ENGINEERING

McMaster University

Project Four - Power in Community

ENGINEER 1P13 – Integrated Cornerstone Design Projects

Tutorial T08

Thurs-51

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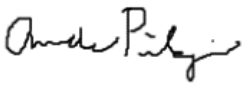
Amanda Pilgrim 400311582



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Jeremiah Musselman 400332133

Executive Summary

Everyone deserves to be able to do the things that they love and have the freedom to do so. The client enjoys gardening as a hobby, however, due to some of her medical conditions it has become difficult to perform the physically demanding aspects of home gardening. We chose to help Alanna get back into gardening by designing a tool that makes the task easier and more efficient. The client discussed difficulties bending at the waist, therefore it was important that the tool we designed was easy to use without the requirement of bending down to the ground. Her lymphedema makes it hard for the client to put a lot of physical strain on their body, so our design should be one where it is not required to use a lot of physical body strength. Sometimes it is difficult for the client to grip something for a long period of time; it becomes easier when the grip is larger, and the material used is comfortable to hold.

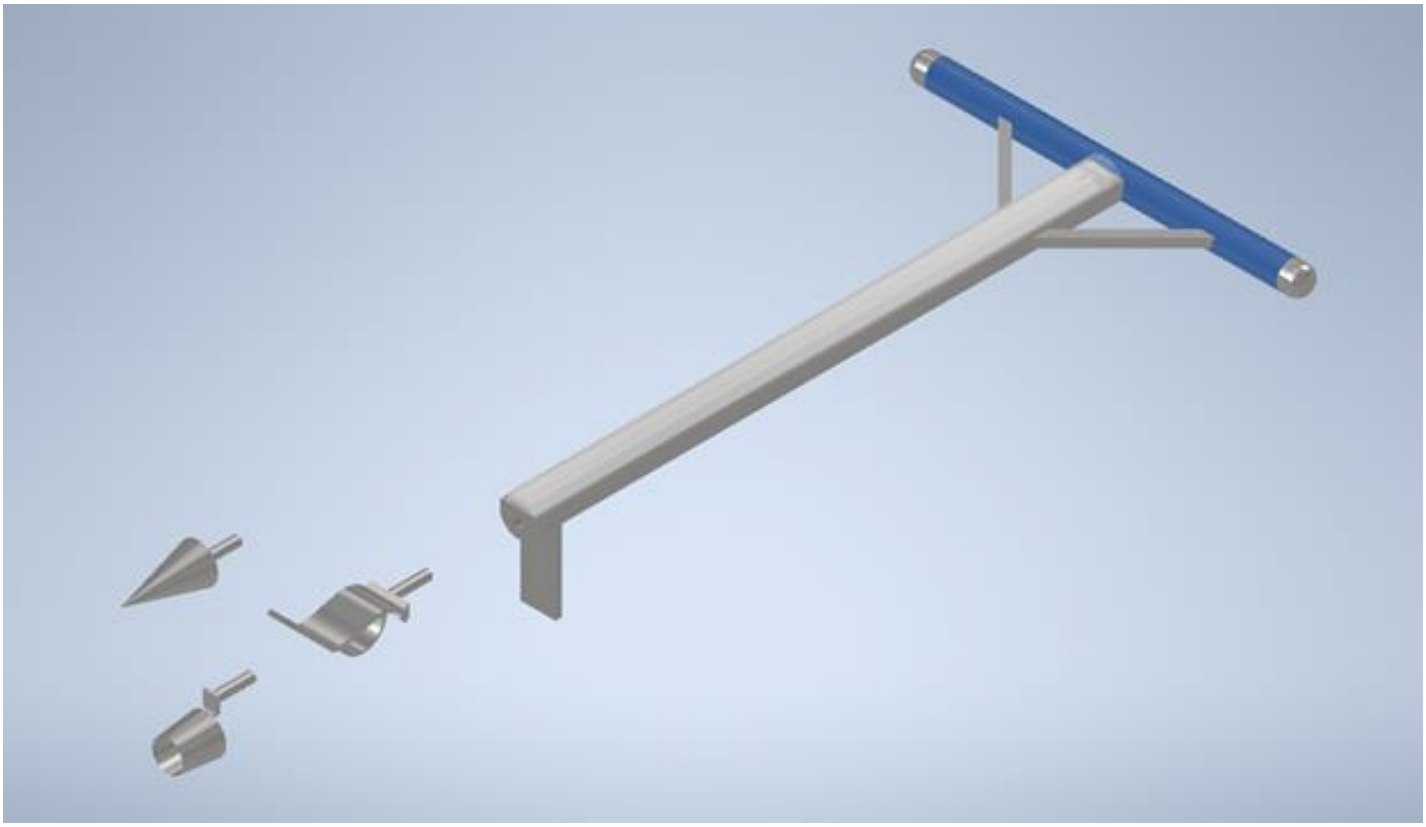

Figure 1: A visual display of the final prototype.

The main goal for our design was to create an efficient device which will allow Alanna to get back into seed gardening. This needed to be a device which does not require her to bend at her waist, as she said this causes discomfort, comfortable, durable, easy to use, safe and lightweight so she does not bear more weight on her body than she needs to. After ranking our 4 designs in a design matrix, our most effective designs were the

Comfortable Grip Digger and the T-Bar Planter. The final prototype utilizes ideas from both initial prototypes to maximize comfort, efficiency, and simplicity. Our design has a list of functionalities that allow Alanna to complete different gardening tasks on her own. The design can complete different tasks such as: digging a hole, seeding, and removing weeds efficiently. With the three points of contact, the tool can be operated with minimal exertion and bending of the waist. The user's arms never need to be raised as she stated it causes her discomfort. With safety and minimal weight of the product also being a key component covered in our design, we were able to come up with our final prototype. Moving forward with the design, we would add additional gardening tools that can be attached to help Alanna explore different gardening tasks.

Introduction

Background Information

Alanna has various medical conditions that were taken into consideration while designing this product. First, she has lymphedema which can cause arm symptoms including discomfort, heaviness, swelling, lack of strength, and skin issues. This can lead to a lot of problems for gardening because when a person is gardening most existing tools require a lot of arm strength to use. A second condition is fibromyalgia which can lead to sleep disturbances, fatigue, headache, morning stiffness, paresthesia's, and anxiety. This also ties into gardening because if a person is experiencing tiredness due to lack of sleep, their body will be weak making it extremely difficult to perform gardening tasks. A third condition is spinal arthritis. Spinal arthritis can result in back and neck pain, stiffness, or loss of flexibility in the spine. This makes it difficult for a person with spinal arthritis to bend at the waist making most existing gardening tools useless to them. Finally, the client has a condition called spondylitis which could cause discomfort in the shoulders, hands, ribcage, hips, thighs, and feet. Like the other conditions, spondylitis would make it extremely challenging to perform simple gardening tasks.

Refined Problem Statement

Design a system or mechanism to help Alanna comfortably and efficiently garden in her backyard, considering her immobility and physical challenges, so she can do the things she loves again.

Objectives and Constraints of Design

There are three main objectives to this design which include the product being lightweight, comfortability, and easy to use. First, it is important for the tool to be lightweight because that makes it easier for the client to use without requiring a lot of physical strain. If the product is very heavy it will require a lot more effort to use the tool, whereas if it is lightweight, it would take a lot less effort to use. Second, the product

should be comfortable, if it is awkward to hold it makes it more difficult to use it properly. Also, the client mentioned that certain materials can be problematic to her, therefore it is important that the material used is comfortable to be gripping for a long period of time. Third the product should be easy to use because if it is a complex system, it can make it harder to function properly.

Existing Ideas/Solutions

A 'bulb planter' is a common gardening tool that features a cone-shaped blade for digging small holes. Other attachments for the tool, such as the pike and the weeder, are also nothing new in terms of gardening. Our idea was to engineer around these already existing designs to suit the client's needs and challenges.

Conceptual Design

Ideation

The team decided that a morph chart would be the most suitable design tool for the first steps of the brainstorming process. This decision was made on the basis that a morph chart provides an organized approach to coming up with different concepts that open the search to a defined design. Based on the group's prior knowledge of gardening, numerous functionalities that the tool should perform were brainstormed. These included digging a hole, planting seeds, refilling a hole, and removing weeds. For each function, the group came up with four potential means of completing this task, such as a tube for planting seeds. Creating this morph chart laid out many potential ideas for the group members to base their preliminary sketches from. Each group member created two concept sketches, trying to incorporate as many of those functions as possible. Group members would move on to refine what they believed to be the most apt of their two initial sketches in preparation for the next stage of the design process.

Design Alternatives

After heavy consideration, aspects from two group members' refined sketches were combined to move on with the design process. None the less, all group members provided viable solutions to the problem at hand. One alternative design was focused on a unique means of digging a hole that involved twisting the tool into the ground with a drill bit. Another was inspired by the comfortability of scooter bars and implemented a T-bar shape to effectively perform the function of digging a hole and refilling it. Next, a group member produced a refined sketch of a multi-tool, with many capabilities including a sweeper to fulfill the function of filling a hole. All these alternative designs shared similar functionality, but each had a unique means of completing it.

Decision Matrix

A decision matrix was used to help determine which initial designs were most practical. There were five different criteria each weight differently based on its importance. The ranking from most important to least important were as follows; effort to use, efficiency, comfortability, lightweight, and safety. It was decided that effort to use should be weighted the highest because the main goal of this gardening tool is that it is easy to use with very little physical strain so that anyone can easily use the tool. Second the efficiency of the tool is very important as well because we want the tool to work just as well, if not better, than other already existing gardening tools. Based off this list of criteria that were important to consider when choosing a design for the product we were able to narrow it down to two designs the T-Bar Planter and the Comfortable Grip Digger because both were able to best implement the criteria into the design.

Design Evaluation

After deciding on the two designs feedback was given to help improve the design further. The feedback for the Comfortable Grip Digger included adding length to adjust the size of the tool and creating a third clip for digging smaller holes. We were also given feedback to increase the grip size since the client can have difficulty gripping small objects for long periods of time, as well as the seed dropping mechanism being poorly placed. For the T-Bar Planter we were told to consider more support on the material, this would make it work for a longer period and under a larger amount of pressure.

After receiving the initial feedback, the team decided to take some of the strong points from both designs to create a combined design. To address the problems of grip size as well as the seed dropping mechanism from the first design, we added the T-bar from the second design to the first design. This ensured that the tool was easy to grip and hold for a long period of time well also making it easier to use the seeding part of the device since both hands will now be located at the top of the tool together. Another idea taken from the second design and added to the first design was a foot stomp. The main problem with the first design initially was the physical strain on the user, however, with these adjustments the user could now use both hands/arms as well as their foot to help distribute the physical strain throughout their body. The clip-on idea from the first design was kept. However, we decided on three different clip ons a pike for digging the hole, a weeder, and a cone for filling the hole. One more minor thing we had changed was the original method for digging was a shovel, however, we chose to change this to a pike because a pike would require less physical effort by the user.

Final Proposed Design

Final Design Description

The final design was created with a reinforced T-bar with supports where Alanna would be able to easily hold the device with both hands on the T-bar. There is a foot stomp on the rod of the device where Alanna can also use her foot to add power when using the device. The tube has a seeding mechanism to help Alanna drop seeds into the ground without requiring much movement or bending at the waist. This seeding mechanism is in the form of a tube that separates into four different sections. Finally, there is three different attachable tools used for various parts of gardening. The first tool is a pike used to create small holes. The second tool is a weeder which removes weeds from the ground. The third tool is a bulb planter which can create a larger hole as well as fill that hole back up with dirt. Each tool can be attached to the rod by sliding in.

Specifications of Design

Our final product is a comfortable multifunctional gardening device perfect for our client Alanna. The reattach-able tools design maximizes the functionality of the device. Alanna will be able to perform a variety of gardening tasks such weeding, seeding, digging, and filling a hole, all within the use of one device. The tools can be easily inserted into the bottom of the device and you will be able to push it in and it will stay in place. The removal process is easy and requires little to no effort of pulling the tool out. The device also includes a seeding tube mechanism that helps Alanna get back into using seeds. The tube separates into four different sections to allow for even distribution. To focus on our client's comfortability, we have added a three point of contact idea to our design with the hand bar and footrest. The hand bar tool is thick and is covered with a foam material to allow for a comfortable grip. Near the bottom there is a footrest attached where the client will be able to exert most of the force. The three point of contact concept will make sure that our client will be able to complete all gardening tasks standing up.

Discussion of Objectives/Constraints Met

The first objective that we considered important was sustainability. It was determined that the ideal way of determining how sustainable a product is, was to count how many parts of the product are recyclable. On the final product each material used is recyclable making the product sustainable. The next objective was how durable the product is, determined based off its fatigue strength and its performance in a stress test to simulate years. For this objective we would use Autodesk Inventor to create a simulation that would determine how durable the final product is. The next objective is low cost, based off the materials selected we were able to

calculate the price of the final product which would be around $22, this is a reasonable price therefore the objective of low price is met. The final objective was user friendly, measured through a rating of comfortability. To meet this objective a foam grip was added as well as the three-point contact method. It was also tested using the physical model we created.

Why Certain Materials Were Used

For the re-attachable tools, the material used was stainless steel. We chose this material because it has a resistance to scratching and rust as well as a high yield strength. We believe it is important for the tools to not deform from use over time. The shaft and bars would be constructed using aluminum because it is relatively lightweight and would be painted for protection against rusting. The top bar is covered with EPDM foam (ethylene propylene diene monomer foam), which is a common material used for grips. We decided to implement this material not only for overall comfort, but also considering the client's lymphedema. Finally, the material for the seed dropper is made from PET (polyethylene terephthalate) which is a hard, recyclable plastic. Using these materials results in the product meeting the objective of being relatively lightweight and not too expensive.

Conclusions

Looking Ahead

Given more time to work on the final product we would have run some more tests on the device, such as the length a person could hold onto the device before getting tired. Another test would be building the device to physically demonstrate how the device would function and how the building process would happen, showing how long it would take for the final product to be produced. If we had more time, we could have redefined the device and gotten feedback from the client to better understand any potential problems the client may have with the product. Looking ahead we could potentially add more reattach-able gardening tools to help Alanna perform more tasks with ease. We could also implement an improved method of attaching the tools to the rod for better security.

Looking Back

For this project, the problem presented was very open ended, giving the team a lot of freedom with what specific problem to tackle. This caused the group to really focus on one specific problem instead of trying to solve everything at once. In the previous projects the problem was very structured, but for this project we were required to analyze the problem and work through it as a real-life problem would be approached. In this team

dynamic we used a lot of communication skills so we could effectively and efficiently finish the work in a reasonable amount of time. Each member contributed their share to the overall project. We were able to work off each other's ideas, combining them to make the ideal product. In the future the design process should give more time for each step of the project as well as putting more time and thought process into the brainstorming before the actual building of the device. One major change to the work dynamic of the team would be actual meetings in person rather than virtual. Another change would be more in-depth research on resources and availability of more resources for the project.

List of Sources

[1] “Engineer 1P13B: Integrated Cornerstone Design Projects in Engineering,” P4 Project Module for 1P13B, Faculty of Engineering, McMaster University, Term 2, 2021.

Appendices

Section 1

Patents of other similar designs:

United States Patent [19]
Bartholomew

[11] **Des. 253,390**
[45] ** Nov. 13, 1979**

[54] **GRASS TRANSPLANTER**

[76] Inventor: **Glen W. Bartholomew**, P.O. Box 17565, San Antonio, Tex. 78217

[*] Notice: The portion of the term of this patent subsequent to Oct. 10, 1992, has been disclaimed.

[**] Term: **14 Years**

[21] Appl. No.: **890,226**

[22] Filed: **Mar. 27, 1978**

[51] **Int. Cl.** ..... **D8—01**
[52] **U.S. Cl.** **D8/7**; D8/5
[58] **Field of Search** ..... D8/5, 7; 294/50.7, 50.6; 47/1 R; 172/22

[56] **References Cited**

U.S. PATENT DOCUMENTS

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D. 235,504	6/1975	Kramer	D8/7
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3,025,636	3/1962	Warren	294/50.7 X
3,089,721	5/1963	Puckett	294/50.7

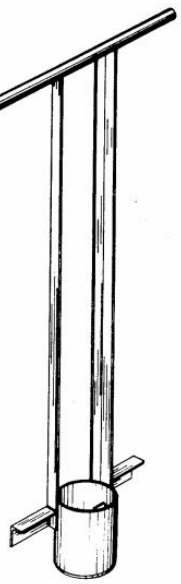
Primary Examiner—Bernard Ansher
Attorney, Agent, or Firm—Donald R. Comuzzi

[57] **CLAIM**

The ornamental design for a grass transplanter, as shown.

DESCRIPTION

FIG. **1** is a perspective view showing the top and front of the grass transplanter;
FIG. **2** is a perspective view showing the bottom and rear of the grass transplanter;
FIG. **3** is a side view as the grass transplanter appears viewed from the left of FIG. **2**;
FIG. **4** is a rear view as the grass transplanter appears viewed from the rear of FIG. **1**;
FIG. **5** is a bottom plan view as the grass transplanter appears viewed upwardly from the bottom of FIG. **4**;
FIG. **6** is a top plan view as the grass transplanter appears viewed downwardly from the top of FIG. **4**;
FIG. **7** is a side view as the grass transplanter appears viewed from the left of FIG. **1**; and
FIG. **8** is a front view as the grass transplanter appears viewed from the front of FIG. **1**.



US006003915A

United States Patent [19]

Bierman

[11] **Patent Number: 6,003,915**

[45] **Date of Patent: Dec. 21, 1999**

[54] **AVALANCHE SHOVEL**

[76] Inventor: **Paul Douglas Bierman**, P.O. Box 7163, Bozeman, Mont. 59715

[21] Appl. No.: **08/533,619**

[22] Filed: **Sep. 25, 1995**

[51] **Int. Cl.**[6] **E01H 5/02**; A63C 11/22

[52] **U.S. Cl.** **294/51**; 294/24; 294/57; 280/823

[58] **Field of Search** 294/24, 51, 57, 294/58, 61, 54.5; 280/813, 816, 819, 823; 7/116, 167; 30/164.5, 164.7

[56] **References Cited**

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4,402,529	9/1983	Cavazza	280/816

FOREIGN PATENT DOCUMENTS

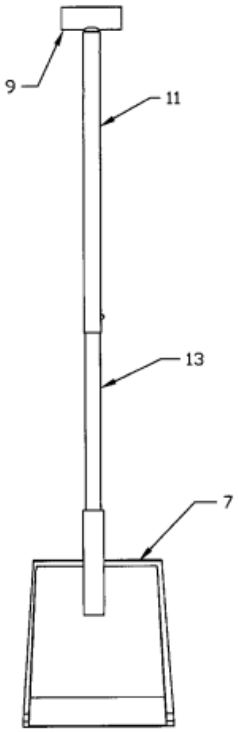
667608	11/1938	Germany	294/57

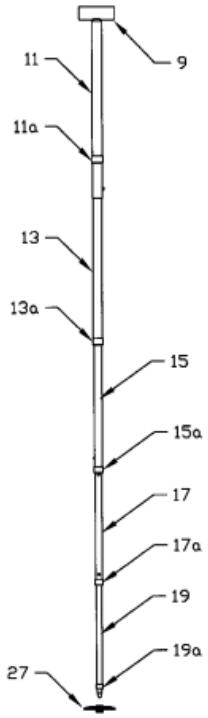
Primary Examiner—Dean Kramer

[57] **ABSTRACT**

An improved snow shovel with a telescoping handle comprised of a plurality of tubular elements, the outermost element having a grip at one end and the innermost element having a tip at the opposite end; a detaching blade, and a permanently mountable secondary tip and manually mounting removable basket. With the blade removed, the handle telescopes to a length greater than seven feet thus converting into a singular rod or snow probe used to feel or probe for buried victims in avalanche debris. When the handle is retracted, the blade is attached and the outermost telescoping element extends outwardly to a locked position. This increases leverage when digging to recover avalanche victims. With the blade detached and the handle extended, the secondary tip secures to the primary tip on the innermost element. This allows the snow basket to be mounted. The handle is then adjustable to any one of several positions for use as a spare ski pole when necessary. When the snow basket is removed and the handle is retracted fully, the individual elements of the shovel handle interlock within each other so that the shovel handle remains in a locked position. In this manner, the handle and blade are small enough to be carried into the back country by either skiers, snow shoers, or snowmobilers. Thus, the Extreme Avalanche Shovel offers winter enthusiasts a more effective and efficient recovery technique for saving lives of avalanche victims than current procedures offer.

13 Claims, 9 Drawing Sheets



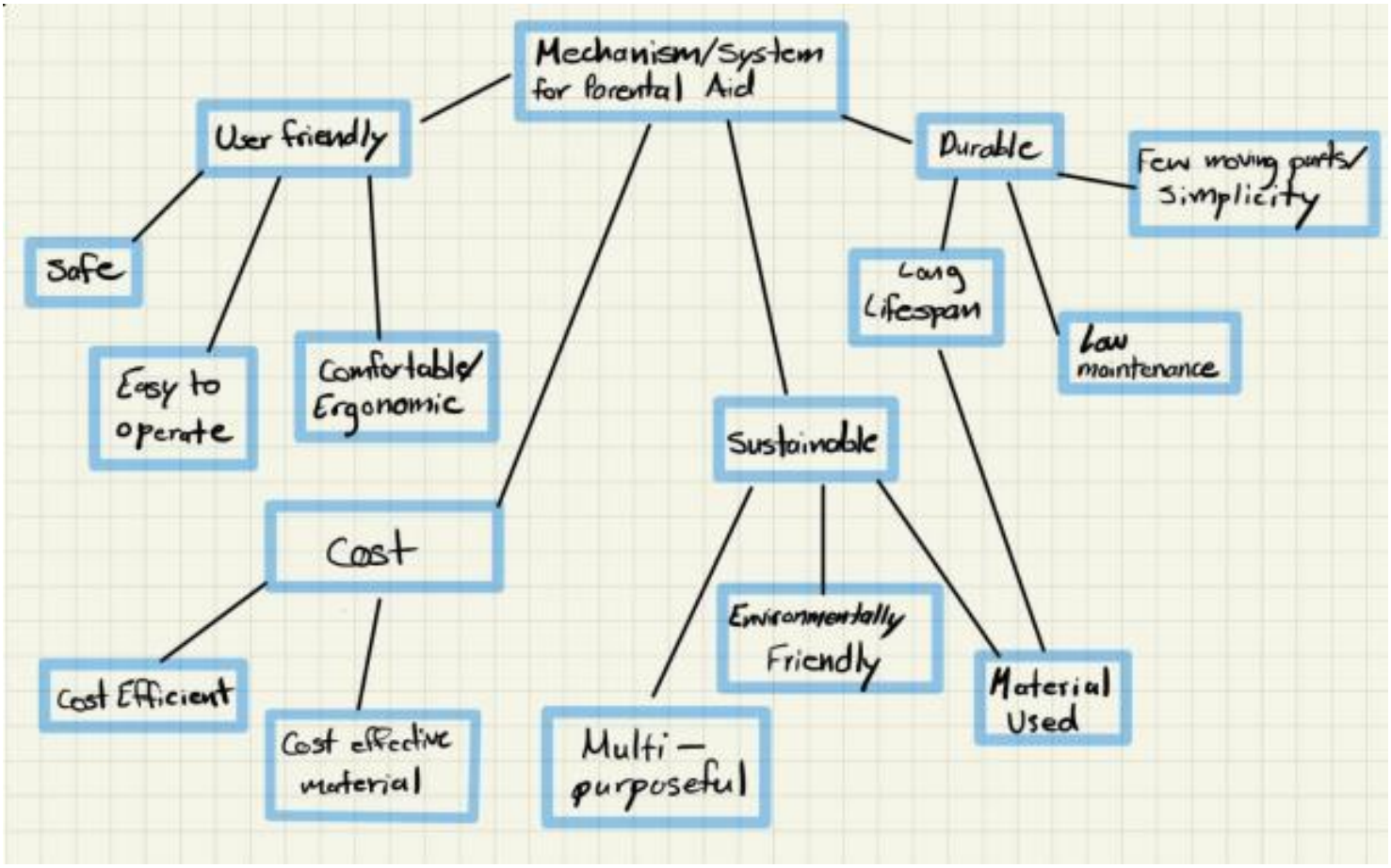


Similar commercial products:

Bulb Planter:

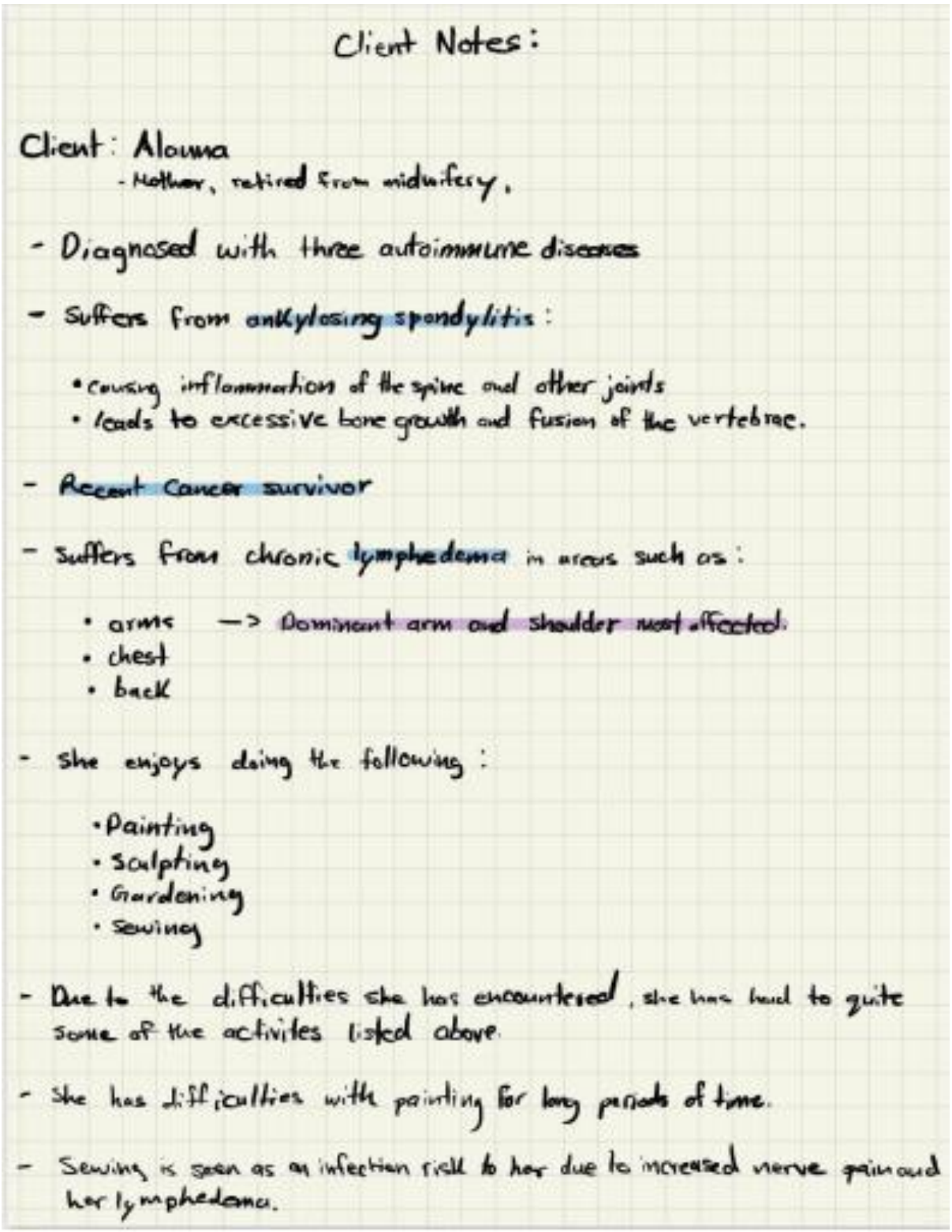
Weeder:

Objective Tree



Client Meeting Notes

Maryam Butrus



Client Notes:

Client: Alouna
- Mother, retired from midwifery.

- Diagnosed with three autoimmune diseases
- Suffers from ankylosing spondylitis:
  - causing inflammation of the spine and other joints
  - leads to excessive bone growth and fusion of the vertebrae.
- Recent Cancer survivor
- Suffers from chronic lymphedema in areas such as:
  - arms —> Dominant arm and shoulder most affected.
  - chest
  - back
- She enjoys doing the following:
  - Painting
  - Sculpting
  - Gardening
  - Sewing
- Due to the difficulties she has encountered, she has had to quite some of the activites listed above.
- She has difficulties with painting for long periods of time.
- Sewing is seen as an infection risk to her due to increased nerve pain and her lymphedema.

- Does not have any preferences when it comes to materials but would benefit from any type of strong materials such as metal to help with the feeling of dizziness and nausea.
- Wrist size: 5.75 inches on both left and right
- Is allergic to:

  - gluten

  - pre-primed canvas

- Gardens indoors and outdoors
- Likes to garden different types of things such as:

  - medicinal herbs

  - flowers

  - vegetables.

- Would like to use actual seeds for gardening but is currently buying plants.
- Her lymphedema is currently maintained but it does affect the abilities in her arms to hold things for a long period of time. It also causes:

  - arm tightness

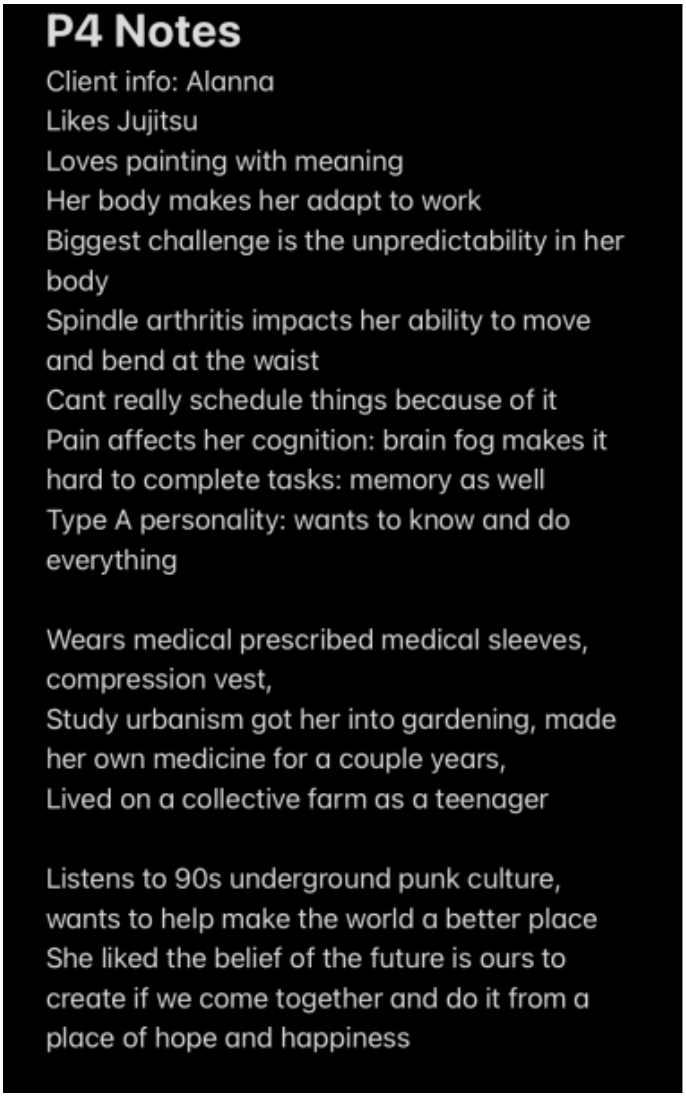
  - heaviness/fullness

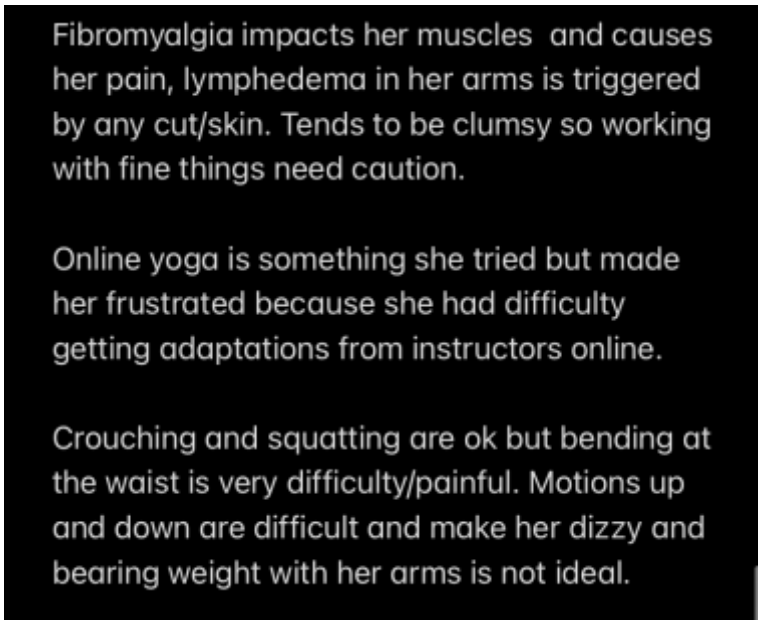
  - discomfort

  - reduced limb control.

- She is unable to support her own weight which is why she sits on the floor to work on her paintings.
- Easier for her to hold onto handles that are thicker (big painting brush vs small painting brush).
- Can carry up to 10 pounds of weights without major difficulties.
- Prefers to use an oblique grip method as it makes it easier to control with her hands.

Areeb Jamal


P4 Notes
Client info: Alanna
Likes Jujitsu
Loves painting with meaning
Her body makes her adapt to work
Biggest challenge is the unpredictability in her body
Spindle arthritis impacts her ability to move and bend at the waist
Cant really schedule things because of it
Pain affects her cognition: brain fog makes it hard to complete tasks: memory as well
Type A personality: wants to know and do everything
Wears medical prescribed medical sleeves, compression vest,
Study urbanism got her into gardening, made her own medicine for a couple years,
Lived on a collective farm as a teenager
Listens to 90s underground punk culture, wants to help make the world a better place
She liked the belief of the future is ours to create if we come together and do it from a place of hope and happiness


Fibromyalgia impacts her muscles and causes her pain, lymphedema in her arms is triggered by any cut/skin. Tends to be clumsy so working with fine things need caution.
Online yoga is something she tried but made her frustrated because she had difficulty getting adaptations from instructors online.
Crouching and squatting are ok but bending at the waist is very difficulty/painful. Motions up and down are difficult and make her dizzy and bearing weight with her arms is not ideal.

- Alanna helped in a free summer camp for gardening and has a lot of experiences with plant beds.
- She plants indoors and has space outdoors to plant.
- Had previously grown vegetables, but she does not know if she has the patience for it right now
- Likes to grow medicinal herbs and flowering plants: she would love to plant more flowers
- "The more flowers the better"
- She used to plant pre grown but she would love seed planting
- Had trouble with small brushes. She explains the pain does not let her hold the position for a length of time. She can grip but after gripping for a period is difficult.
- Working with the arthritis society, nothing is that painful to do; basic tasks are fine.
- Cannot work with gluten, some pre primed canvas have flour-based paste involved in the priming process so she keeps an eye out for that.
- Nothing that she can name that she is directly allergic to, but she is usually cautious with chemical products.
- Bearing the weight of her own arm is sometimes a lot of work.
- Lymphedema affects her torso and not only in her arm. As she is weight bearing, she can feel it in her pectoral muscle and the lat muscles in her back and they get exhausted quickly.
- The closer she is to the ground the less she feels dizzy and nauseous.
- Length and width of her hand are 6.5 inches and 4 inches, respectively.
- Wrists are small, both being 5 and ¾ inches at the base.

Jeremiah Musselman

Background

- Healthcare
  - Midwife for over 15 years
  - Reproductive health
- Developed autoimmune diseases
  - Stopped working as a midwife
  - Car accident
  - Breast cancer
- Seeks to make the world a better place
- Started painting
  - Healing
  - Communicate inspiration and resilience
- Spends time doing…
  - Painting
  - Meditate
  - Yoga
  - Vision future painting
  - Adaptive Brazilian jujitsu
  - Sculpting
  - Gardening

Q & A

- Tell us more about your paintings?
  - Body makes her adapt to work
  - Struggles with holding paintbrush
    - Got new wider paintbrushes
    - Wraps something around the brush and her hand
  - Has many works in progress
  - Mediums
    - Acrylic paint, cold wax, collage, canvas
- Tell us more about your sculpting
  - Finds working with clay difficult and frustrating
    - Difficult on the hands
  - Using found or collected objects
    - Create new vision out of them
  - Lymphedema creates risk of infection when working with wires and sculptures

- Biggest challenges on a day-to-day basis
  - Absolutely no predictability of physical conditions
  - Lymphedema can be worse on some days
  - Small brushes can be hard to hold
  - Spondylarthritis is autoimmune in sacroiliac joints
    - Impacts mobility
    - Ability to bend at waist
    - Hard to clean up after kids
  - Difficulty lifting
  - Hard to schedule things due to unpredictability
    - Painting
    - Social life
    - Time with children
  - Brain fog
    - Difficult to complete tasks
    - Memory is impacted
    - Keeps notes to remember tasks
- Aspects of art that you have had to change due to disabilities?
  - Has to paint differently because it's hard to hold brush
  - Difficult to paint fine details
    - Takes a lot of time and focus
  - Used to sew and quilt but can't anymore
- Tools and products to help with spondylitis and lymphedema
  - Wears medical prescribed compression sleeves
  - Compression vest for torso
    - Wear during painting, exercising, lifting etc.
  - Belt
    - Used for walking, exercise
    - Uncomfortable
  - Homemade posture necklace
    - Didn't work very well, so she stopped using it
  - Blanket laid on the floor to paint on (laying down)
- What do you do in the garden?
  - Makes own medicine
  - Herb garden
  - Doesn't grow food anymore, but knows how to
  - Hard to do the physical planting
    - Wishes to be able to do that
- Any COVID related precautions?
  - Still undergoing chemo
  - Health is always at risk
  - Has been staying home since march
    - No jujitsu gym

        - Part of community
      - Has come up with home workouts
    - Attends yoga class online
- Talk more about stress management
  - Stress can impact physical pain and conditions to flare up
  - Has had to learn to manage stress because it is unavoidable
    - Stress comes from kids and overall busyness
- Has there ever been a specific activity that you wished you had help with
  - Dreams of having an exoskeleton
    - Wishes she could have mobility again
  - Has accepted that the way her body is now is beautiful and special
  - Does things on the floor
    - Painting
    - Jujitsu
    - Helps her feel physically secure
- What part of your body gives you the most trouble?
  - Differs from day to day
    - Spine one day, hands on another, some days both
  - Hard to sit still for long periods of time
  - Moves around from sitting to standing a lot during the day
    - Tries to listen to body to determine where to work
- What is your daily threshold?
  - Daily tasked are planned each morning
    - Doesn't plan tasks beforehand because abilities change day by day
  - Some days rests all day to prepare for kids coming home from school
  - Other days can paint for hours and cook and take care of kids
  - Sleep impacts daily threshold
    - Oral chemo causes some insomnia
  - Stress affects daily threshold
- Can we hear more about activism?
  - Activism comes from Mother
    - Taught her that we are obligated to leave the world a better place
      - Life philosophy
- How have you had to adapt as a parent?
  - Kids are 9 and 11
  - Can be challenging
    - For example, takes kids to park and can't get home
    - Has learned to not overexert
  - Used to love the physicality of parenting
  - Hard to parent because she is taking care of herself a lot
  - "Emotionally exhausting"
- Is your house optimized for your conditions?
  - Since she is renting it is hard to change things

    - Has good hand rails
    - Studio is in one room to avoid having to move around a lot
- What is the desired outcome from collaborating with the wonderful students of McMaster Engineering?
    - Wants to see tools to make painting easier/less painful
    - Tools to support body 'gently'
    - For us to see how compassion fits into engineering

- Any particular chores that are harder?
    - 'Everything' is more difficult
    - Fine motor skills
    - Bending at the waist
        - Squatting is helpful but tiring
- Is there an approximation for weight you can lift?
    - About 5-10 pounds is reasonable
- Do you plant seeds or plants?
    - Prefers to plant seeds, but has done plants
- Do you plant from a raised plant bed?
    - Not anymore, but she used to
    - Has an indoor and an outdoor garden
- What do you garden?
    - Vegetables (not sure if she will anymore)
        - Impatient
    - Medicinal herbs and flowering plants
- Range of motion of hands?
    - When having spasms, limited range of motion
    - Holding things can become uncomfortable after a long time
- Do you have any allergies?
    - Allergic to gluten
    - Allergic to some pre-primed canvas
    - Cautious with chemical components
- Is it hard to bear the weight of your arm
    - Lymphedema is in arms *and* torso
    - Muscles get exhausted very quickly from just her arm
        - Even harder when holding something
- When the lymphedema flares, what happens?
    - Has been able to catch flares early recently

  - 1-2mm of swelling
- Are there some things that are easier to do than others?
  - Much easier to extend then to grasp
  - It is easier to lower arm then raise it
- Do you have a preference for portability vs function?
  - No preference
  - Wants something that she can use on her own without help
- Are there any motions that don't cause pain?
  - Non-repetitive motion
  - Holding things for long periods of time is what hurts

Amanda Pilgrim

Client Notes

Background on Client

- She has developed enough autoimmune diseases to be required to quit working.
  - They can also cause a lot of physical challenges performing normal everyday tasks.
- As well as the autoimmune diseases she has also been through a car crash, as well as had breast cancer. Which only added to her challenges.
- Some of the normal activities that she enjoys including painting, meditation, yoga, jujitsu, sculpting, and gardening.
  - Each of these simple hobbies has required some sort of adaptation.

Conditions

Lymphedema

This causes swelling or infection on any cuts or wounds.

Spinal Arthritis

Impacts ability to bend at the waist.

Fibromyalgia

Makes things on the body feel very uncomfortable.

Spondyloarthritis

Hobbies

Painting

One of the main challenges faced with this hobby is caused by hand spasms. These are painful muscle spasms that can make it difficult to hold onto a paint brush. One adaptation for this problem has been getting a new different type of paint brush, however, this also limits the type of paintings she will be able to do.

For example, she really loves creating detailed artwork with an intricate design using fine lines. However, now she can only do that in limited capacity, and it takes a long time to finish a detailed piece due to her body capabilities.

Sculpting

Clay has proven to be very difficult to use given her body limitations. Therefore, she has found other methods of sculpting through creativity. She uses found or collected objects to create a new vision out of them.

For example, she built a three-dimensional torso using hospital bracelets for the ribs along with wires connecting them. This became an extreme problem for her lymphedema.

Sowing and Quilting

A hobby that she used to love but can no longer do. She lacks in her hand eye coordination now making this a nearly impossible task.

Gardening

Used to grow herb gardens of her own medicine before her illness. Now she needs to plan the garden but get others to help her plant it.

Challenges

Predictability

She is unaware of when things are going to happen with her body. It is random depending on the day. Therefore, she is unable to make plans ahead of time because she doesn't know what she will be physically capable of doing prior to the day.

Brain Fog

When pain goes up she gets 'brain fog' which makes it difficult to complete tasks. This also impacts her memory. Which she uses paper notes to help her remember things.

Quarantine

Due to her treatment of five year post surgical oral kemo her health can be quite precarious. Also, she is unable to get an IV in her arm, so it must be put in her foot. This makes it very important for her to be extra careful during quarantine.

To adapt to the isolation, she came up with ways for movement in her own home. She also began to attend yoga classes, taking a teacher's course to ensure the movement was being done properly. She also uses meditation as a form of helping her mind during these times.

Stress

Stress causes her conditions to flare and act up. Which is why it has become important for her to manage stress internally.

Adapting

She needs to fully adapt how she uses her body. For example, working on her paintings on the floor rather than standing or sitting to work on them. She has a stool to put the canvas on to work on the painting from the floor.

Day to Day Activities

Daily tasks are planned in the morning and cannot be planned prior to the day because her body is too unpredictable. Sleep can impact this change.

- Sometimes she is required to rest all day so she can be with her children when they get home from school.
- Sometimes she can paint for hours along with doing other tasks plus take care of her kids at the end of the day.

Being a Parent

She has two children; one is nine and the other is eleven. It was hardest to parent them when it first started. However, she learned little things to help such as bringing a cane to the park and walking slowly, also not doing as much activity.

Optimization

Environment

A nice home environment that helps stay focussed on rising through the challenge. For example, having a studio that is its own space.

Physical

Small things that help:

- Handrails on the stairway.
- Having a sink in the studio.
- Having the studio, bedroom, and washroom all on the same level.

Products That Help

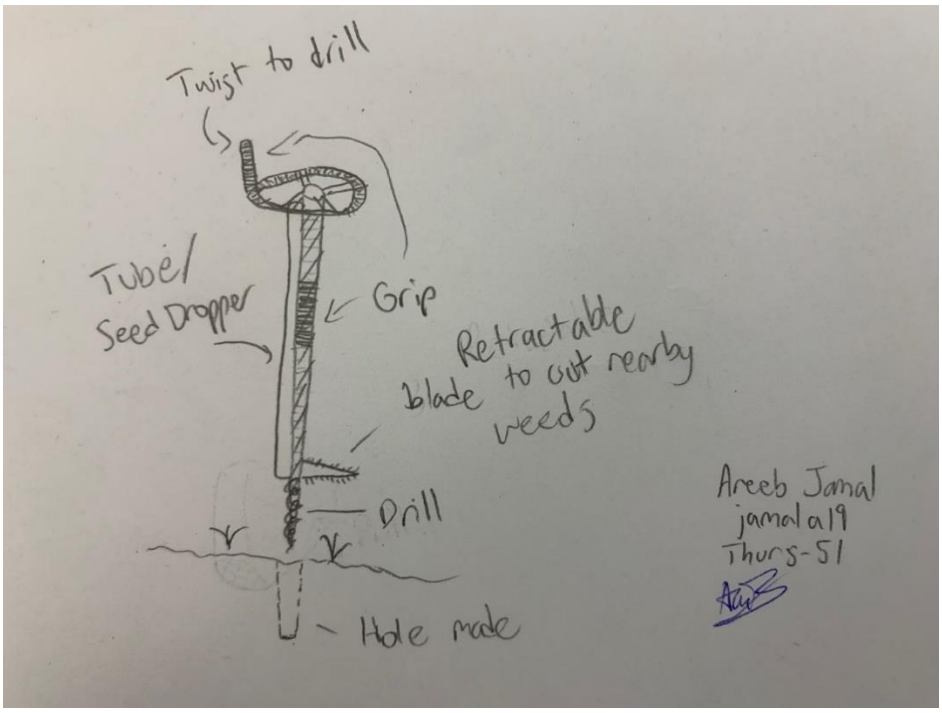
- Medical Prescribed Compression Sleeves, Gauntlets, & Compression Vest
  - It is used any time she is painting or exercising.
  - It helps to be more functional.
  - However, it is not very comfortable.
  - The compression vest helps with her torso.
- SI Brace or Belt
  - Helpful for walking.
  - Uncomfortable.
  - Does not use anymore.
- Posture Necklace
  - Homemade to help with posture.
  - Did not work very well.
- ***Desired*** Exoskeleton
  - Give her mobility that she no longer has.

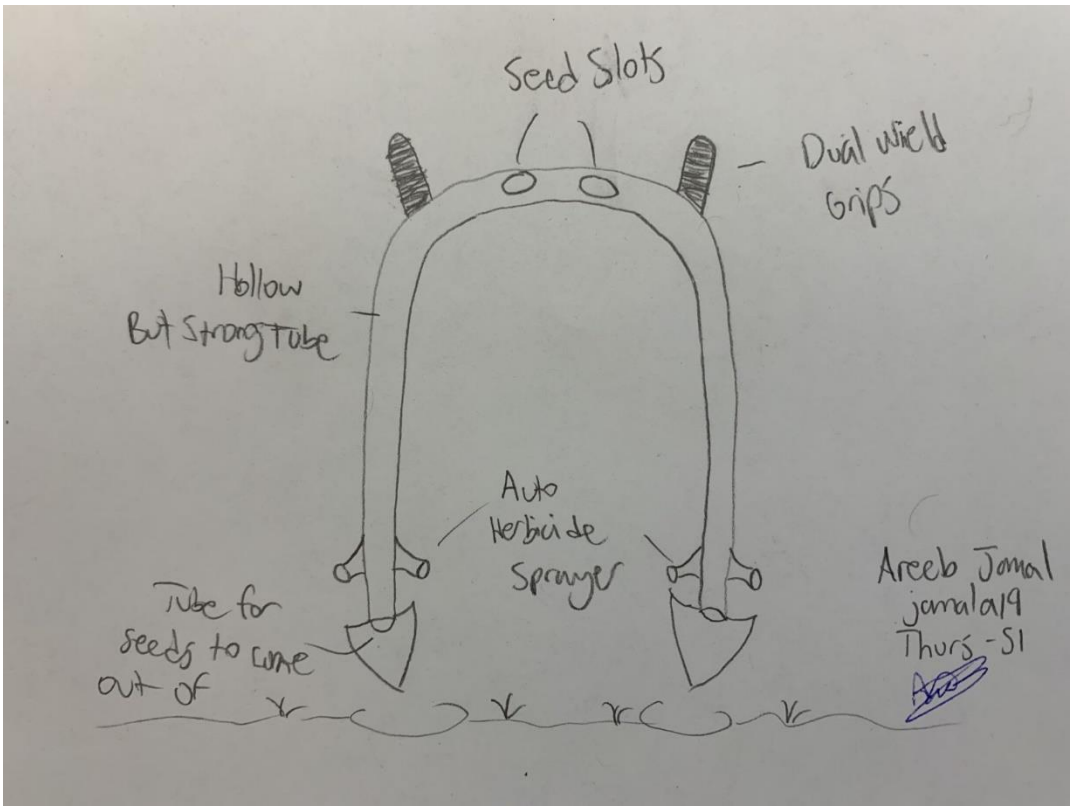
- Holding a paint brush in a different way would need adapting. But detailed work involving fine lines would be more difficult.
- How does pain differ using different joints?
    - Hands not currently impacted. Ultrasounds done on hands.
- What daily activities are more difficult?
    - Everything
    - Anything involving fine motor skills with hands or bending at the waist.
        - Easier to stand and wash dishes then bend and fill dish washer.
- In terms of work, what size paintings are completed.
    - Largest about ten feet by ten feet. Not a canvas. It has nine panels put together with weaving.
- Lifting heavy objects
    - Maximum load is five to ten pounds.
- Paint only in studio. There is an area connected to studio which is meditation and movement space.
- Gardening
    - Plants are grown from seeds preferably. But she currently gets them from plants.
    - Run children's community center for gardening.
    - Garden is indoor as well as outdoor space unplanted.
    - Previously grown vegetables. Not enough patience right now.
        - Medicinal herbs and flowering plants. Wants to plant more flowers.
- Range of motion when hands are in pain.
    - When having muscle spasms hand freezes up giving limited range of motion.
        - Sometimes can't even hold the paint brush.
    - Range of motion isn't as bad as gripping for a long period of time.
- Set up of painting on floor.
    - Sometimes closer to ground because can't stand, uses cushion under her and props canvas on stool.
    - On floor uses floor to hold body up. Easier to put body down sometimes.
- Painful things include repetitive prolonged movement. Holding something isn't bad but actually needing to do something with it is difficult.
- Allergies
    - No gluten. Pre primed canvas with flour-based paste.
    - Cautious of chemicals. Reacts to things unpredictably.
- Wrists are small. Right wrist (dominant) is 5 and three quarters inches at base. Left wrist is the same.
- Uses variety of brush sizes when painting. Finger painting at some point during each piece.
- The weight of own arm can be a lot of work as well.
    - Lymphedema in arms and torso.
    - Muscles get exhausted just holding up own arm not only from holding objects.

Section 2

Sketches

Areeb Jamal:





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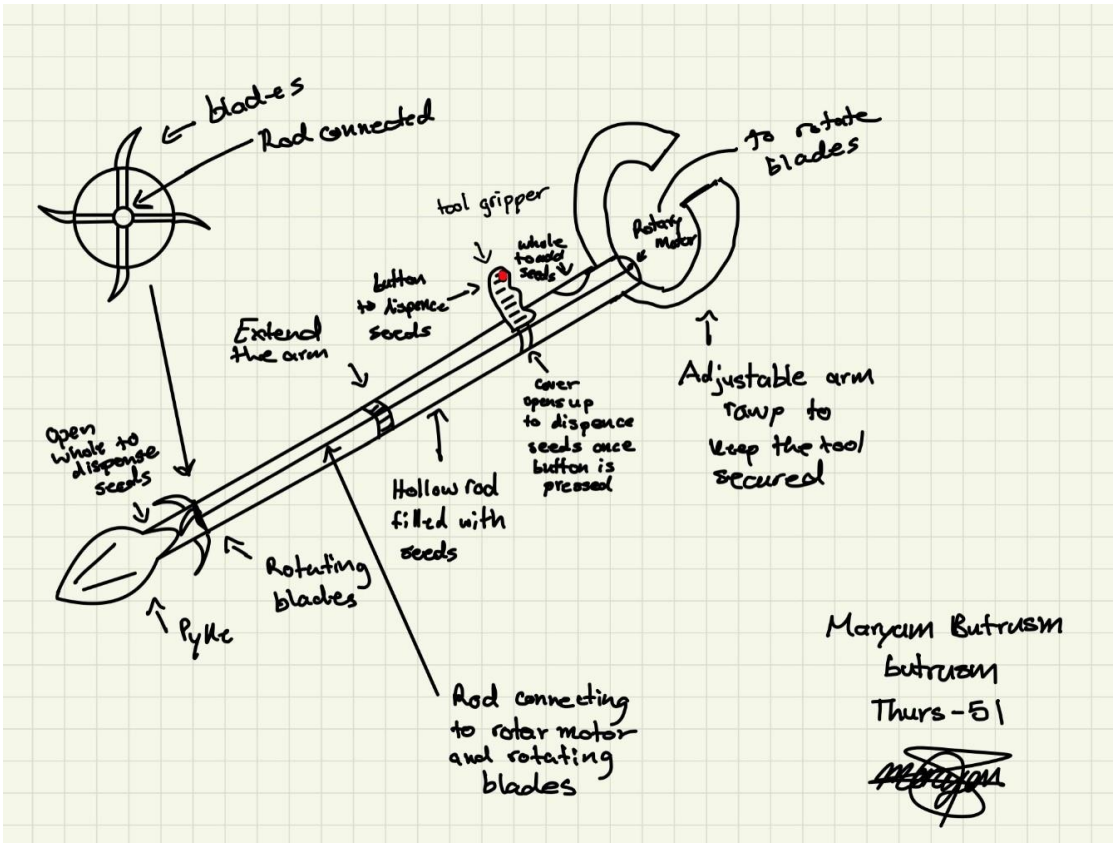

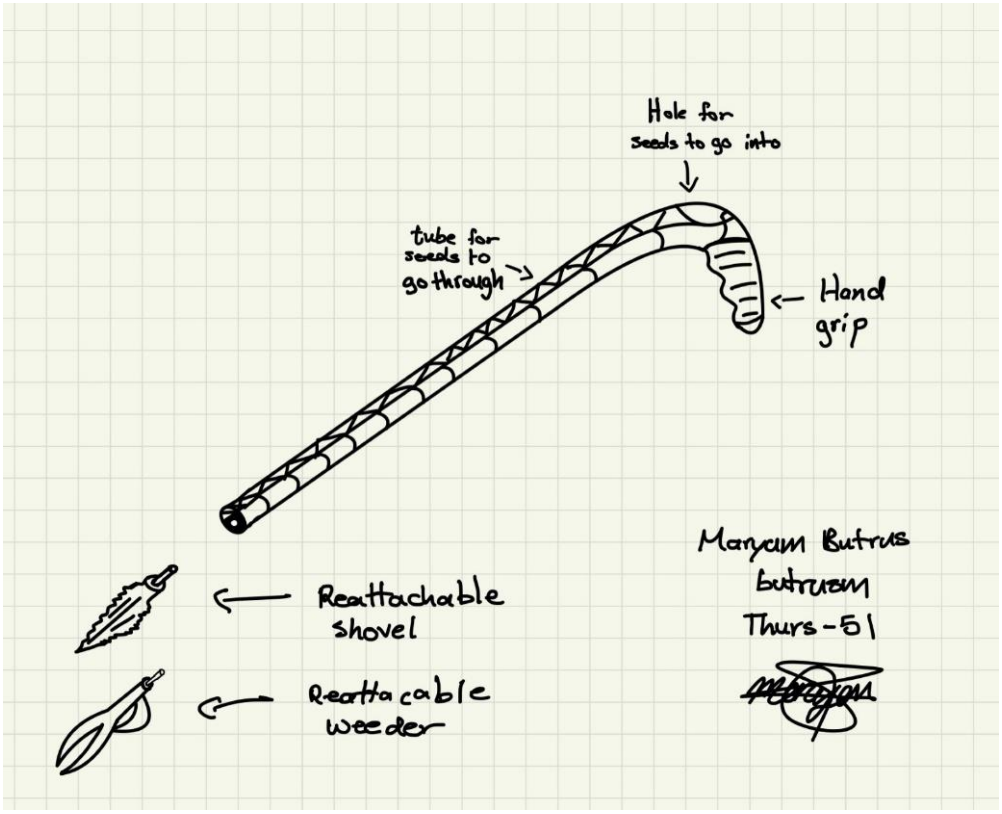

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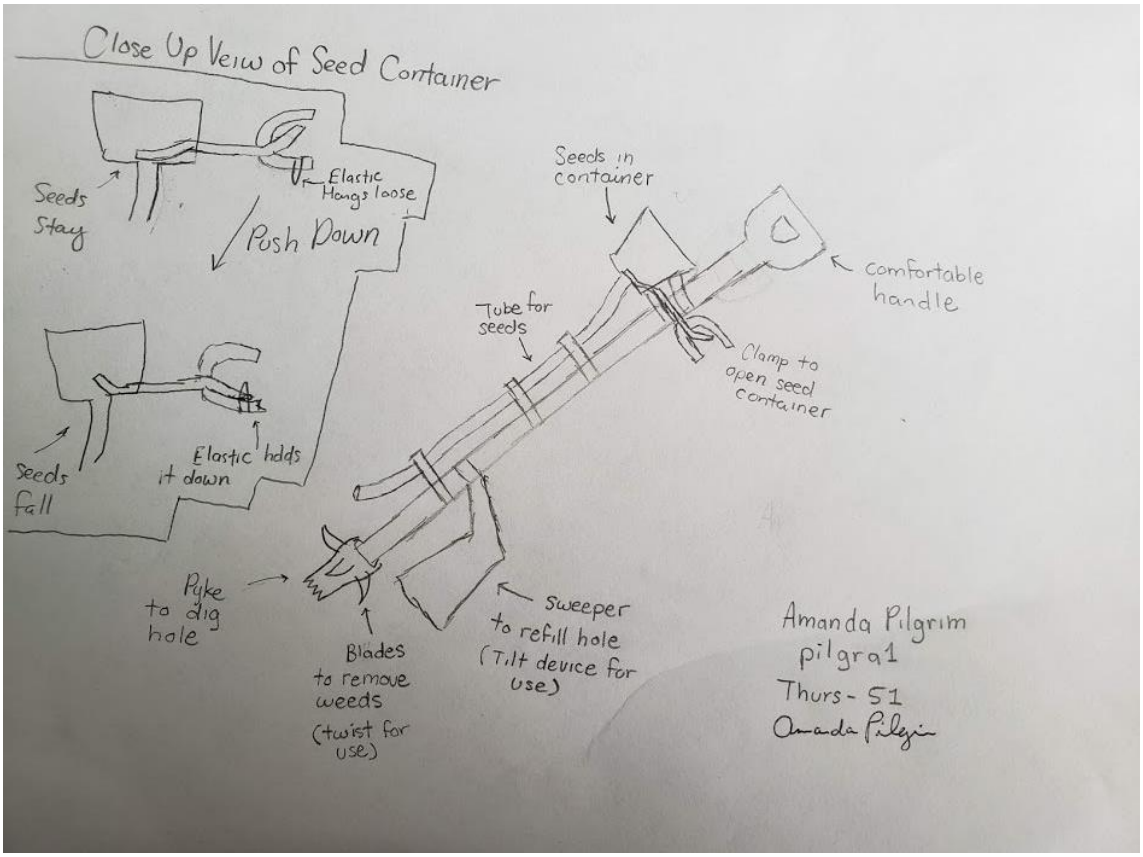
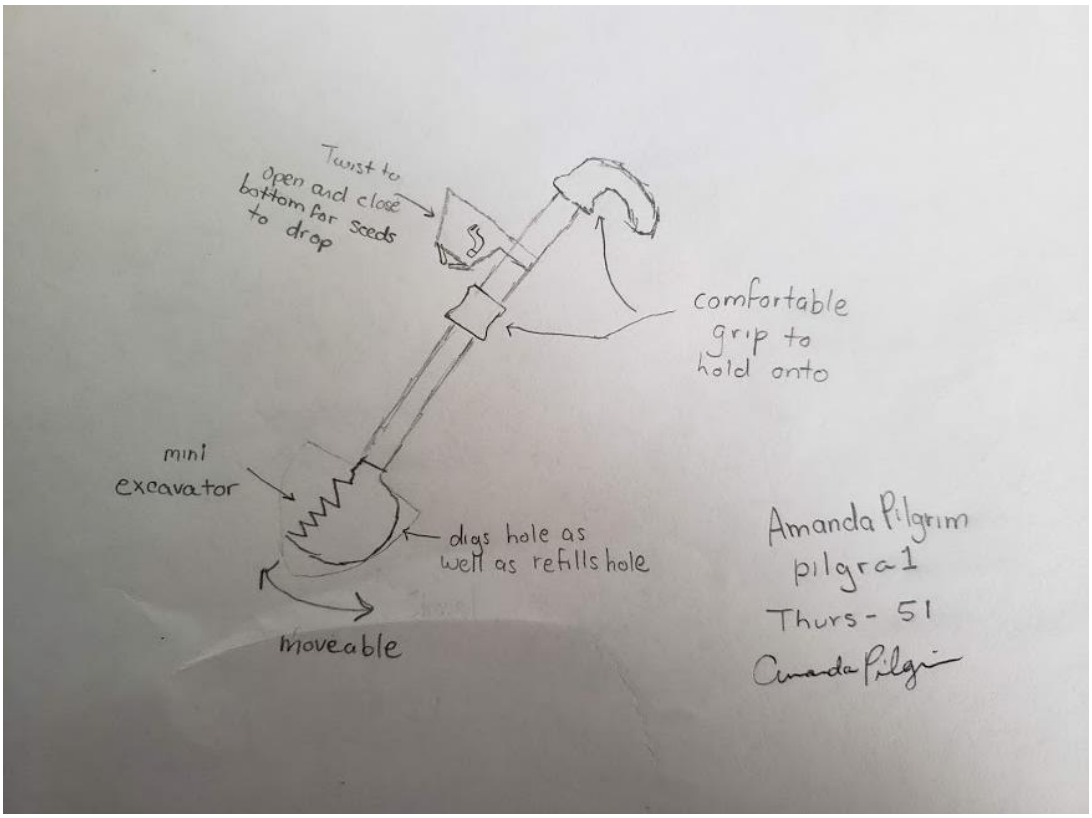
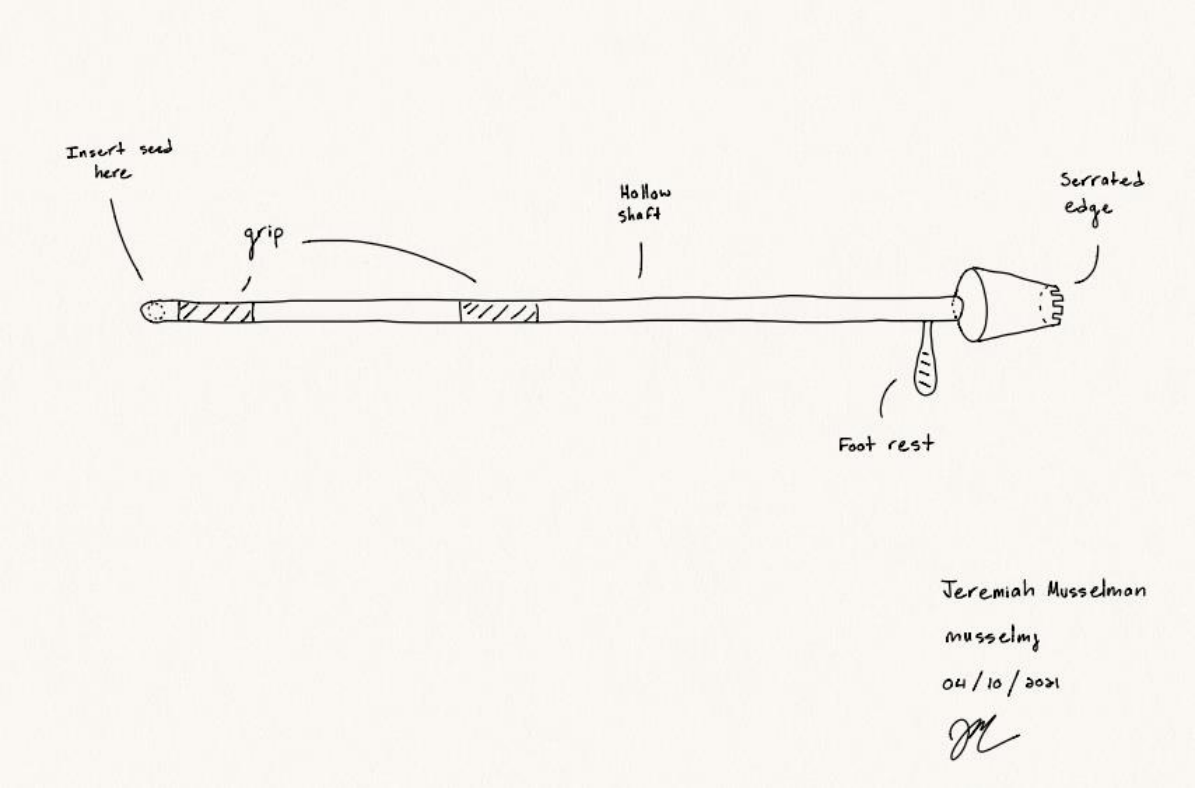
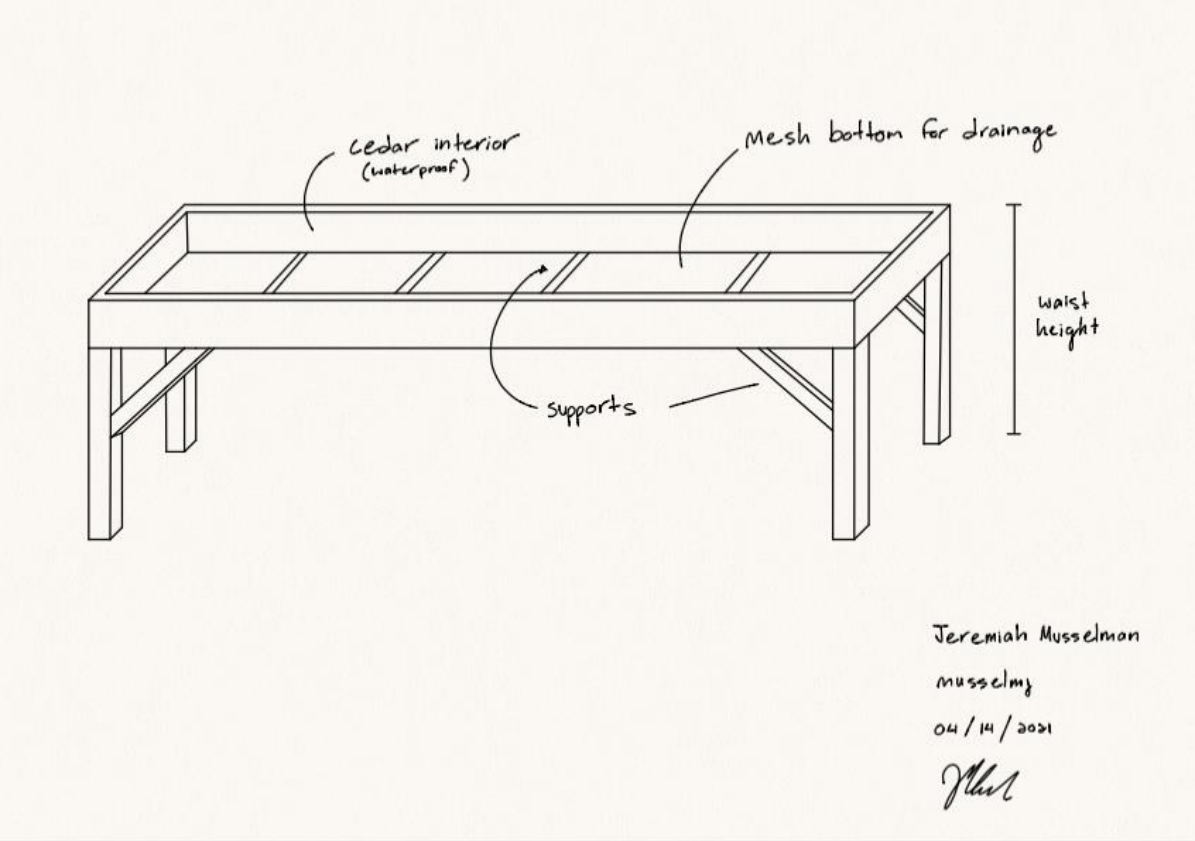




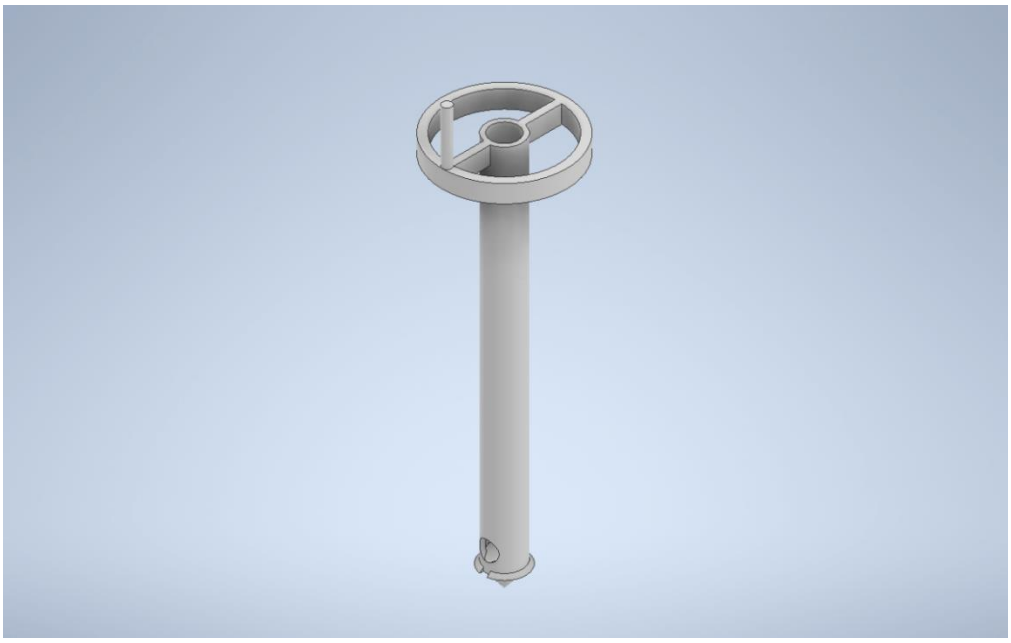
Jeremiah Musselman:





Prototype Iteration Pictures

Areeb Jamal:



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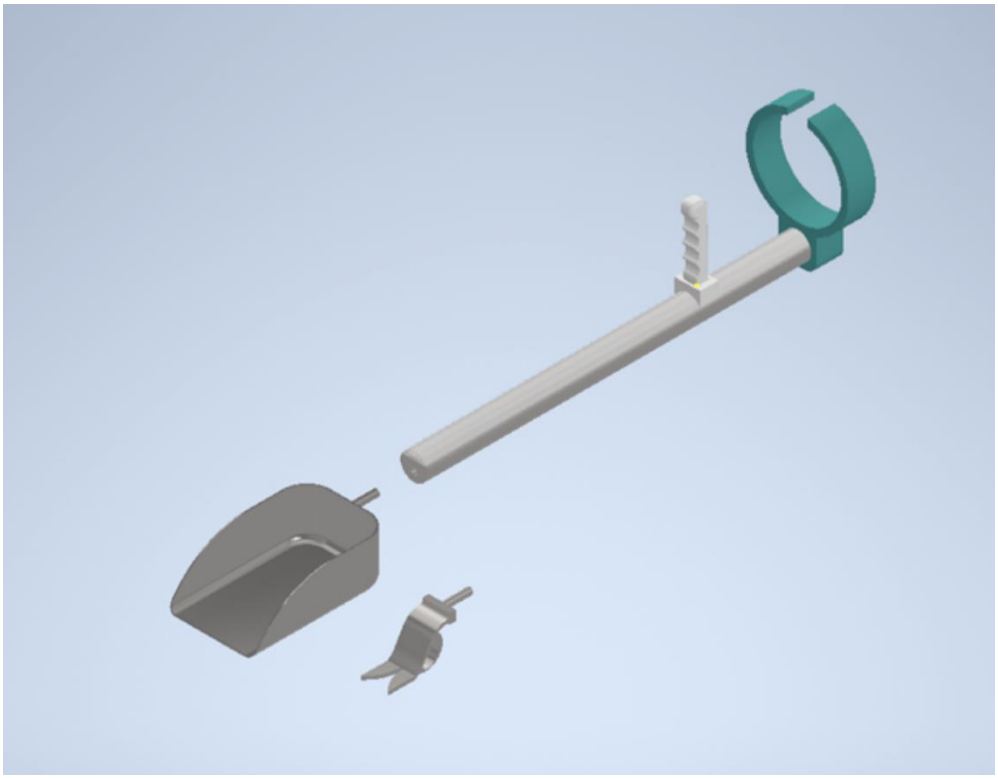


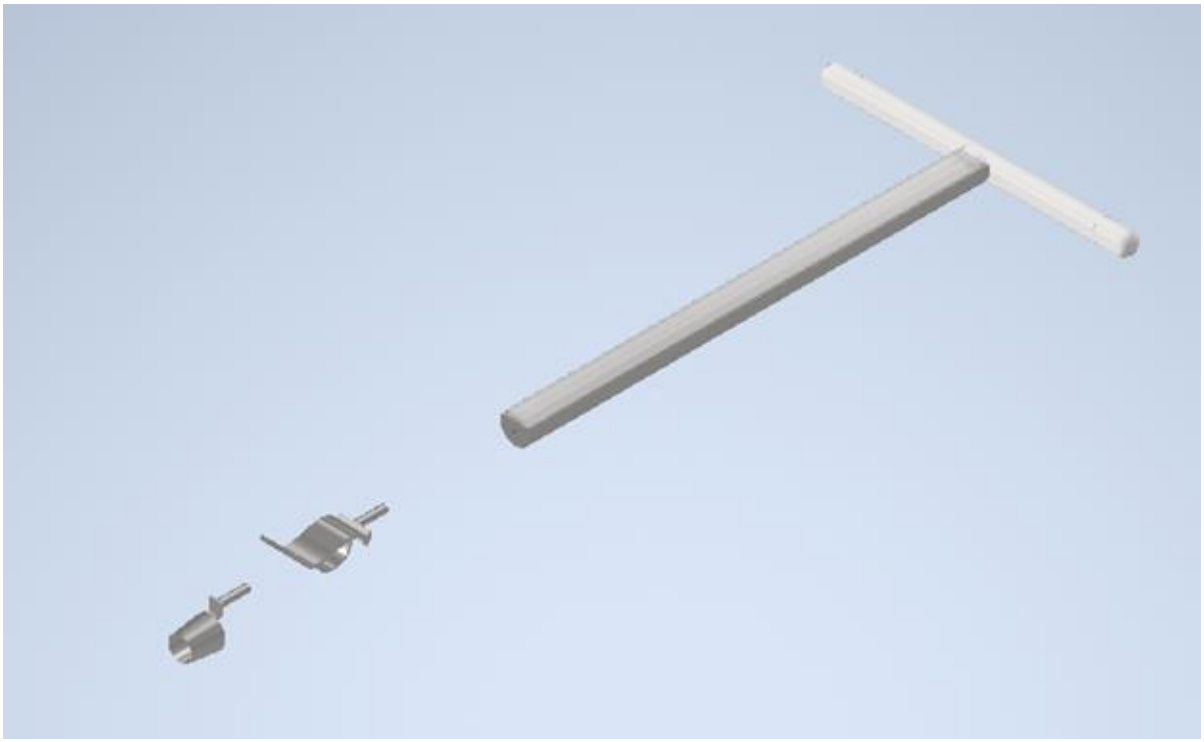
Amanda Pilgrim:

Jeremiah Musselman:

Decision Matrix

Criteria	Weight	Axle-Twisting Plantation Device	T-Bar Planter	Multifunctional Garden-Helper 2000	Comfortable Grip Digger
Comfortability	3	2 (6)	4 (12)	2 (6)	5 (15)
Efficiency	4	4 (16)	3 (12)	5 (20)	5 (20)
Safety	1	5 (5)	5 (5)	5 (5)	5 (5)
Effort to use	5	4 (20)	5 (25)	4 (20)	3 (15)
Lightweight	2	5 (10)	5 (10)	5 (10)	5 (10)
Total	**-**	**57**	**64**	**61**	**65**

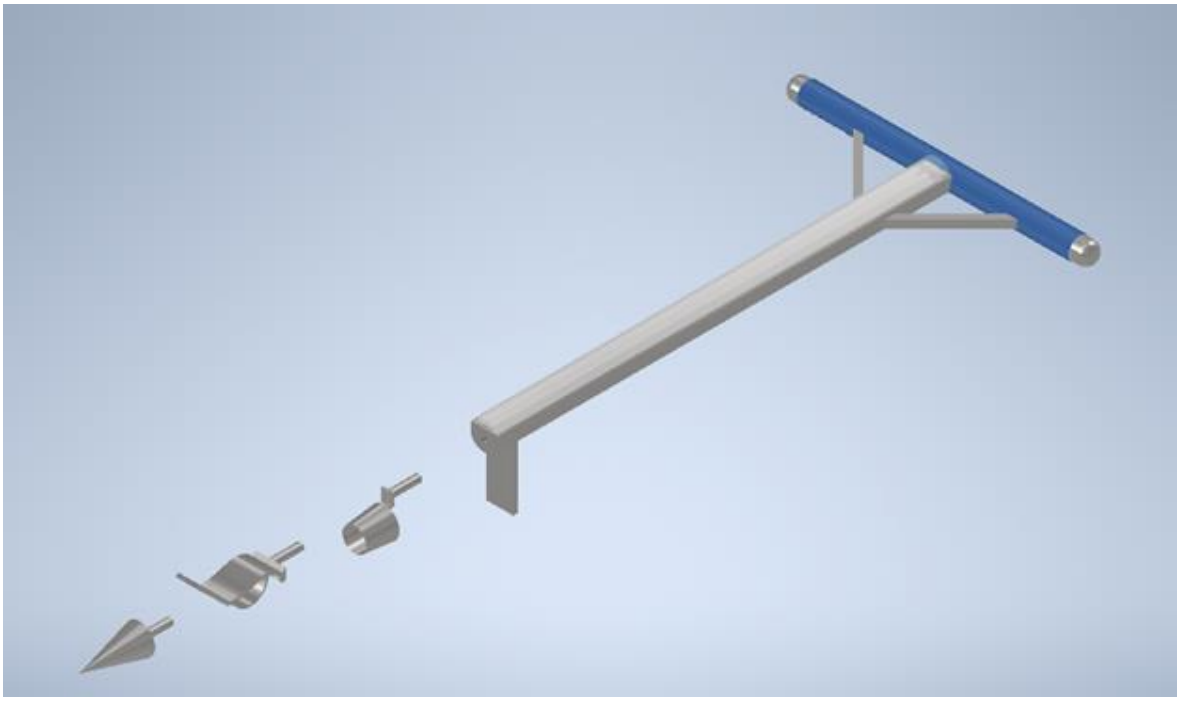
Initial Prototype



Section 3

Final Prototype pictures

Final design:



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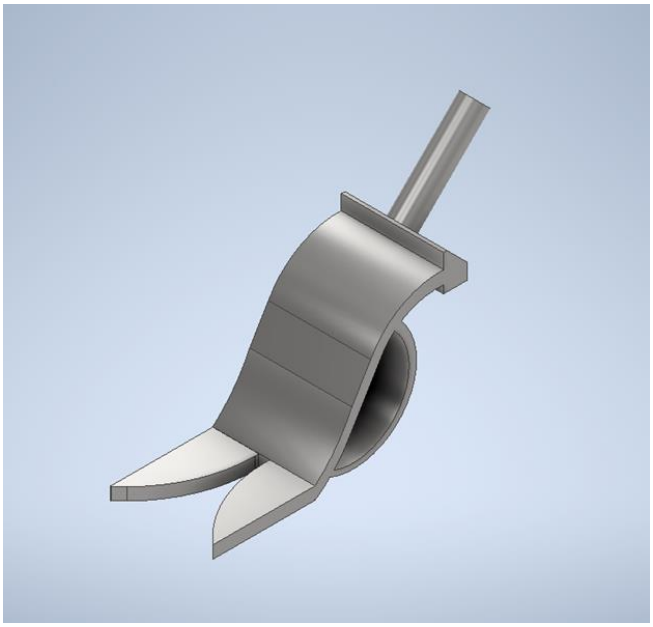

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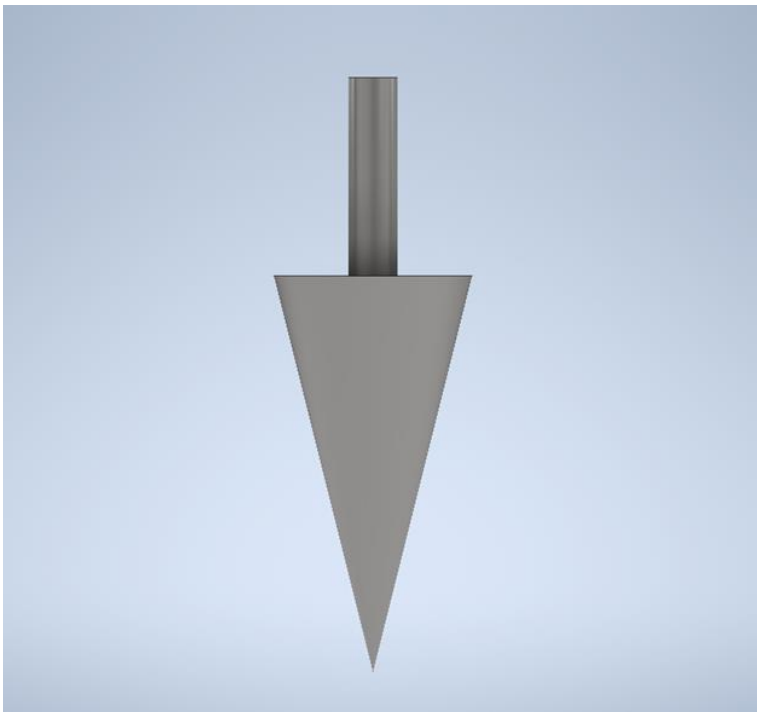
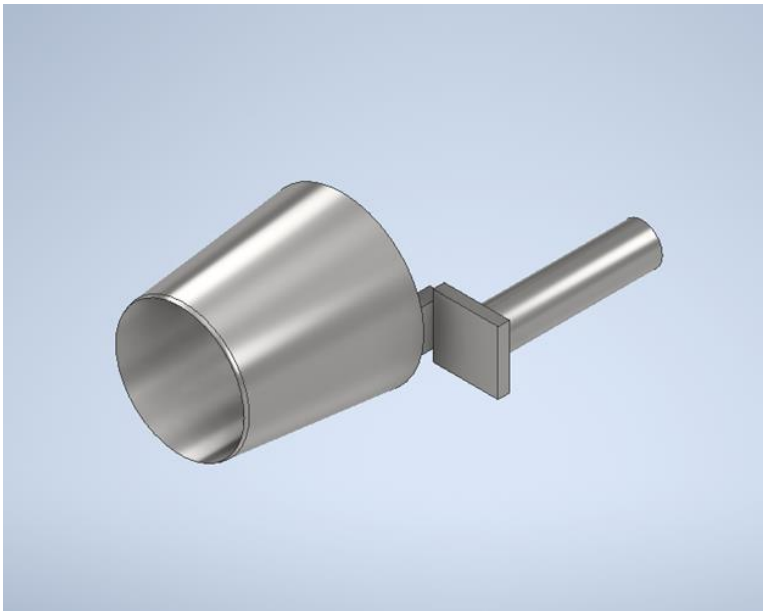


Cone:



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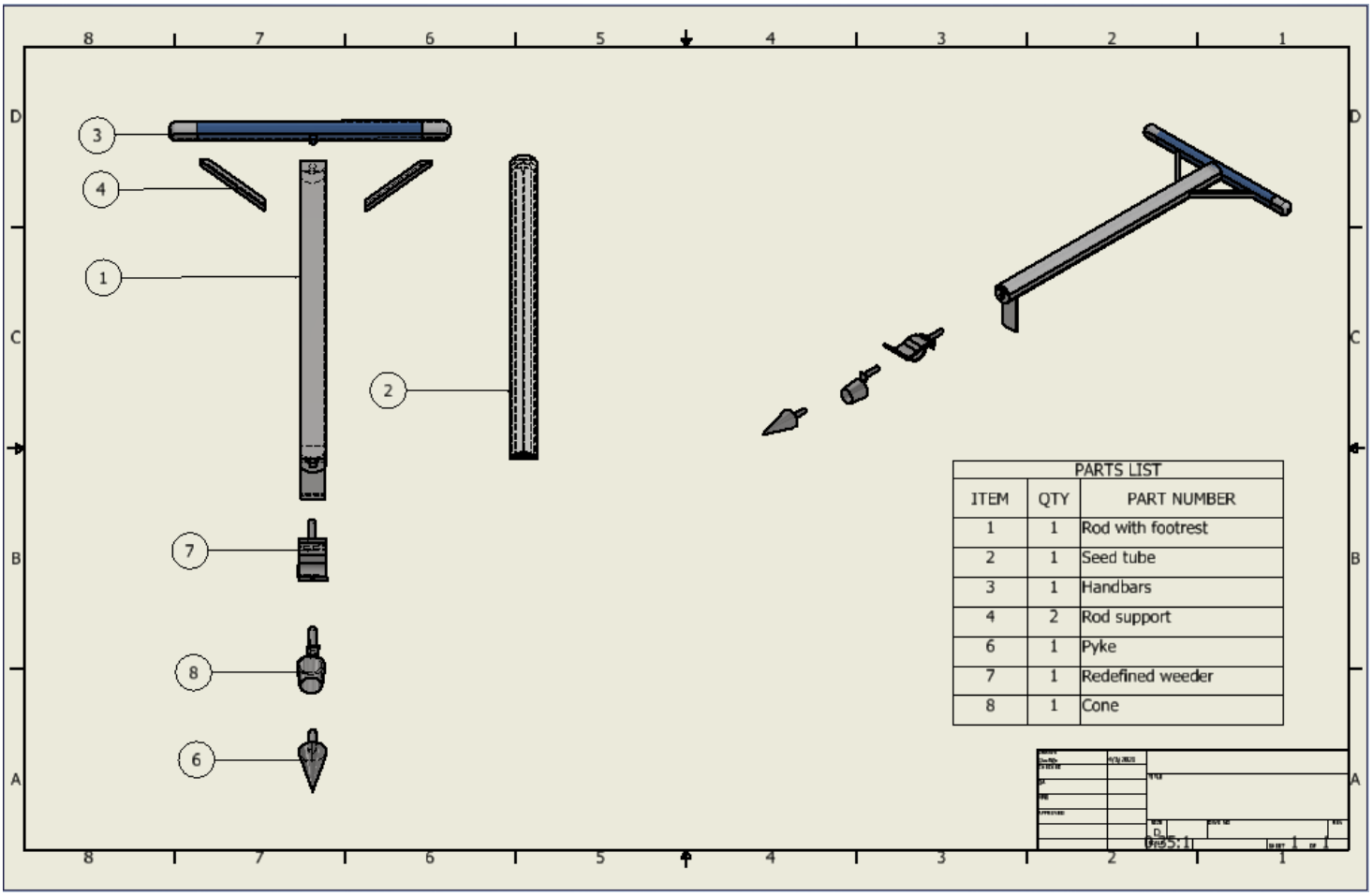
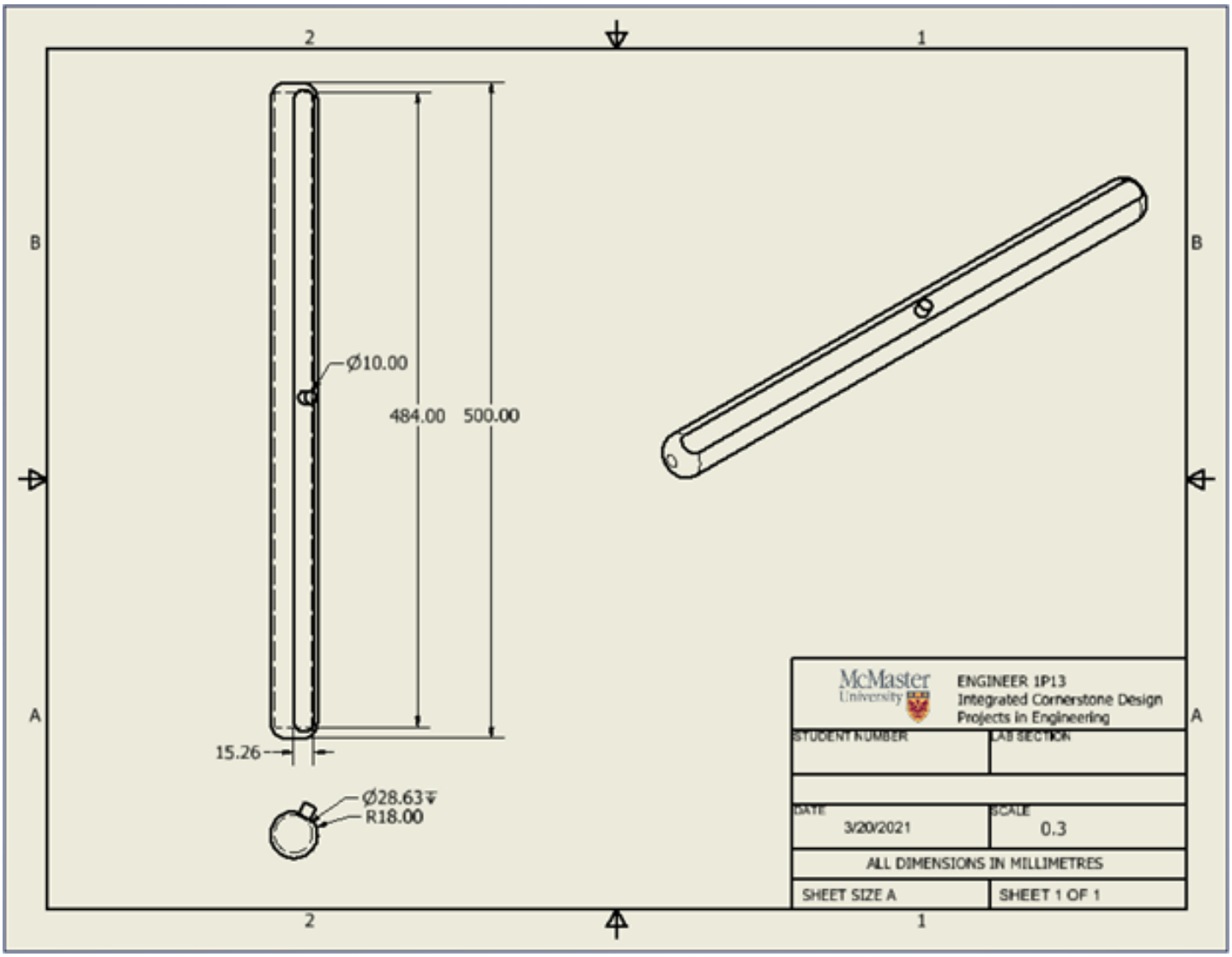


PARTS LIST		
ITEM	QTY	PART NUMBER
1	1	Rod with footrest
2	1	Seed tube
3	1	Handbars
4	2	Rod support
6	1	Pyke
7	1	Redefined weeder
8	1	Cone

Final Drawings:

Handlebar:



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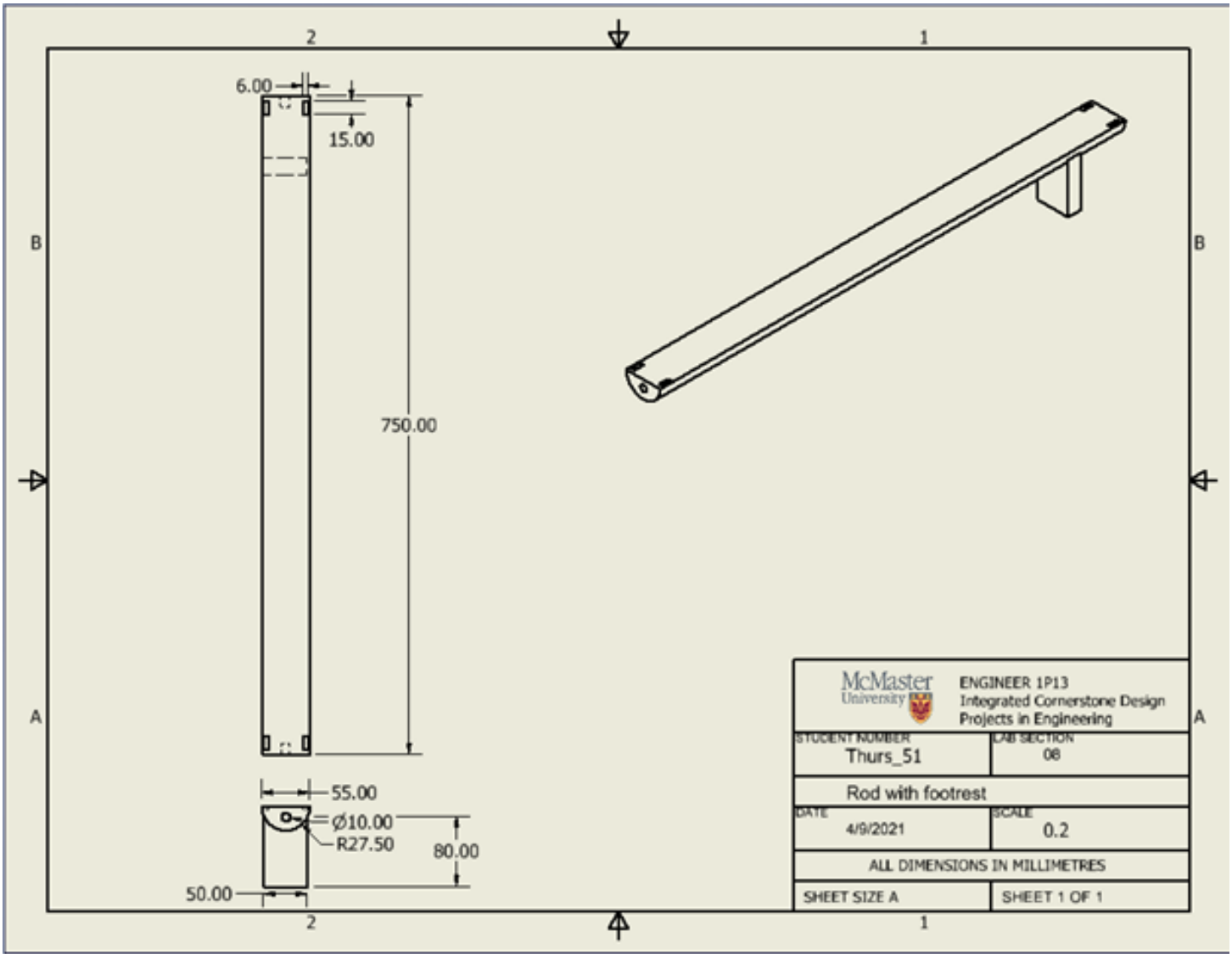

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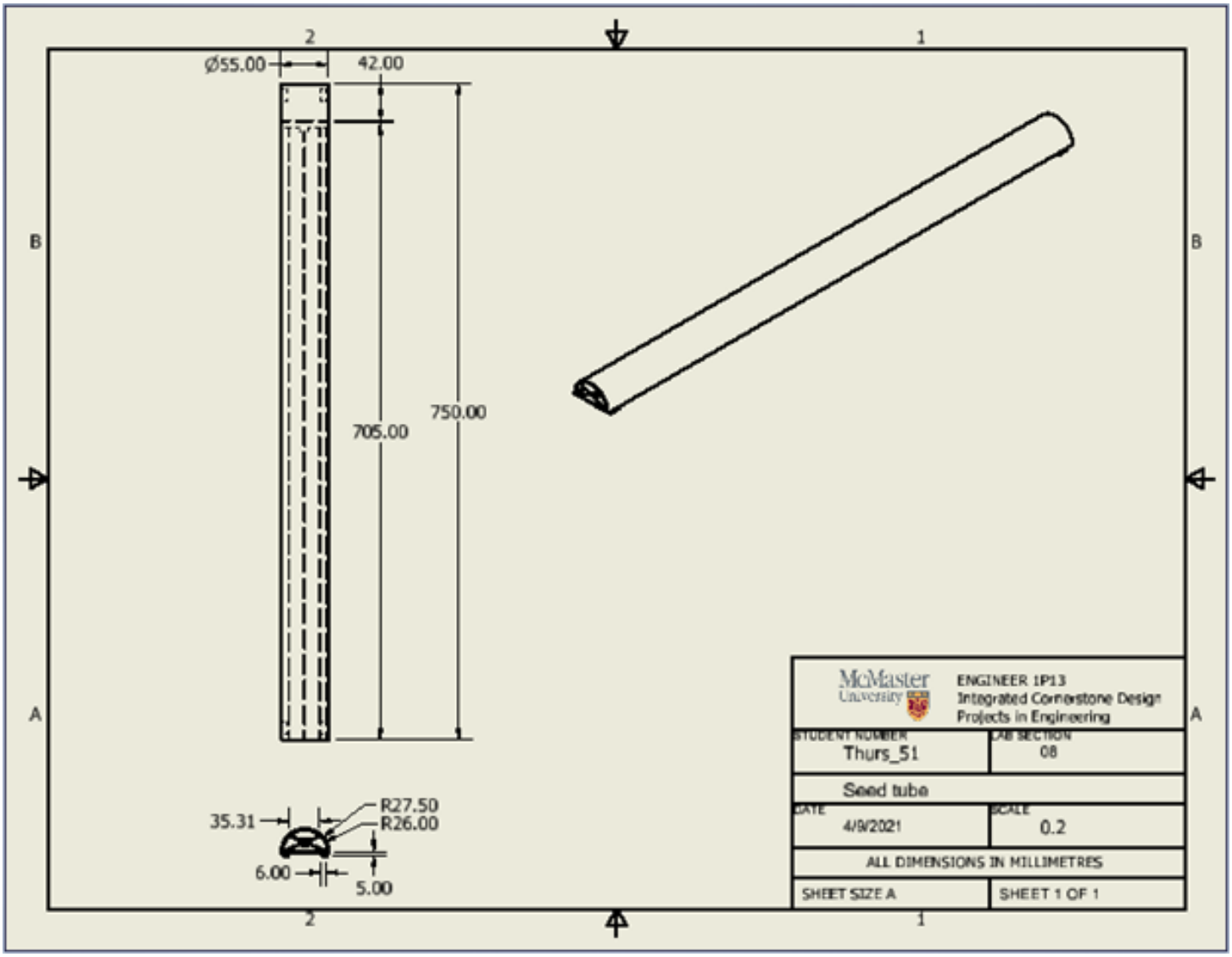
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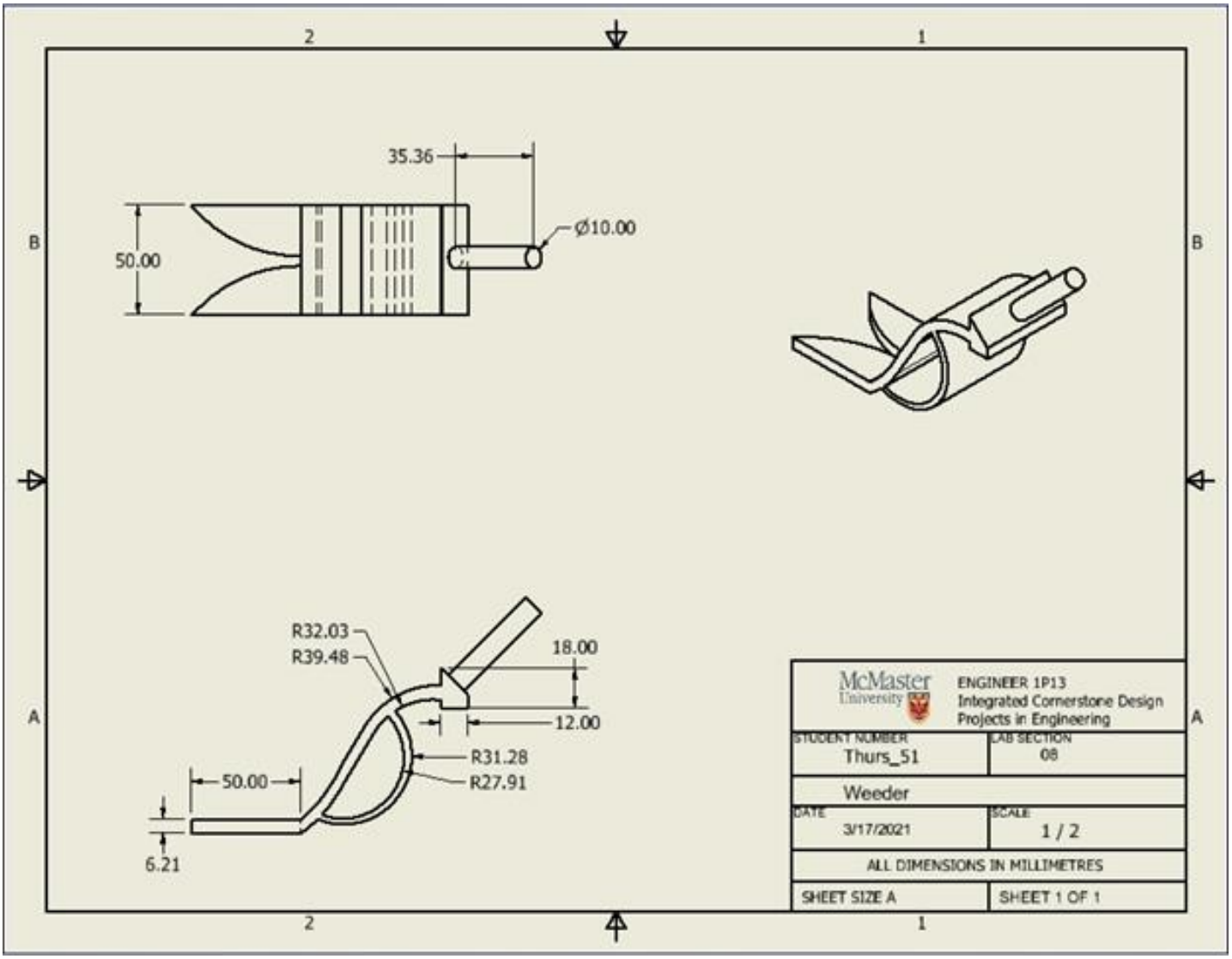
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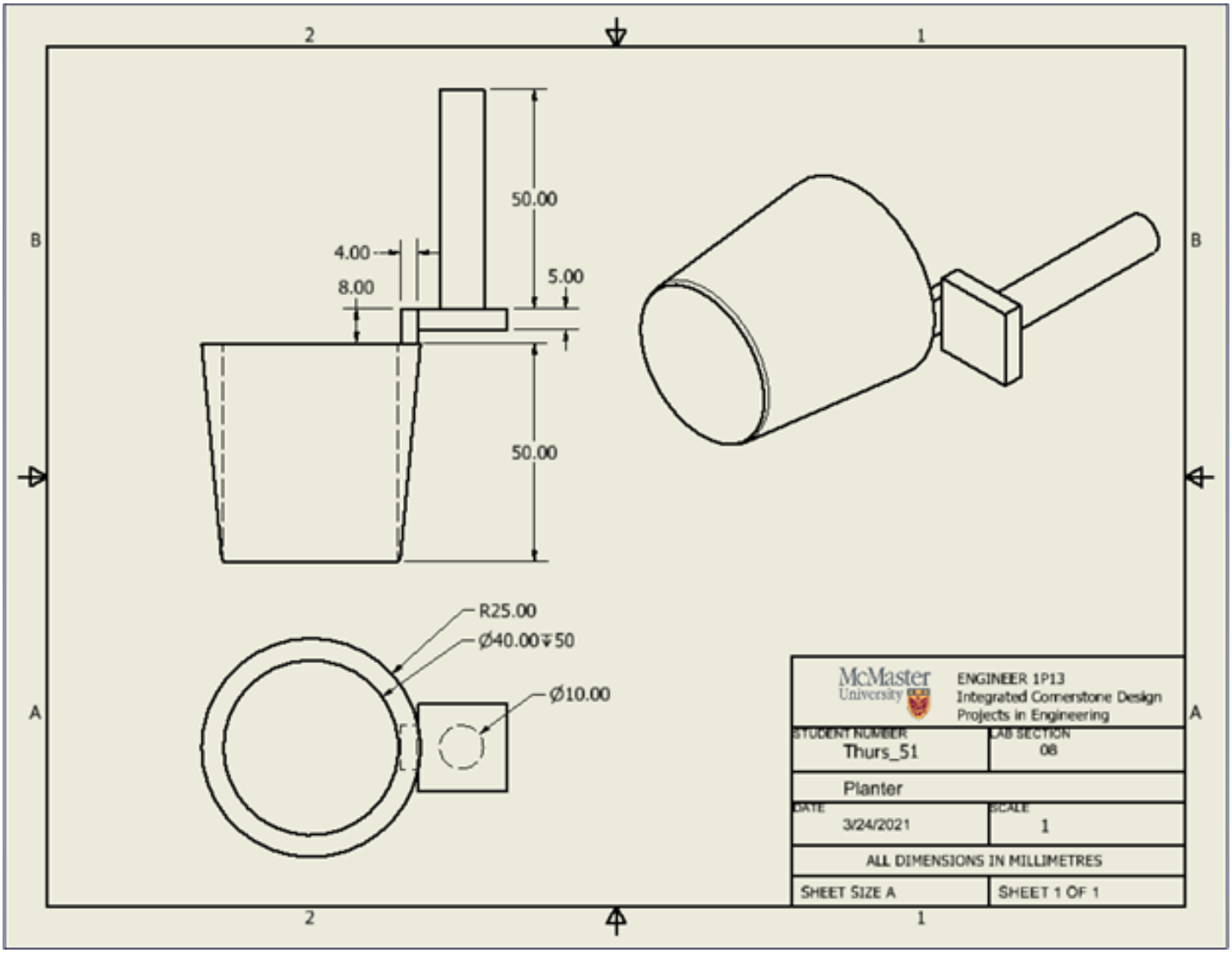
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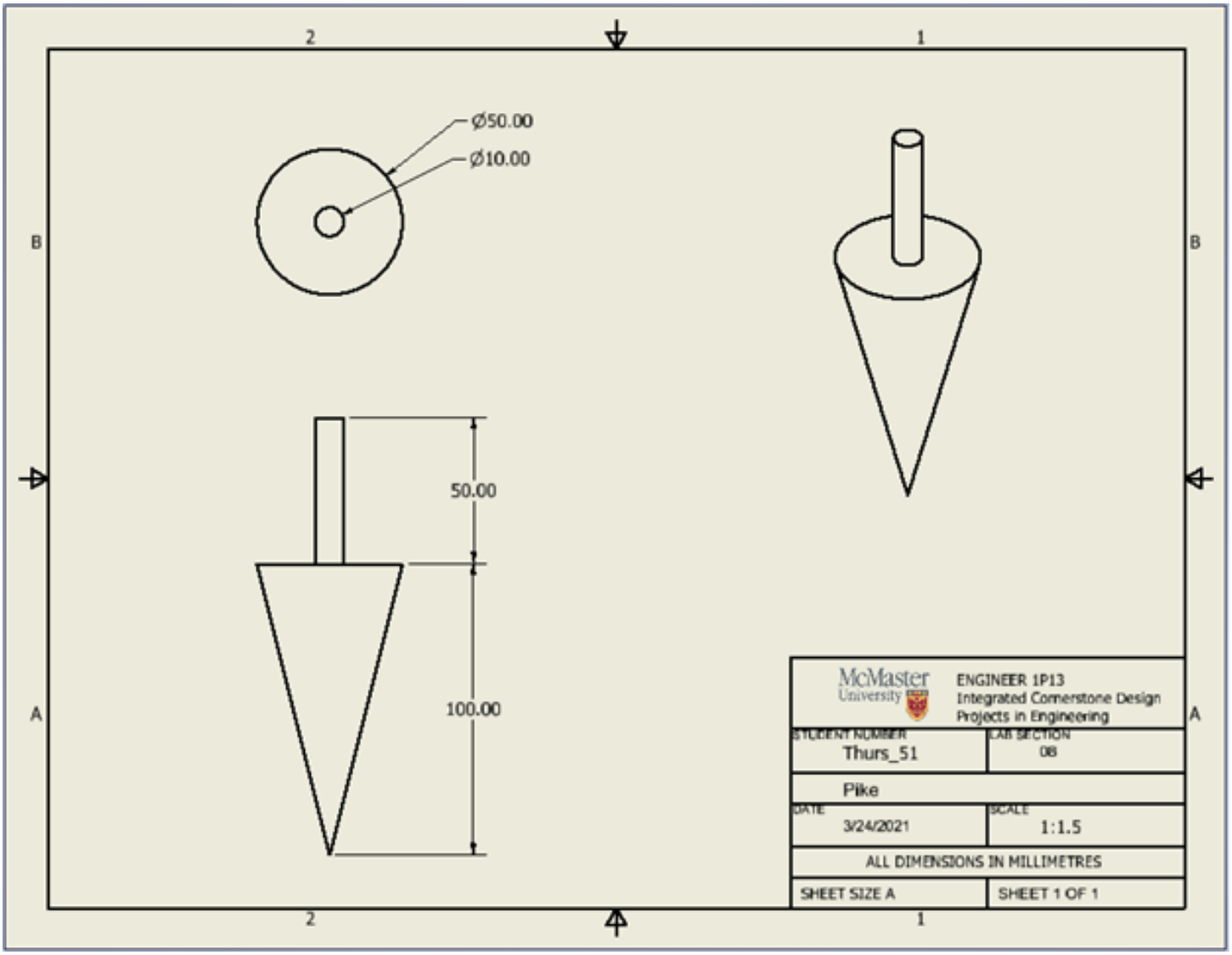
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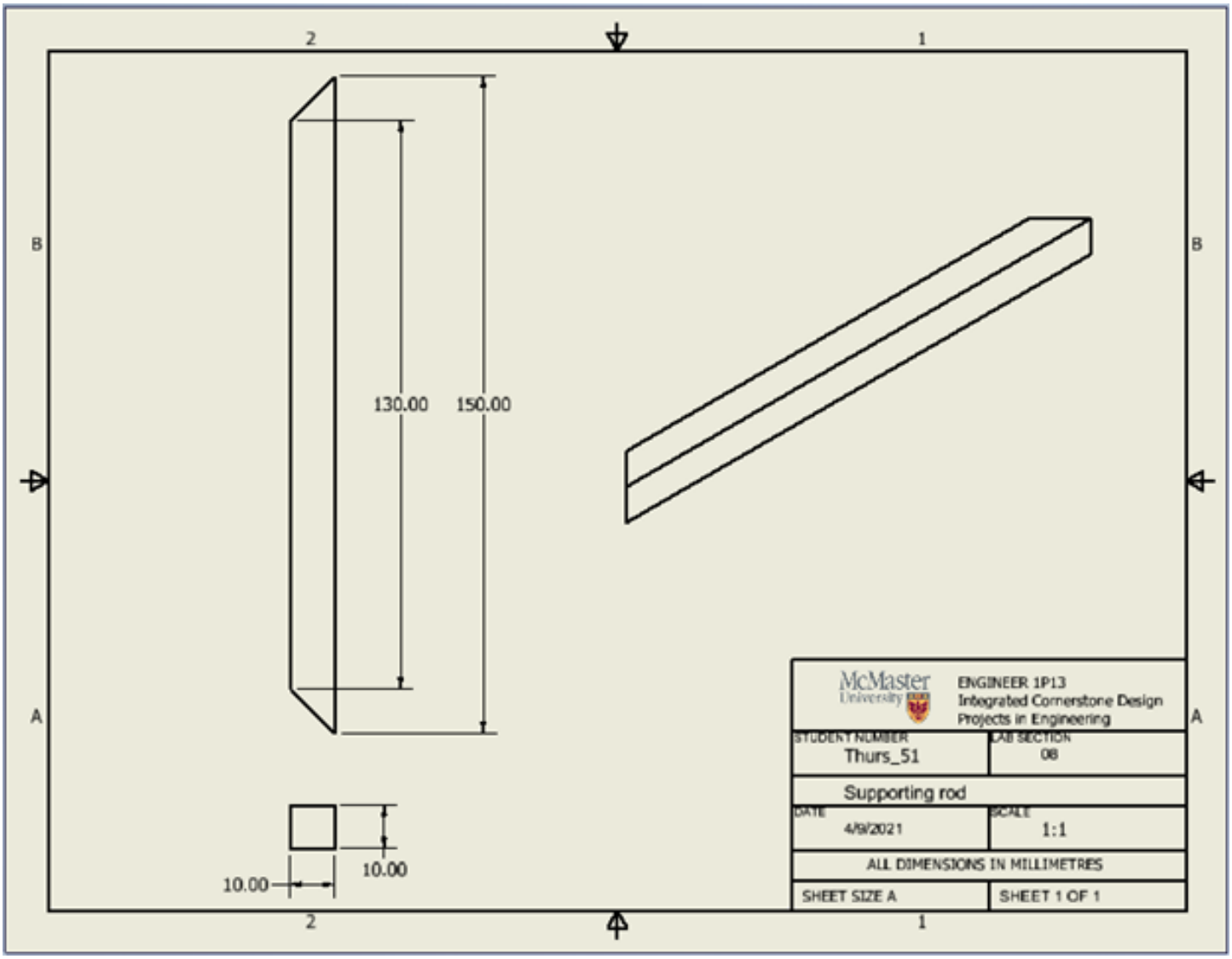
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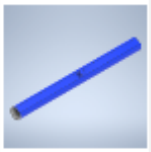
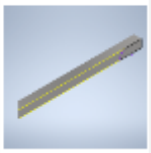
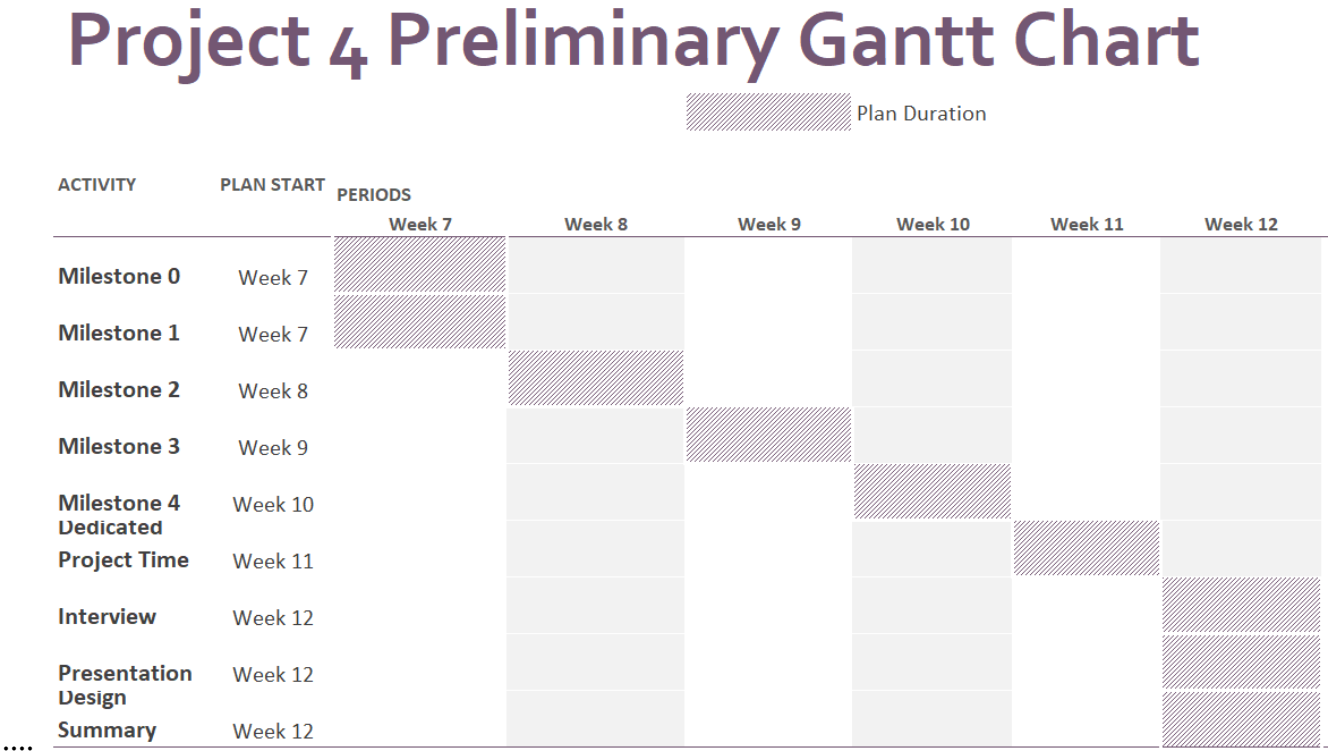
SHEET 1 OF 1

Bill of Materials for final design:

Part Number	Thumbnail	BOM Structure	Unit QTY	QTY	Cost Center
Rod with footrest		Normal	Each	1	$10
Seed tube		Normal	Each	1	$2
Handbars		Normal	Each	1	$2
Pyke		Normal	Each	1	$2
Redefined weeder		Normal	Each	1	$2
Cone		Normal	Each	1	$2
Rod support		Normal	Each	2	$2

Section 4

Preliminary Gantt Chart



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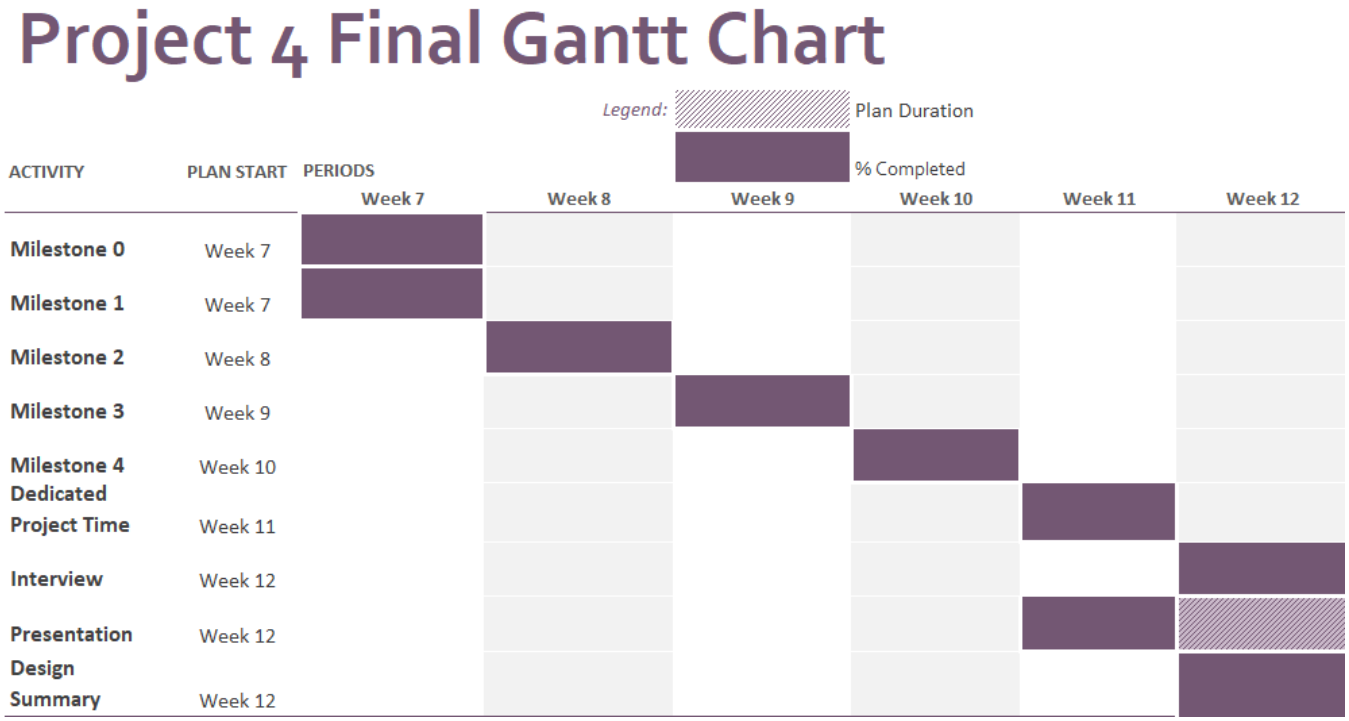
Final Gantt Chart



Logbook

Date	Reason	Length (hours:mins)
March 12	Finishing up milestone 2	0:30
April 4	Working on video presentation slides and script	1:09
April 6	Recording video presentation	0:30
April 11	Working on project summary	1:14
April 13	Working on project summary	1:42
April 14	Final touches on project summary	1:00

Section 5

Source Materials Database

[1] "Engineer 1P13B: Integrated Cornerstone Design Projects in Engineering," P4 Project Module for 1P13B, Faculty of Engineering, McMaster University, Term 2, 2021.

[2] H. J. Yoo, W. Kim, S.-Y. Lee, J. Choi, Y. J. Kim, D. S. Koo, Y. Nam, and K.-J. Cho, "Wearable Lymphedema Massaging Modules: Proof of Concept using Origami-inspired Soft Fabric Pneumatic Actuators," 2019 IEEE 16th International Conference on Rehabilitation Robotics (ICORR), 2019.

[3] T. C. Gillespie, H. E. Sayegh, C. L. Brunelle, K. M. Daniell, and A. G. Taghian, "Breast cancer-related l lymphedema: risk factors, precautionary measures, and treatments," *Gland Surgery*, vol. 7, no. 4, pp. 379–403, 2018.

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