Asparagus Harvester
Clients: Steve Shoemaker, Richard Barker

12/11/14
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Executive Summary

Asparagus is ready for harvest in the spring, and when it is ready it needs to be harvested every day. The harvesting process is a very repetitive process that requires constant bending and can be very strenuous on the back. It can take roughly ten hours for one person to harvest a ten acre plot. In response, our clients, Richard Barker and Steve Shoemaker, asked us to design a tool that eliminates strain while harvesting and make the process more efficient. The tool or process developed needed to be gentle and decisive; the asparagus is fragile and cannot be sold when the floret is damaged. Also, the operator needs to be able to decide which asparagus is ripe for picking and which need more time.

Our solution to these problems was to develop a cart the client could propel by himself. Instead of designing a new cart, a cart that was already on the market was found. This cart allows the client to sit while harvesting, which adds strain to the legs, but reduces strain on the back and allows for a faster harvest. To help reduce the overall strain an arm was added that allows the client to harvest and grab the asparagus with a simple squeeze of a handle. Additionally, the client will not have to bend while sitting to cut and grab the asparagus. The cart also incorporates a new way of holding the harvested asparagus. Instead of using a messenger bag previously used by the client, which added strain to the back, a bucket system that allowed for easy storage of harvested asparagus was developed on the cart for easy asparagus storage. Our project budget was two hundred dollars, and the final budget was one hundred sixty one dollars. Since there is no asparagus farm to practice harvesting on, it is impossible to tell whether our project reduces the time required to harvest the four acre field. However, our design does reduce the strain on our client, which was our main goal.

Based on the testing that was done, the combination of the modified bucket, the modified arm, and the tractor scoot cart allow for our client to harvest asparagus with little strain. However, our testing was limited to a very small patch of asparagus inside of a building on a hard flat surface so it is unclear if the product will work in an actual field.

Introduction

Problem Statement

Richard Barker and Steve Shoemaker of Dancing Oak Farm are going to begin to seasonally harvest asparagus. Their current method of harvesting creates physical strain on the body, especially on the lower back. As of now, it takes 12 hours per day to harvest. A product needed to be created that reduces these strains and the harvesting time. It has to be light-weight device that various people can use, and has the ability to cut and collect asparagus in a more efficient way that reduces physical strain on the body.

Background Information

Harvesting asparagus consists of walking the field, bending over, and cutting every shoot by hand, and since asparagus has the potential to grow ten inches in twenty four hours, the whole four acres needs to be picked every day. (Michigan Asparagus Advisory Board). The picker of the asparagus must handle the asparagus carefully because its value is lost if the asparagus is damaged. Since the wholesale price of asparagus is only sixty four cents, any farmer cannot afford ~~to~~ a process that consistently damages the asparagus. (Cultivating a Healthy Food System). The asparagus is collected by either cutting the base with a knife, or snapping it with the fingers. The problem with this typical method is the lack of efficiency and the physical strain on the body. Dancing Oak Farm has 4 acres to farm and cannot use the bend and pick method day after day. Currently, Dancing Oak Farm owner Steve Shoemaker is farming all of the land entirely on his own.

The client is expanding his farm and needs a more efficient method of harvesting that reduces the physical strain. The harvesting of asparagus causes serious physical strain, particularly on the lower back. In order to reduce the physical strain and increase the efficiency of harvesting, a device must be designed that eliminates any bending of the back.

While working on coming up with a design, our group did research on products that could possibly be used as a model or something that could easily be modified. One product that was found was a Fiskars Head Shears, which originally was going to be ordered (Staples). Then the design changed after finding the idea of a deluxe tractor scoot (Gardener's Supply Company). When the changed our design, the Fiskars Head Shears was not ordered because it was too long, so more research was done on different cutting arms. One arm that was found was the Zenport Long Reach Pruner (Amazon). This was the arm that the design was based on.

Specifications

The specifications set up a parameter that the design must follow. The design must be able to function within the dimensions of the asparagus fields, which are set up in rows 4-5 ft. apart with crowns growing 12 inches apart from each other. There is a 10 ft. buffer at the end of each row that the product must be able to turn in without damaging the asparagus.

It is also extremely important that the design can properly harvest the asparagus. The product must be able to cut or aid the user in cutting the asparagus 3-4 in. above the ground to get it to the commercial length, which is about 6-10 in. It must be able to individually cut asparagus because the shoots do not grow at the same rates. The asparagus, specifically the floret, cannot be damaged in the harvesting process because this decreases the value of the harvest. The floret is the tip of the asparagus that is very tender and damages easily, so it is important that the device can handle the asparagus with extreme care.

Aside from performing its initial function of aiding in the harvest of the asparagus, the product must be durable and able to withstand rough terrain as well as all weather conditions, such as rain, wind, and mud. Not only does the design need to function in this terrain, but it also needs to be efficient, essentially cutting down the current 12 hour workday to 6-8 hours.

The device must accommodate our client who is 6 feet 2 inches tall and left handed. It must also be adjustable for other users of various heights and those who are not left handed. The client would prefer that the device is close to the ground so he can inspect the asparagus before cutting it. He would also like it to be light weight so it would be easy to transport. The product must avoid adding strain on the client, and it needs to reduce the current strain on the knees, hamstrings, and the back. The design is also limited to a $200 budget.

Design

Design for Small Group 1:

The team of twelve was originally two teams of six. These smaller teams originally brainstormed their ideas separately. The teams not only brainstormed products that could be fabricated to eliminate strain and to speed the harvesting process, but they also thought of materials that could be used and other processes of harvesting to speed up the process and reduce strain. After the initial brainstorming, designs were narrowed down to the ones that would reduce strain the most, were more time and energy efficient, were possible to fabricate, and were cost effective. The group developed three major ideas through brainstorming. The first was a paddle boat style cart, which allowed for two people to work at once while pedaling through the field. Another was a tractor implement, which would be a wagon hitched to a tractor, allowing one person to sit and pick. The third was a single person pedal car, which was similar to the paddle boat but only allowed for one person to work. The group used a decision matrix, shown in Figure 1, to decide which was the best option. We came up with different aspects of the design which we thought were important to consider and ranked them on a scale from 1 to 5 on which we could weigh each aspect. Then each idea was ranked on a scale from 1 to 5 based on how well it incorporated each aspect. The weighted totals were then compared, and for our design we found that the best design was the paddle boat. However, after some discussion and sketching, the decision was made that this design would be too expensive and very difficult to fabricate. The group then decided to add a fourth possibility, the extension arm. The final decision matrix favored the extension arm because of its low cost, feasible fabrication, and its work and harvesting efficiency.

Design Matrix					
	Weight	Tractor Trailer	Paddle Boat	Pedal Cart	Extension Arm
Work Force Efficiency	3	1	5	5	5
Physical Effort/Strain	5	4	3	2	4
Storage	2	5	3	2	1
Harvesting efficiency	4	3	5	4	4
Fabrication	4	2	1	2	4
Total Score:		53	60	53	69

Figure 1. Group 1 Decision Matrix. This is the decision matrix group 1 used to determine which design would incorporate our specifications best.

Design Description for Small Group 1:

Although the extension arm was a better choice, the group decided to create a decision matrix as well in case more money was available. Our cart design included a wide enough body for two people to harvest different rows at the same time, and a pedal system that allowed two people to pedal at the same time. Adding a tongue to allow the possibility of being hooked up with a tractor was also considered. The design of our combination asparagus cutter and collector was based off of a tree lopper. The design was a combination of a lopper and a padded grabber to collect the asparagus while cutting. Our design allowed for our client to be able to harvest the asparagus with a simple squeeze and slight turn of the wrist. Our biggest problem with this design was the lack of storage, so a pull behind cart was added as shown in Figure 2. The cart had a shoot that extended in front of the person harvesting, which eliminated twisting for the client, and made the process more ergonomically sound.

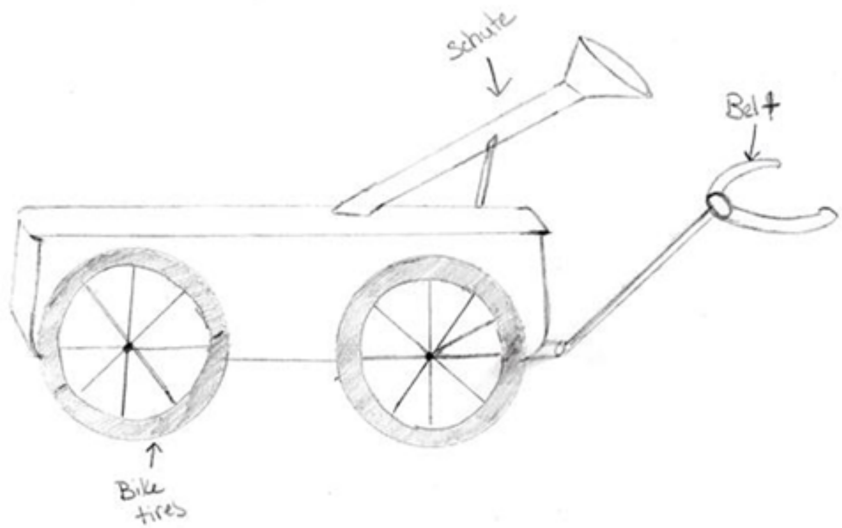

Figure 2. Cart Collection System. This is the sketch for the collection system for the extending arm design. It includes a side shoot for the asparagus to slide into the crate, a belt to attach the cart to the farmer, and bike tires.

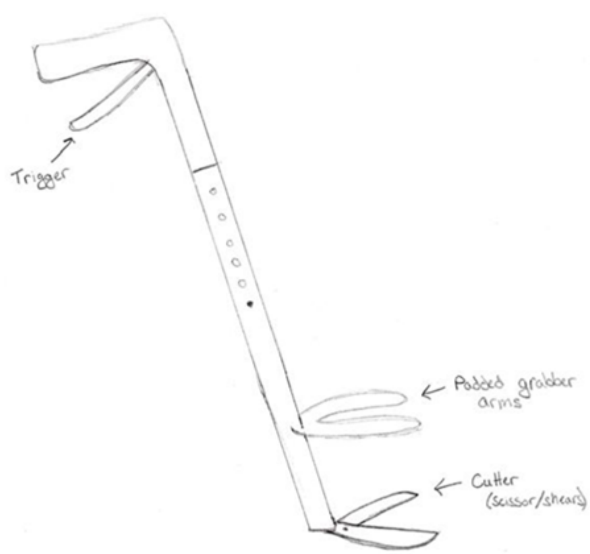

Figure 3. Arm Grabber. This is the drawing of the extended arm grabber. It includes a padded grabber, scissors to cut, and a trigger to make the grabber and scissors close.

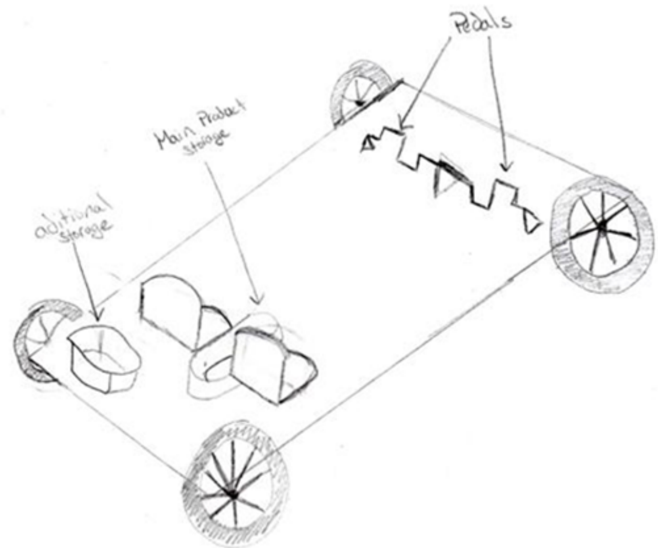

Figure 4. Paddle Boat Cart. This is the sketch of the paddle boat cart. It includes pedals that move backward and forward, a main storage section between the seats, and thick tires.

Design for Small Group 2:

The other small team initially came up with a problem statement and a list of specifications after asking the client questions and gathering research about asparagus harvesting. We then started the brainstorming process to come up with different ideas for the design. We split the brainstorming up into different categories to help facilitate the brainstorming process. Some of the categories included ways to get the farmer to the ground, ways to cut asparagus, ways to hold asparagus, tires, accessories, and materials. From these different categories, we went through and analyzed each one and decided which ideas we wanted to incorporate into our design. When we combined all of these ideas, we came up with one design for our small group, which was a recumbent bike design that allowed the farmer to sit low to the ground and pedal along the rows to harvest the asparagus. The way that the farmer was going to cut the asparagus, though, was still in debate for our group. We had four different ways that the farmer could cut the asparagus. One way was a design we came up with called the jaw scoop multitool, which is seen in Figure 5. The other three ways were by using a manual knife, snapping the asparagus stalk with your fingers, or by cutting it with shears. To decide which way would be the best way to cut the asparagus, we used a decision matrix which is shown in Figure 6.

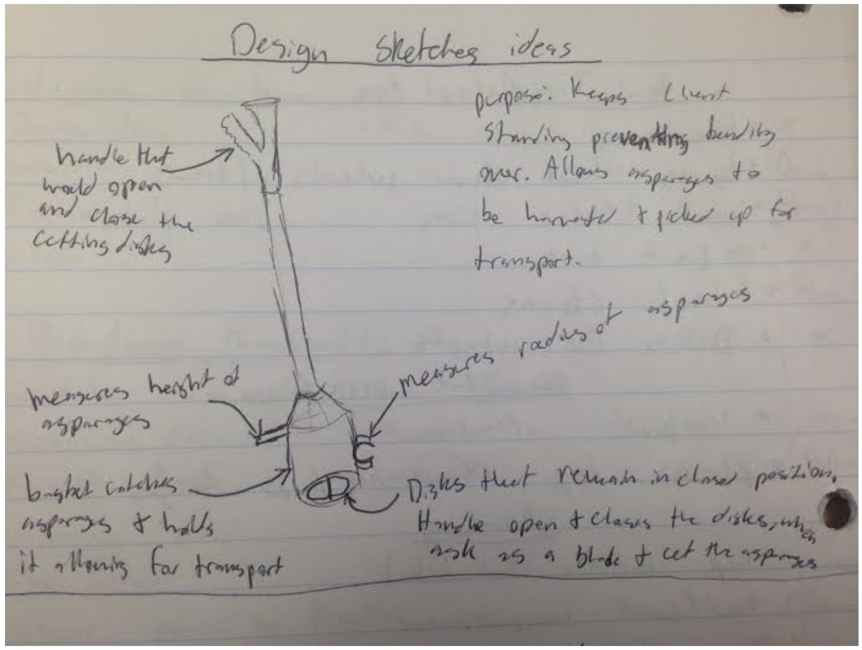

Figure 5. Jaw Scoop Multitool. This picture shows the jaw scoop multitool, which would allow the farmer to measure, cut, and collect asparagus.

Aspect	Weight	I) Jaw Scoop Multitool	II) Manual Knife	III) Snapping with Fingers	IV) Sheers
Safety	3	4	3	5	3
Weight	2	3	4	5	3
Cost	1	1	4	5	3
Functionality	5	3	4	2	4
Fabrication	4	2	5	5	3
		42	61	60	50

Figure 6. Group 2 Decision Matrix. This decision matrix helped small group 2 decide which method of cutting would be the right option.

Design Description for Group 2:

The group decided to go with the recumbent bike design, as seen in Figure 7 for the-main design. This design would allow the farmer to sit low to the ground and pedal slowly along the

rows to harvest the asparagus. There would be a crate, shown in Figure 8, on the side of the bike where the farmer could collect the asparagus. This crate would be able to be put on either side of the bike to accommodate either left or right handed users. Additionally we would have a container being pulled along from the back of the bike that would hold extra crates to carry asparagus. Additionally, the chair would be able to be adjusted both forward and back to accommodate for different heights and leg lengths of the users. Behind the chair there would be an extra compartment to hold extra tools or a first aid kit. On the armrest there would be cup holders and a holder for an umbrella as well. Also, the bike would be a fixed gear so that no hand brakes would be required, since our client wouldn't have to move a very long distance in one cutting. The steering would be controlled through handles that are next to the user. Also, if we had extra any extra time and extra money in our budget, we thought about designing a measuring tool, which is shown in Figure 9. The measuring tool would be used to see if the asparagus was the right height to be harvested. There would be a marker for the minimum height, a maximum height, and a cutting
height.

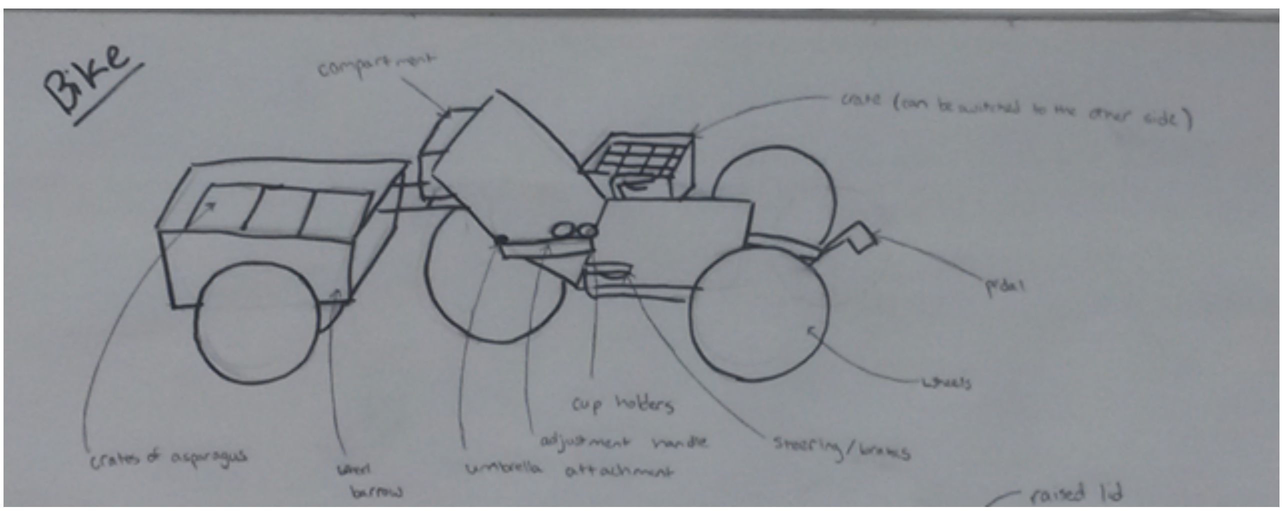

Figure 7. Recumbent Bike Design. This is a sketch of the recumbent bike design that small group 2 designed. The design includes pedals, handles for steering, and an adjustable seat.

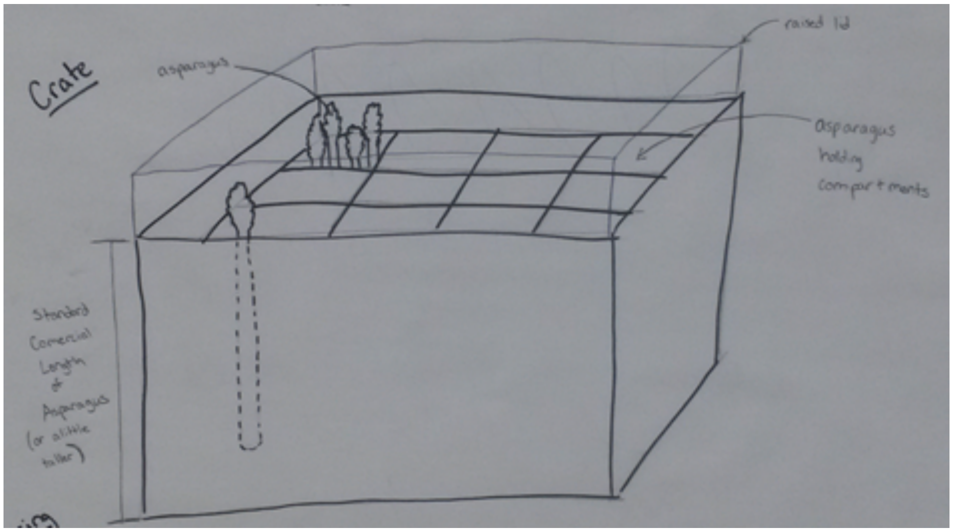

Figure 8. Crate Design. This is a picture of the crate design from small group 2. The design features dividers that keep the asparagus stored upright and a raised lid so as to not crush asparagus.

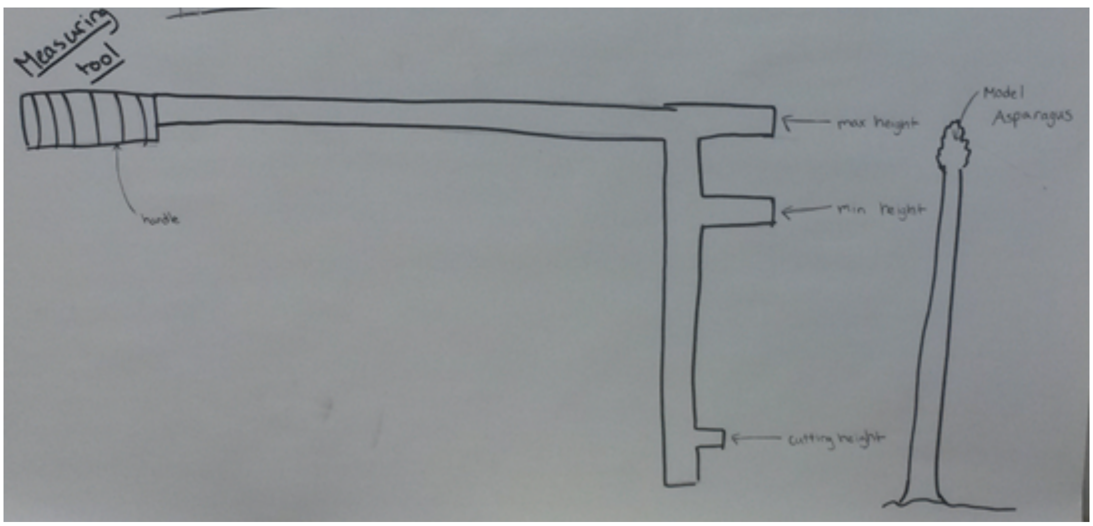

Figure 9. Measuring Tool Design. This is a sketch of the measuring tool design from small group 2. This tool would be able to measure the maximum height, minimum height, and where to cut the asparagus.

Final Design

After the two teams joined together and formed a larger group, there was a discussion about the overall design and the group figured out that it was not feasible to fabricate either the recumbent bike or the boat style cart design under the 200 dollar budget. The design ideas were presented to the shop professionals who informed the team that it was not conceivable to

Figure 10. Fiskars Hedge Shears.
This is a picture of our first extendable arm that our group was considering. (Staples).

fabricate either of the two designs unless everyone obtained a green pass with a welding upgrade and dedicated a lot of time over the semester to fabricating. Trying to stay within the budget, some alternative designs were considered. Generally, the two ways to reduce the strain are to either lower the client to the ground or to keep the client standing up.

One design the team thought of was an extension arm, as seen in Figure 10. The blade is low to the ground and a handle at the top of the arm allows the user to cut while standing up. A u-shaped metal catcher on the side of the arm allows the users to collect 5-10 shoots of asparagus at a time before transferring them to the collection system. To make the harvesting more efficient, we came up with a cart design as the collection system. The cart was designed to be low to the ground and hold a crate. This was to make sure that the asparagus can be efficiently collected without a drastic raising hand motion to release the asparagus. For the handle, we implemented a u-shaped design to make sure that the cart can be pushed easily around without using one's hands.

The other idea was to keep low to the ground by using a deluxe tractor scoot as seen in Figure 11. For this design, we would order a deluxe tractor scoot and assemble it. One negative aspect of only having a deluxe tractor scoot with no extendable arm would be that there is still Some bending while collecting the asparagus. The strain, however, is much less severe compared to the original method of harvesting.

Figure 11. Deluxe Tractor Scoot. This is a picture of the deluxe tractor scoot which would allow the client to be low to the ground.

Along with the deluxe tractor scoot, our team had to think of ways that the asparagus would be cut. Two major ways to cut the asparagus were decided upon by our team. One way was to use a hand weeder to cut the base of the asparagus. The second way to cut the asparagus would be by an extendable arm. To make decision on which design we would be using, our group used a decision matrix, as seen in Figure 12.

	Weight	I) Collection System + Extension Arm	II) Rolling Cart	III) Rolling Cart + Long Knife	IV) Rolling Cart + Extension Arm
Cost	4	3	7.5	6	4.5
Fabrication	3	3	8	8	5
Strain	5	6	4	5.5	7
Efficiency	4.5	7.5	6	6	6
Total		84.75	101	102.5	95

Figure 12. Integrated Teams Decision Matrix. The results shows that Design II and III were the highest scoring, yet our group decided to focus on design IV because overall this design offered the least amount of strain to our client.

After consulting our decision matrix, our team decided to go with the tractor scoot design with an extendable arm. We decided upon this design, even though it was not the highest scoring, because this design reduced the most strain on the harvester. Our team agreed that reducing the strain was the most important aspect to the design and our ultimate goal for this project.

Figure 13. Fiskars Head Shears. This is a picture of the extendable arm which our group modified.

Our group had to design an extendable arm that would work with the deluxe tractor scoot, so we did some research. One arm that we found to be the most feasible was Fiskars Head Shears displayed in Figure 13. This cutter has a rotating blade head and automatically locks once one squeezes the handle. The only modification to the arm that we saw was necessary was a way the cutter could hold the asparagus after it was cut. We brainstormed multiple different ways to have the arm collect the asparagus. One design was to modify one of the plastic guards on the blade so that instead of squeezing shut with the blade, the guards would not close all the way and leave a space for the asparagus stalk. But this design could not be fabricated. Another way to have the arm hold the asparagus would be to have 4 screws sticking out of the blades and rubber bands looped on the top of the screws as shown in Figure 14. This way when the blade cuts the asparagus, the rubber bands would close around the asparagus and hold the stalk. We decided to use the 4-screws and rubber band design as the method for the arm to hold the asparagus because it was feasible.

Figure 14. Screws in the blade. This is a picture of the two screws in the blade of the arm cutter. At the top of the screws is where the rubber bands are placed.

Once we knew how the asparagus was going to be cut, we needed a way it could be stored as our client moved down along the rows. For this problem we decided to use a 5-gallon bucket to hold the asparagus because the deluxe tractor scoot has a basket on the side made for holding a 5-gallon bucket. Within the 5-gallon bucket, however, we needed a way that the asparagus could fit without it being damaged. So we designed an inner bucket with 4 slots to hold the asparagus as seen in Figure 15. This inner bucket is also removable for easy removing of the collected asparagus without damaging the floret.

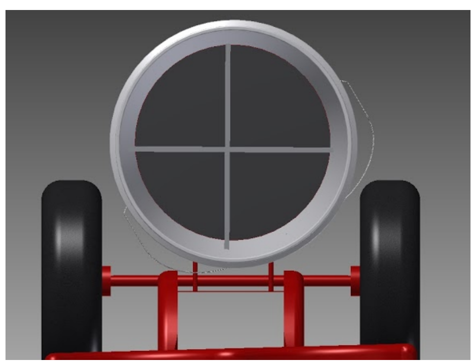

Figure 15. Bucket. This is a picture of the 3-D sketch of the bucket with the dividers.

Altogether, our final design consisted of a deluxe tractor scoot with a bucket collection and an extendable arm to cut and collect the asparagus.

Testing

To ensure the new asparagus harvesting process actually worked, the team had to test to see if the asparagus harvester cut and grabbed the asparagus without harming it, and the team also had to test the dual-bucket system that holds the asparagus after it had been harvested.

The best way to test the design was to simulate what the client does in the field. We did not have a field of asparagus to test on; however, so we simulated rows of asparagus by cutting holes in a box with the spacing that would be expected in a common asparagus field as seen in Figure 16. We placed the box on the ground in the shop, and we were ready to test.

Figure 16. Asparagus Prep. This is a picture of the asparagus stalks which were placed in a box in order to simulate asparagus in the field.

Chase was our test subject, and he started on the tractor scoot about five feet away from the asparagus plot. He rolled the cart towards asparagus, simulating how our client would. He then stopped near the plot, and began to cut the asparagus with the asparagus harvester in his left hand because our client is left handed. The asparagus harvester grabbed the asparagus while cutting. Chase brought the asparagus to right hand, then placed it into our dual bucket collection system. His sleeve caught on the wire handle of the bucket as he was placing the asparagus in the bucket. We then tested our dual bucket design system by lifting the inner bucket out of the outer bucket, which allows for our client to easily handle the harvested asparagus. The testing can be seen in Figure 17 and Figure 18.

Figure 17. Testing the Product. This picture illustrates one of our team members testing our product.

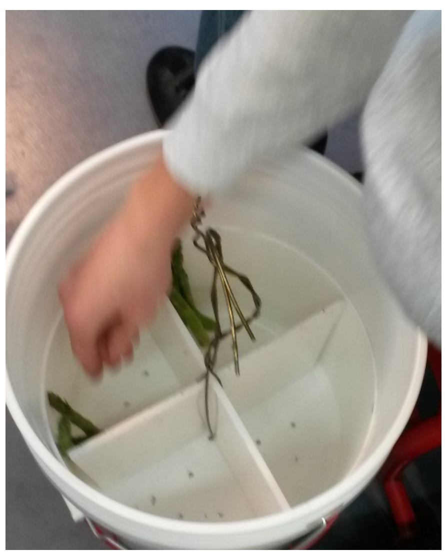

Figure 18. Testing the Bucket Collection. This picture shows one of our team members testing the storage of our bucket system. As illustrated in the picture, the sleeve was getting caught on the handle.

Our testing showed us that our product would work for our client. The cart rolled in a straight line without difficulty. Our asparagus harvester cut the asparagus with ease; it did not require difficult squeezing motion. It also held onto the asparagus while cutting it, which allows for easy collection of the cut asparagus. The asparagus was placed into the dual bucket collection system, and we noticed a safety concern when Chase's sleeve caught on the wire handle, so we placed plastic tubing over the sharp wire to decrease the possibility of our client being cut. The collection system also worked. Since the inner bucket can be removed and there are holes in both buckets, it allows our client to easily handle and wash the collected asparagus. Overall, our design works great. We were unable to eliminate all forms of strain, but we made the strain on the body much more manageable.

Design Limitations

Our design, although it solves the issues provided to us by our client problems, is not free of flaws. The tractor scoot will be very helpful to reducing the strain on the client's back, but is not super lightweight for it weighs 39 pounds, and there will be added strain to the legs of the client as he has to propel the cart using his own power. Additionally, the blade requires two thicker-sized rubber bands to collect the asparagus, which would have to be replaced when the rubber bands become overused and stop holding the asparagus. The rubber stopper on the tractor scoot makes turning more difficult while seated, but most of the steering will be done while the client is standing and not sitting on the scoot. While the combination of the tractor scoot and the extended arm solves most of the client's main concern about strain on the back, there is still a chance of strain on the wrist from the repeated motion of squeezing the trigger. Another problem we noticed is the blade may wear down with time, but the client has the potential to remove the blade and then sharpen it.

Gantt Chart

The Gantt chart shown in Figure 19 was created to organize a schedule and deadlines for the group. The green boxes show the date in which the task was completed.

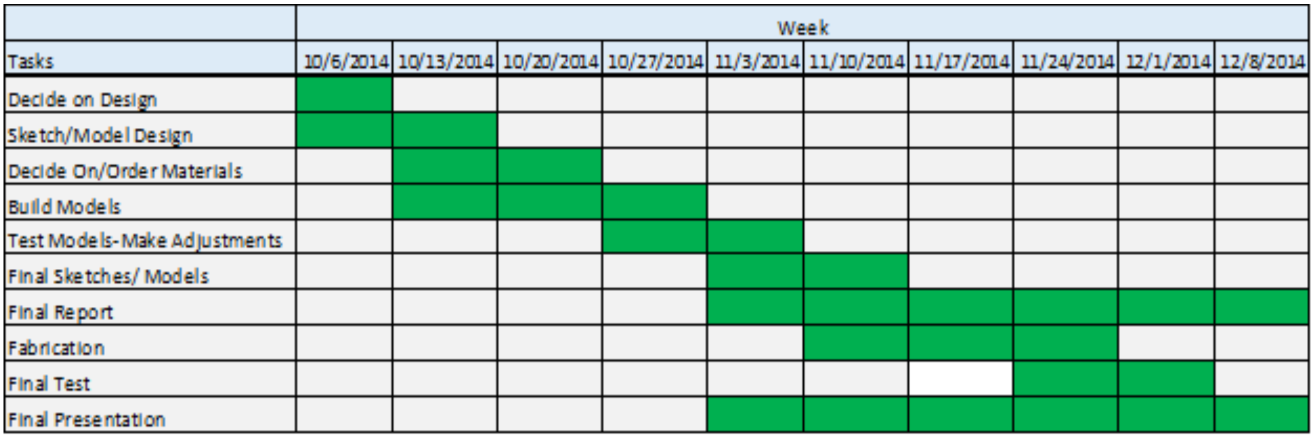

Figure 19. Gantt Chart. The Gantt chart gives the group deadlines for when certain tasks should be complete.

Work Load Allocations

Figure 20 shows the task distribution amongst the team as well as the description of each person's task. While the main job of each team member is listed, each member is not limited to their individual task and may help complete other responsibilities when need.

Name	Title	Task
Chase and Aviah	Co-Manager	Organizes design and oversees the project
Lilly and Hannah	Presentation Manager	Creates PowerPoint and collects information
Cale	Discussion Recorder	Relays messages to members not present at meeting
Emma and Jack	Design/Testing	Tests efficiency of design
Aviah	Materials Manager	Ordering Materials
Charlie	Fabricator/Researcher	Researches different options for design
Colton and Cale	Solid Works Designer/ CAD	3D design creator
Q and Tyler	Design Analyzer	Makes sure design fits the specifications
Chase	Presenter	Rehearse and give design presentation
Danielle	Budget/Contractor	Makes sure we are within budget

Figure 20. Work Load Allocations. This chart splits up roles among the team members so that everyone has a task to work and the team can work effectively.

Conclusion

The project began with a problem presented by the client. Steve Shoemaker and Richard Barker needed a device to aid in the harvesting of four acres of asparagus. Their current method of harvesting is very time-consuming and puts a lot of strain on the lower back specifically. Mr. Shoemaker currently walks the field, bends down to cut the asparagus with a knife, and places them one by one in his messenger bag. The current method is too slow and laborious for the client.

Our design solves the clients' major issues. The tractor scoot eliminates the painful repetition of bending at the waist. The extended arm stops the client from leaning forward to cut or pick up the asparagus. The rubber bands on the blade pick up the asparagus so the client doesn't have to lean forward to catch it. Additionally the scooter has the ability to hold a bucket that can carry the asparagus more efficiently than the messenger bag. It is also less painful for the client to wheel around the asparagus than to have all the weight on his shoulder.

Appendix

Materials

Item Description	Dimensions	Quantity	Price	Retailer
Deluxe Tractor Scoot with Bucket Basket	44-1/2" L x 18" W x 22" H, 10” tire diameter	1	$99.94	Amazon.com
Zenport ZL610 Long Reach Pruner	24 x 2 x 2 inches	1	$40.54	Amazon.com
Plastic Sheet	21” x 8’’	1	$4.00	Student Shop
5 Gallon Bucket	10” diameter x 15” H	2	$8.94	Home Depot
Spray Paint	1 can	1	$3.44	Home Depot
10-24 Screw	1⅞ in. long	4	$0.21	Student Shop
Thick Rubber bands	¼ in. thick	2	Free	Teammate’s House
Coat Hangers	Average size; metal	2	Free	Last year’s supplies
Plastic tubing	3 feet long (used 2 ft.), ½ inch thick	1	$4.39	Student Shop
TOTAL			$161.46	

Fabrication Instructions

Cart

1. Organize parts for assembly.
    I. Wheel assembly: 8 16-mm washers, rear axle, steering link connector, 2 8-mm nuts, 2 8x20 bolts, 2 8-mm washers, 2 axle sleeves, 4 cotter pins, 4 wheels
    II. Tray attachment: 4 6-mm washers, 4 6 x 15-mm bolts, a plastic tray, 2 small reinforcing plates, 2 scoot tray brackets (one is pre-welded)
    III. Seat attachment: 4 10x15-mm bolts, 4 10-mm washers, 4 10-mm nuts, and seat
    IV. Handle Attachment: 8-mm nut and washer on pre welded bolt, 8 x 25-mm bolt, 8-mm washer, 8-mm nut, steering handle
    V. Tools required: needle nose pliers, 2 adjustable wrenches or pliers, Phillips screwdrivers to fit the 6 x 15-mm bolts
2. Attach the steering link to the front axle.
    I. Place the steering link connector nub side up on the front axle support.

Figure 21. Steering Link Connector.

II. Attach using the prefabricated holes and the 2 8 x 20-mm bolts, 2 8-mm nuts and washers as shown in Figure 21.

3. Attach the rear axle.
   I. Insert the rear axle through the rear axle frame
   II. Place an axle sleeve on each side of the rear axle
4. Attach the wheel.
   I. Place a 16-mm washer on both sides of the front and rear axles. Place a tire on each axle after the washers See Figure 22.

Figure 22. Attaching the Tires

II. Place another 16-mm washer on the outside of the tire (the tire should be sandwiched by washers).

III. Finish the attachment by running a cotter pin through the predrilled holes at the end of the axles. (Use the needle nose pliers to bend the ends of each pin.) See Figure 23.

Figure 23. Attaching the Tire with Cotter Pin

5. Attach the steering handle.
   I. Remove the 8-mm nut and washer from the pre welded bolt on the front axle support. Line up the holes on the base of the handle with the pre welded bolt and the hole on the steering link connector.

Figure 24. Attaching the Steering Link Connector.

   II. Use the nut and washer that came with the pre welded bolt to attach the front hole and use the 8 x 25-mm nut, washer, and bolt to attach the rear hole as seen in Figure 24.
6. Attach the under seat tray.
   I. Line up the holes on the plastic tray with the holes on the pre welded tray bracket on front of the cart frame.
   II. Line up the holes of the small reinforcing plates to the holes of the bracket and the plastic tray (sandwich the tray with the pre welded bracket and the small reinforcing plate like in Figure 25 and Figure 26).
   III. Attach using the 6x15-mm bolts, nuts and washers.

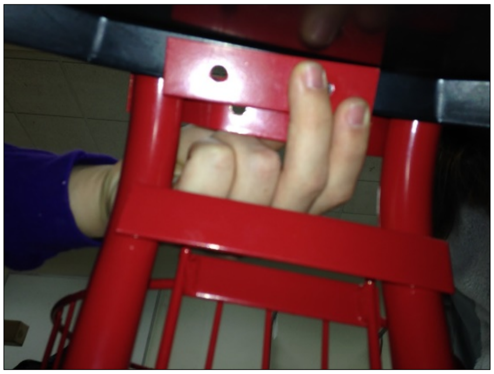

Figure 25 and Figure 26. Attaching the Under Seat Tray.

IV. Repeat the previous steps to attach the back. The only difference is the back bracket is not pre welded.

7. Equip the basket.

I. The bottom brace of the bracket rests on the rear axle frame, and the top bracket rests between the two frame bars.

Figure 27 and 28. Attaching the Seat.

8. Attach the seat.

I. Attach the seat to the seat post on the cart frame by using the 4 10x15-mm bolts, nuts and washers. Use an adjustable pliers or wrench and a phillips screw driver to tighten the washers as shown in Figure 27 and 28.

II. Make sure the cotter pin, which was pre attached, at the bottom of the seat axle is properly wrapped.

Bucket

1. Gather parts for assembly

I. 2 white 5-gallon buckets

II. 2 wire hangers

III. 21" X 8" X .25" sheet of white plastic

IV. 2ft long .5in. width plastic tubing

2. Mark up the dimensions for the plastic dividers
    I. Follow the dimensions as shown below and mark on the sheet where you will be cutting using a scoring tool.
3. Cut the plastic sheet using a bandsaw shown in Figure 29.

Figure 29. Cutting the Plastic Sheet with Bandsaw

4. Cutting one of the buckets
    I. Take one bucket and measure 6.5” from the bottom
    II. Mark the spot with a dry erase marker
    III. Repeat steps I and II 3 more times placing the mark above each divider
    IV. Take a sheet of paper or a sewing tape measure and connect the marks
    VI. Using a dry erase marker, trace along the sheet of paper or tape measure in order to make a ring around the bucket that is 6.5” above the bottom.
    VII. Clamp down the bucket for safety.
    VIII. Use a sawzall to cut along the ring. A hand saw may be needed to cut the last few inches. See Figure 30.

Figure 30. Cutting the Bucket.

IX. Use a deburring tool to remove rough pieces.
X. Use a belt sander to sand down the top of the bucket as seen in Figure 31.

Figure 31. Sanding the Bucket.

XI. Use a deburring tool again to remove rough pieces.
XII. Wash out the bucket to remove any debris and dust.

5. Drilling holes in the bucket.
   I. Mark, with a dry erase marker, four symmetric dots, each about a half inch away from the center of the bottom of the bucket.
   II. Using a drill press and a center drill, make four holes on the four dots. These holes will be used to thread the wire for the handle.

III. Then take both the whole bucket and measure eight dots each about 2" from the center of the bucket. These dots should be evenly spread out around the bucket. Another set of eight dots should be marked about 2" above the first set of dots.

IV. Now Take the half bucket and mark four dots about 2" from the center of the bucket. The dots should be equally spaced between each divider. Another set of dots should be placed about 2" above the first four dots, again equally spaced between the dividers. The final set of dots will be placed 3" from the center of the bucket and about 1" from the dividers. There should be a total of 8 of these dots.

V. Using a drill press and a center drill, make holes on all of the dots marked on both the half and whole buckets. These holes will act as drainage points for the bucket.

6. Making the handle

I. Take the two wire hangers and pull them apart and straighten them so that you have two pieces of wire.

II. Find the halfway point of each wire and bend a U-shape which is about an in. long as shown below in Figure 32.

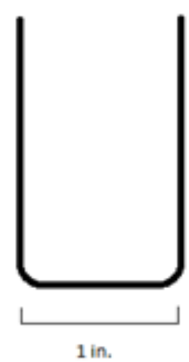

Figure 32. Wire U-Shape.

III. Insert the plastic dividers into the bucket which was cut.

IV. Thread each wire through the holes and up along the plastic dividers.

V. Twist two opposite wires together, starting where the wires stop running along the dividers.

VI. Take the plastic tubing and thread it over each twisted set of wires to make a handle. Bend the wires to the desired shape as shown in Figure 33.

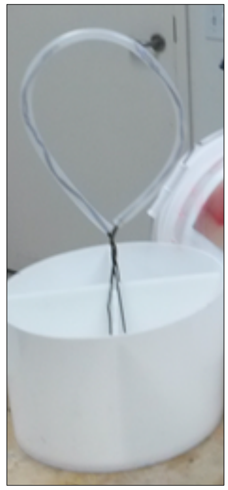

Figure 33. The Final Product

Grabber

1. Gather parts (came assembled).
2. Remove blade.
3. Screw blade to a small board.
4. Place board in a vise on a drill press.
5. Drill two 9/64" holes near the top and bottom of the blade.
6. Tap into the two holes with a 4-mm tap.
7. Screw in bolts to the holes of the blade as seen in Figure 34.

Figure 34. Screwing Bolts into Blade.

8. Tap weld the bolts to the blade as seen in Figure 35.

Figure 35. Welded Bolts to Blade.

9. Reattach the blade to the arm as shown in Figure 36.

Figure 36. Attaching Blade to the arm.

10. Screw two bolts into pre-drilled holes on opposite side.
11. Wrap one rubber band around each set of bolts as seen in Figure 37.

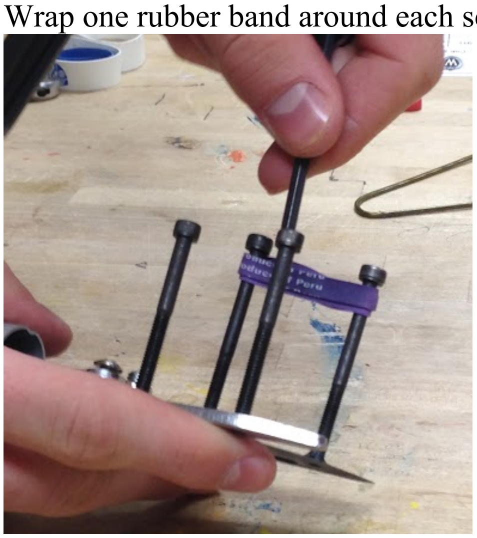

Figure 37. Wrapping Rubber Bands and Screwing in Bolts.

Computer Sketches

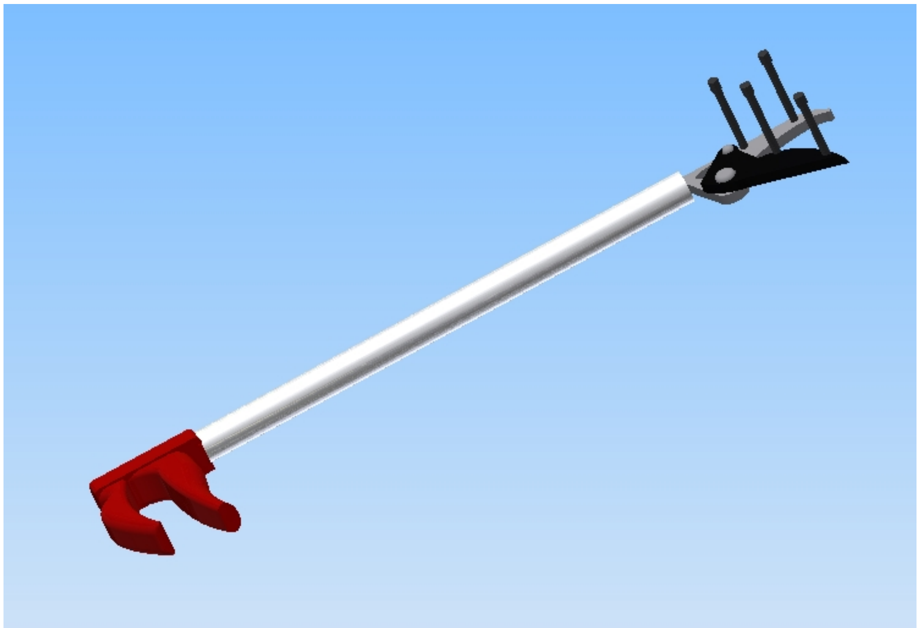

Figure 38. Arm.

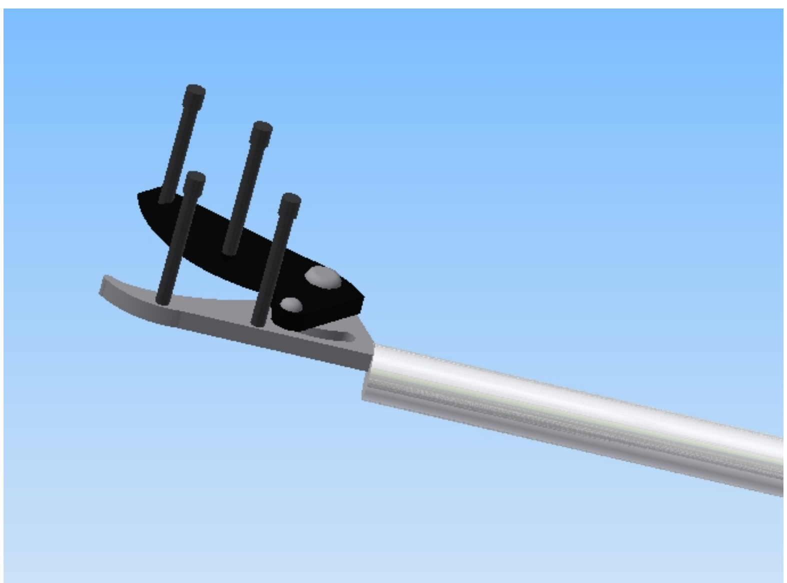

Figure 39. Close up of blade.

Figure 40. Tractor Scoot with Bucket.

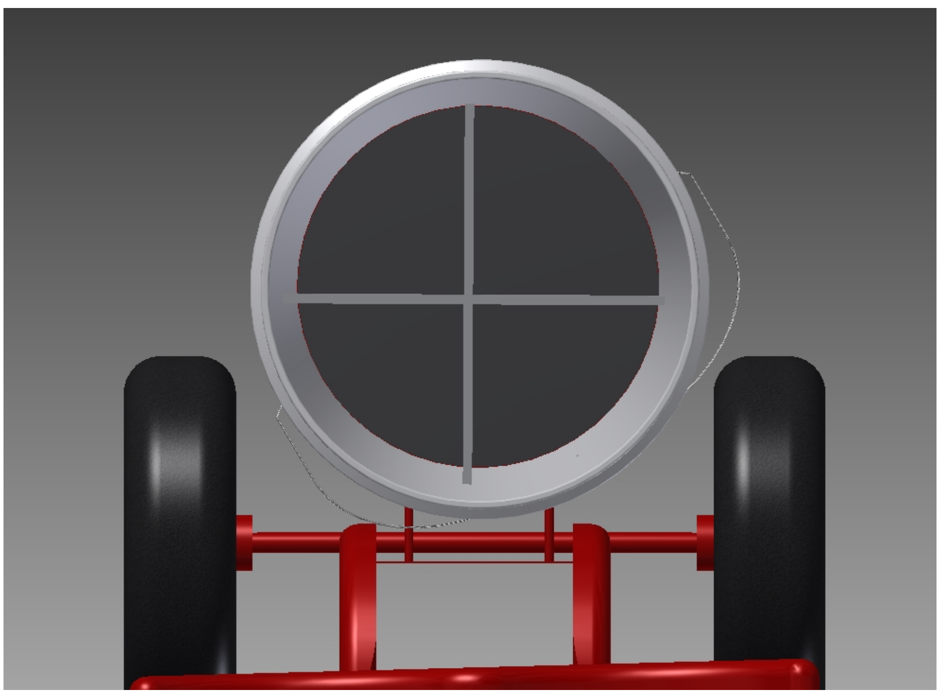

Figure 41. Top View of Bucket.

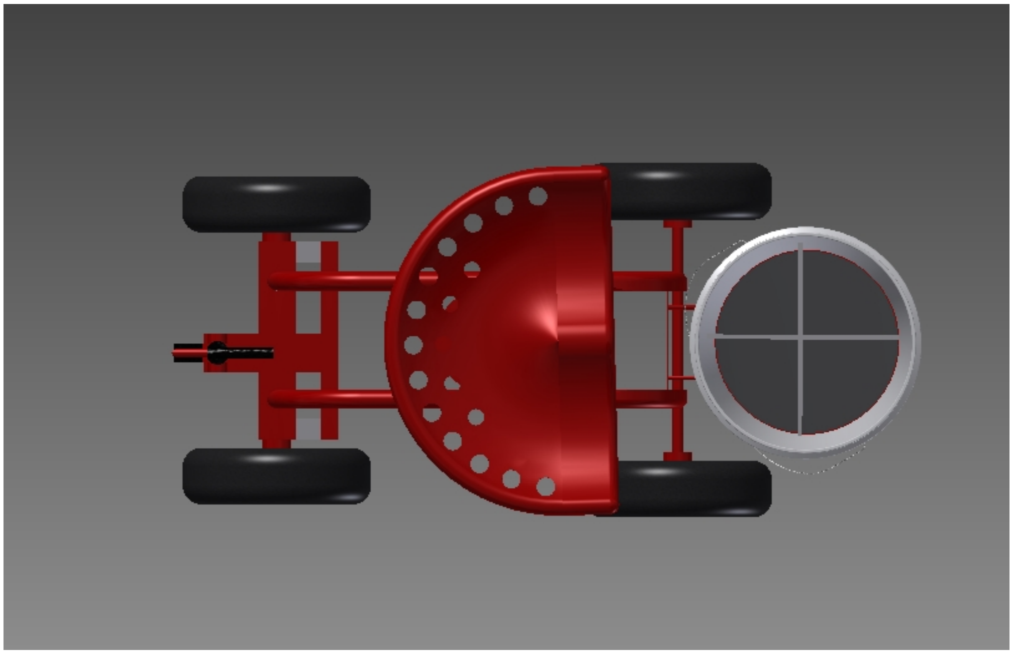

Figure 42. Top View of Tractor Scoot.

Figure 43. Diagonal View of Tractor Scoot.

Dimensioned Drawings

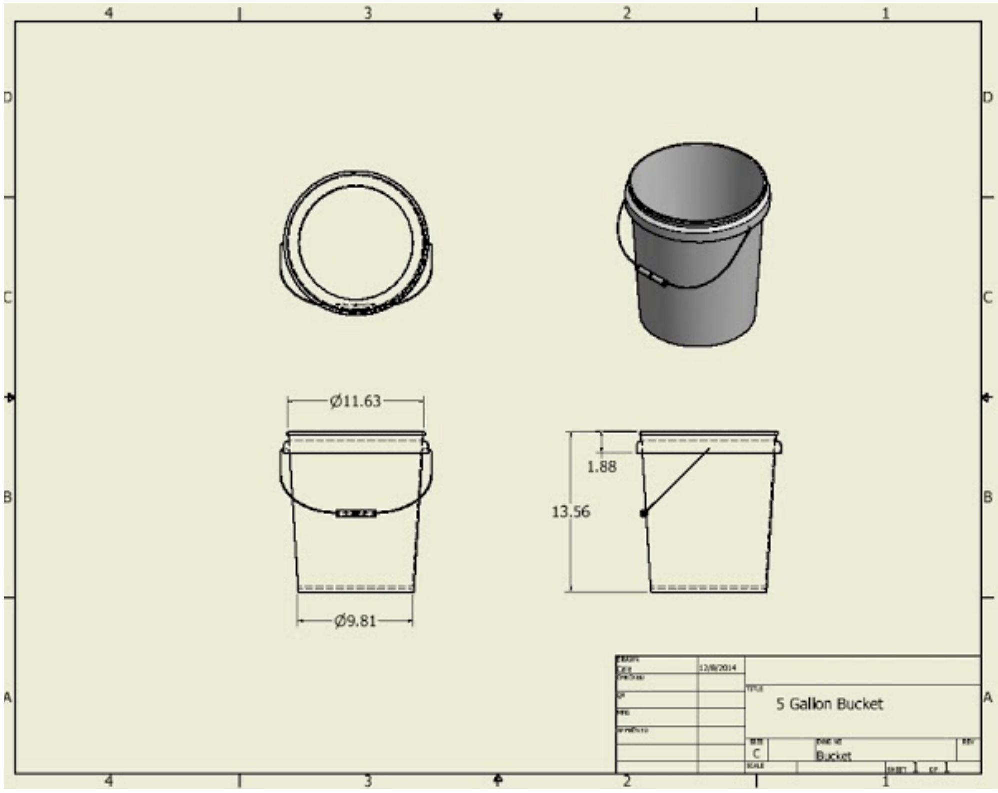

Figure 44. Bucket.

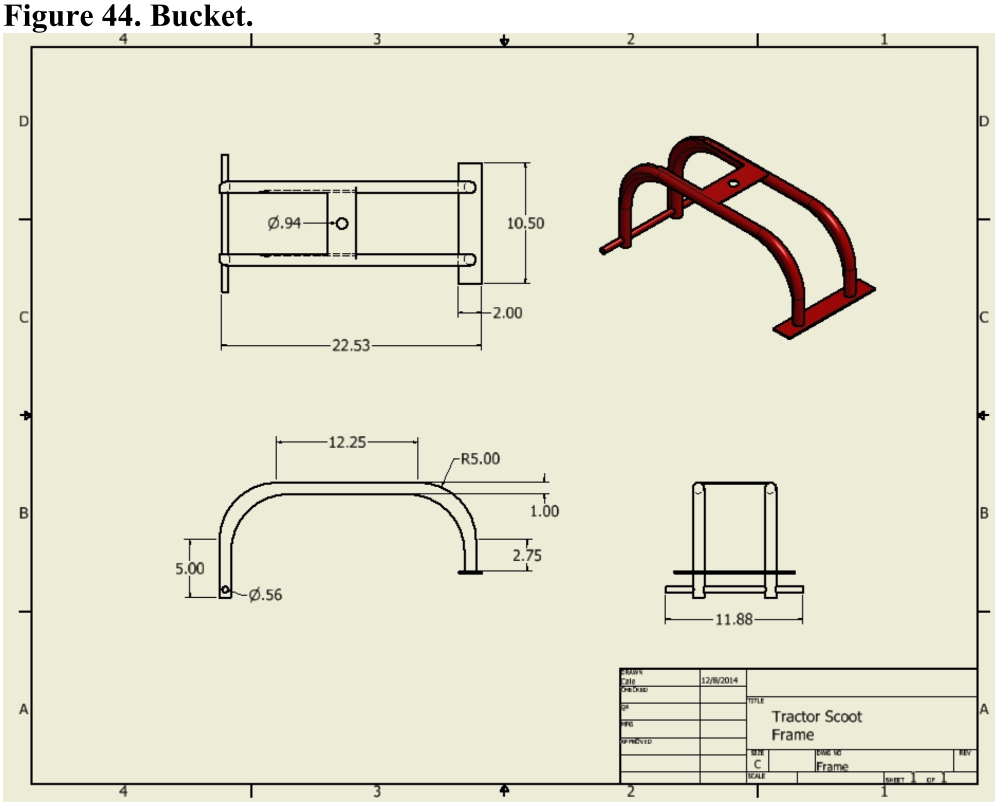

Figure 45. Tractor Scoot Frame.

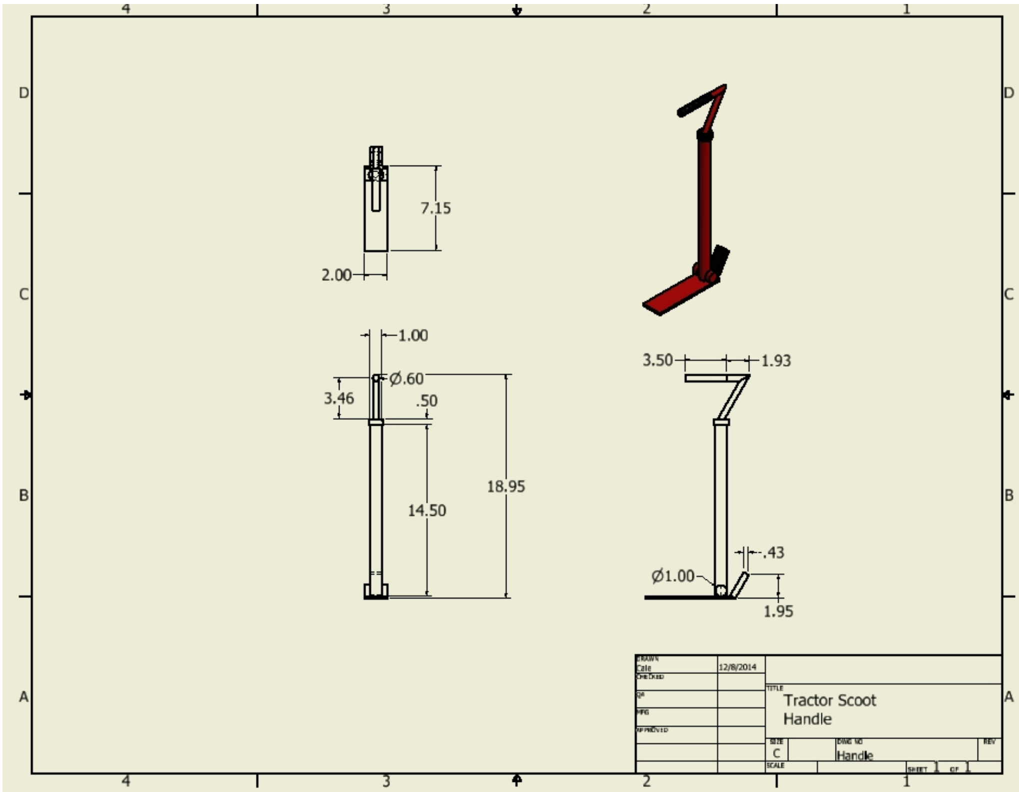

Figure 46. Tractor Scoot Handle.

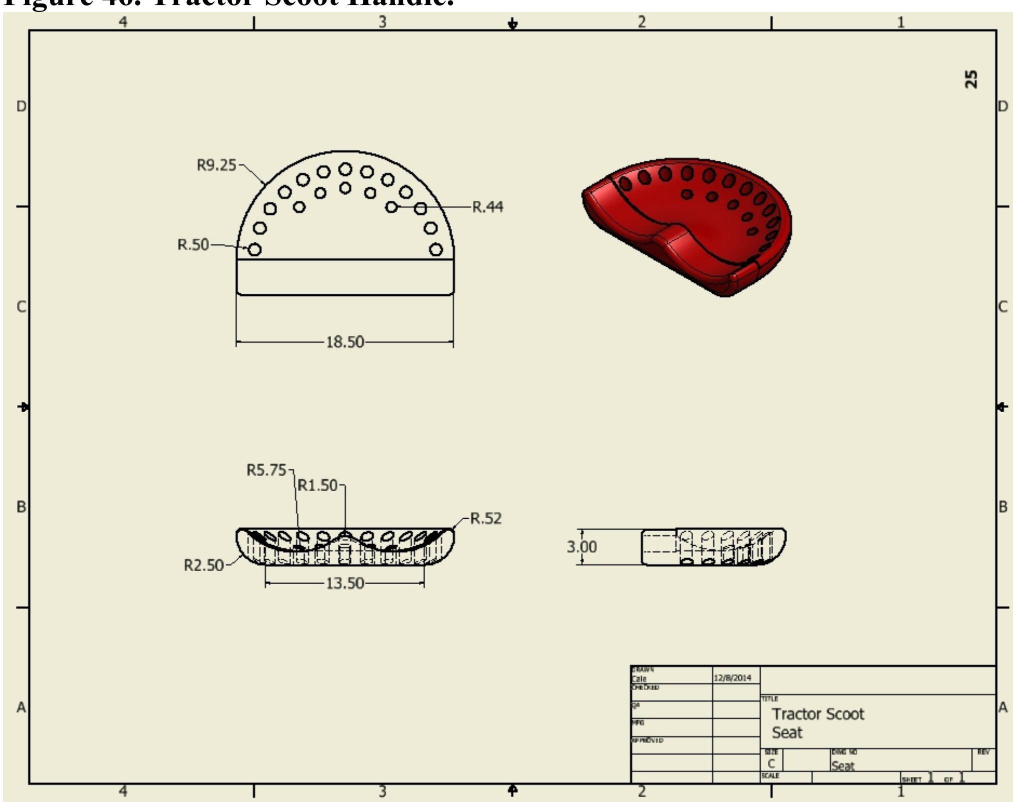

Figure 47. Tractor Scoot Seat.

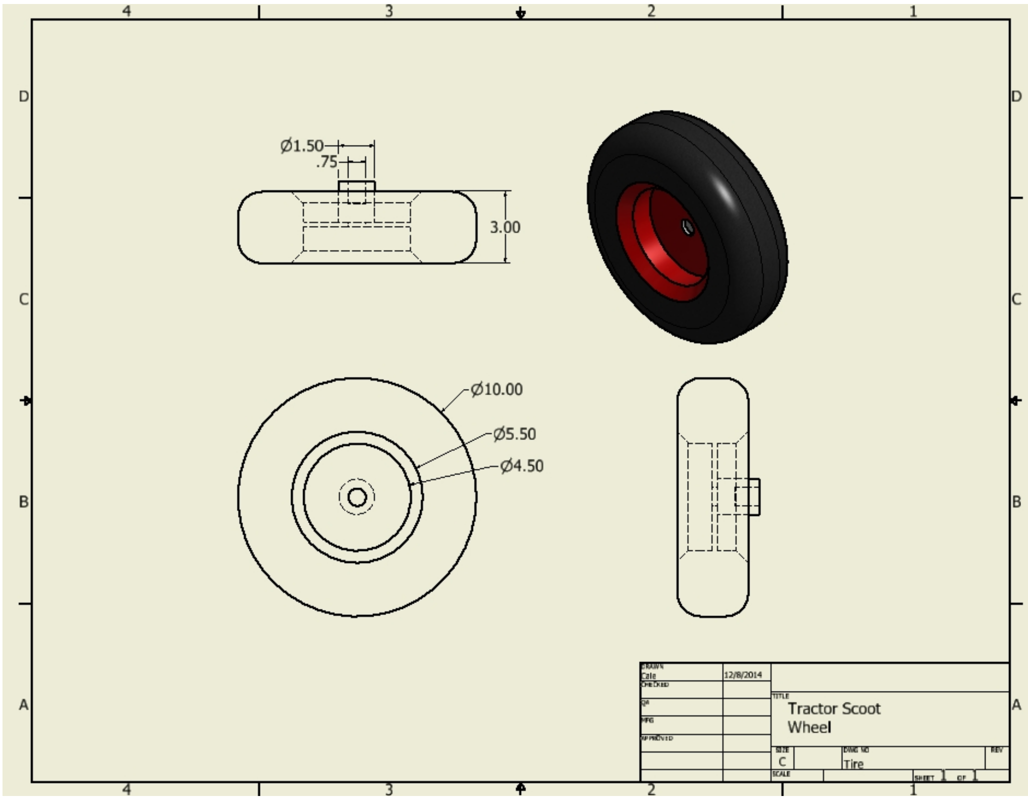

Figure 48. Tractor Scoot Wheel.

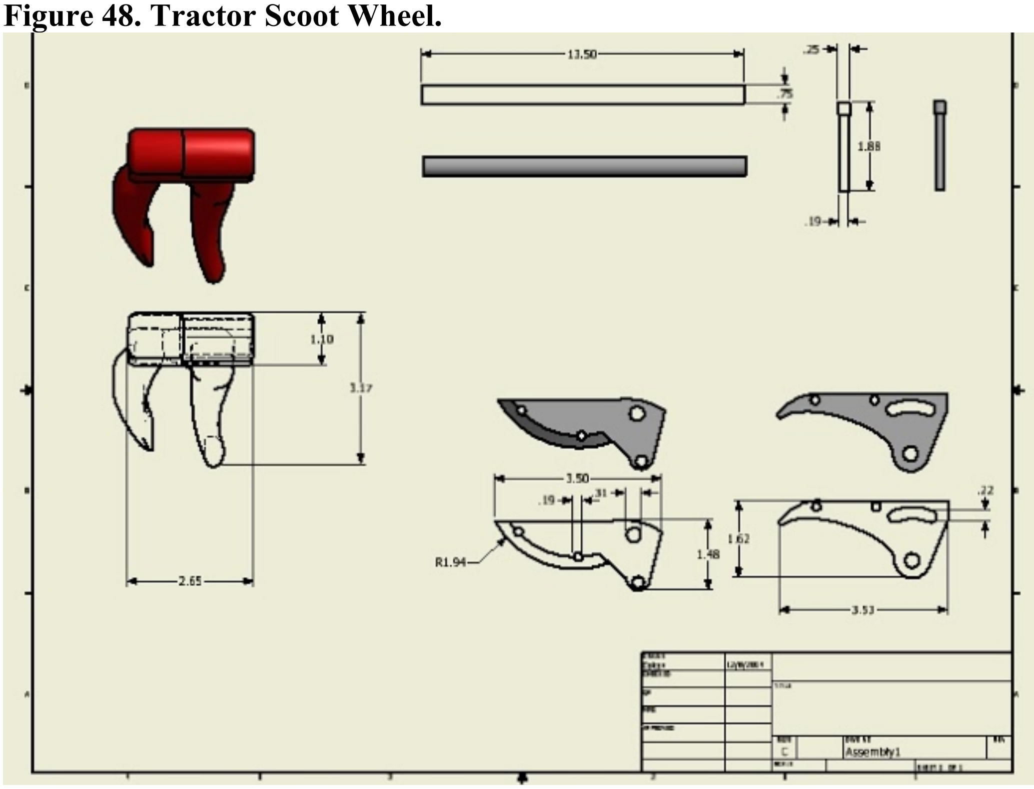

Figure 49. Arm.

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