibilities/ Actions Taken**

Keeping in touch with Chip Clark, potentially meeting at the IDEA Lab to work on project.

**Next Meeting Date:** 3/19/2020 **Location:** Room 210



**Meeting Journal**  
**Department of Engineering Technology**  
**ENT 497/498 - Senior Design Project**  
**Project Title: Robotic X-Ray Plate Holder**

|                 |                        |
|-----------------|------------------------|
|                 | <b>Present</b>         |
| <b>Advisor:</b> | <b>Mert Bal</b>        |
| <b>Student:</b> | <b>Ryan Duty</b>       |
| <b>Student:</b> | <b>Landon Campbell</b> |
| <b>Student:</b> | <b>Austin Williams</b> |
| <b>Student:</b> | <b>Kyle Moss</b>       |

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|--------------------------|-----------|
| <b>Meeting Date:</b>     | 3-19-2020 |
| <b>Meeting Location:</b> | Room 210  |

**Topics Discussed**

Still working on the project, Coronavirus was starting so we werent able to meet in person. Chip Clark seems confident that we will still be able to meet in the IDEA Lab.

**Responsibilities/ Actions Taken**

Keeping in touch with Chip Clark, potentially meeting at the IDEA Lab to work on project. Also keeping in touch with Adam from The Wilds on parts and their shipment dates.

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|---------------------------|------------------|------------------|------------|
| <b>Next Meeting Date:</b> | <b>3/26/2020</b> | <b>Location:</b> | <b>N/A</b> |
|---------------------------|------------------|------------------|------------|



**Meeting Journal**  
**Department of Engineering Technology**  
**ENT 497/498 - Senior Design Project**  
**Project Title: Robotic X-Ray Plate Holder**

|                 |                                   |
|-----------------|-----------------------------------|
| <b>Advisor:</b> | <b>Present</b><br><b>Mert Bal</b> |
| <b>Student:</b> | <b>Ryan Duty</b>                  |
| <b>Student:</b> | <b>Landon Campbell</b>            |
| <b>Student:</b> | <b>Austin Williams</b>            |
| <b>Student:</b> | <b>Kyle Moss</b>                  |

|                          |           |
|--------------------------|-----------|
| <b>Meeting Date:</b>     | 3-26-2020 |
| <b>Meeting Location:</b> | N/A       |

**Topics Discussed**

Still working on the project, Coronavirus is getting worse faster and faster. We are not able to meet in person because of the pandemic. Are trying to find some way to work on the project and keep progress is going.

**Responsibilities/ Actions Taken**

Keeping in touch with Chip Clark, he said that since all buildings are closed at Zane State College, we are not able to utilize the IDEA Lab. Also keeping in touch with Adam from The Wilds on parts and their shipment dates.

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|---------------------------|-----------------|------------------|------------|
| <b>Next Meeting Date:</b> | <b>4/2/2020</b> | <b>Location:</b> | <b>N/A</b> |
|---------------------------|-----------------|------------------|------------|



**Meeting Journal**  
**Department of Engineering Technology**  
**ENT 497/498 - Senior Design Project**  
**Project Title: Robotic X-Ray Plate Holder**

|                 |                                   |
|-----------------|-----------------------------------|
| <b>Advisor:</b> | <b>Present</b><br><b>Mert Bal</b> |
| <b>Student:</b> | <b>Ryan Duty</b>                  |
| <b>Student:</b> | <b>Landon Campbell</b>            |
| <b>Student:</b> | <b>Austin Williams</b>            |
| <b>Student:</b> | <b>Kyle Moss</b>                  |

|                          |          |
|--------------------------|----------|
| <b>Meeting Date:</b>     | 4-2-2020 |
| <b>Meeting Location:</b> | N/A      |

**Topics Discussed**

Continuing with our progress on the projet, Coronavirus has shut down most all public meeting places. We are not able to meet because of this. We are still talking about the progress of the project with one another and are figuring out how the project is going to get completed given the circumstances at this point. Going to start on the final report soon

**Responsibilities/ Actions Taken**

Keeping in touch with Chip Clark, he said that since all buildings are closed at Zane State College, we are not able to utilize the IDEA Lab. Also keeping in touch with Adam from The Wilds on parts and their shipment dates. Looking like the parts are going to be in very soon, then we can finish assembling parts of the project.

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|---------------------------|-----------------|------------------|------------|
| <b>Next Meeting Date:</b> | <b>4/9/2020</b> | <b>Location:</b> | <b>N/A</b> |
|---------------------------|-----------------|------------------|------------|





**Meeting Journal**  
**Department of Engineering Technology**  
**ENT 497/498 - Senior Design Project**  
**Project Title: Robotic X-Ray Plate Holder**

|                 |                        |
|-----------------|------------------------|
|                 | <b>Present</b>         |
| <b>Advisor:</b> | <b>Mert Bal</b>        |
| <b>Student:</b> | <b>Ryan Duty</b>       |
| <b>Student:</b> | <b>Landon Campbell</b> |
| <b>Student:</b> | <b>Austin Williams</b> |
| <b>Student:</b> | <b>Kyle Moss</b>       |

|                          |          |
|--------------------------|----------|
| <b>Meeting Date:</b>     | 4-9-2020 |
| <b>Meeting Location:</b> | N/A      |

**Topics Discussed**

Continuing with our progress on the projet, Coronavirus has shut down most all public meeting places. We are not able to meet because of this. We are figuring out ways to still be able to get work done with the project.

**Responsibilities/ Actions Taken**

Keeping in touch with Adam from The Wilds on parts and their shipment dates. We are working on putting the rest of the project together and finishing it up.

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|---------------------------|------------------|------------------|------------|
| <b>Next Meeting Date:</b> | <b>4/16/2020</b> | <b>Location:</b> | <b>N/A</b> |
|---------------------------|------------------|------------------|------------|



**Meeting Journal**  
**Department of Engineering Technology**  
**ENT 497/498 - Senior Design Project**  
**Project Title: X ray plate robot**

|                 |                        |
|-----------------|------------------------|
|                 | <b>Present</b>         |
| <b>Advisor:</b> | <b>Mert Bal</b>        |
| <b>Student:</b> | <b>Ryan Duty</b>       |
| <b>Student:</b> | <b>Landon Campbell</b> |
| <b>Student:</b> | <b>Austin Williams</b> |
| <b>Student:</b> | <b>Kyle Moss</b>       |

|                          |           |
|--------------------------|-----------|
| <b>Meeting Date:</b>     | 4-16-2020 |
| <b>Meeting Location:</b> | Room 210  |

**Topics Discussed**

Group met up this week to discuss presentation and assemble arm and shaft. Still deciding whether we want to use the aluminum post or steel to hold the arm of the plate holder. Ryan took shaft that attaches to arm to adjust the lowest arm position.

**Responsibilities/ Actions Taken**

Currently assigning presentation responsibilities and working on slideshow.

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| <b>Next Meeting Date:</b> <b>4/16/2020</b> <b>Location</b> Landon's garage |
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