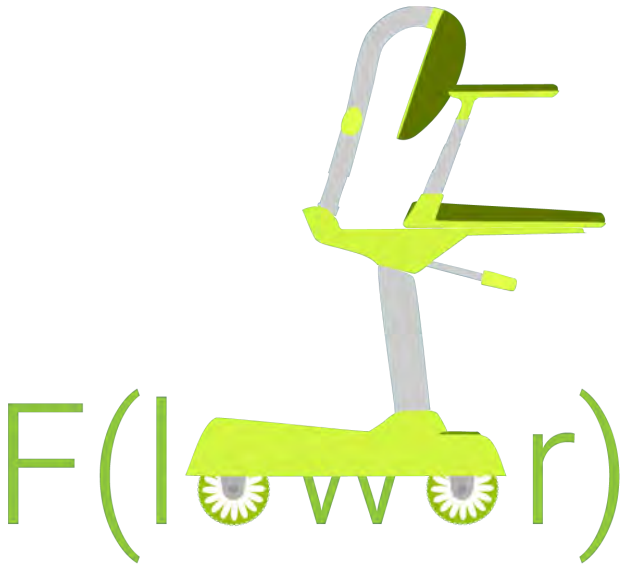
Improving Gardening for People with Arthritis

by

Kristie Bulbrook



Submitted in partial fulfillment of the requirements for the degree of

Bachelor of Industrial Design

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Humber Institute of Technology and Advanced Learning

Supervisors: Catherine Chong and Sandro Zaccolo

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2021

Abstract

Gardening is an activity enjoyed by many, but for people with various forms of arthritis the activity it is not fully accessible. This is a problem since gardening is a good form of exercise and has shown to be very therapeutic. The goal of this thesis is to create a product that makes the experience of gardening accessible to everyone in a safe and unintrusive way. A needs assessment was performed by studying users and their challenges. A one-to-one ergonomic scale model was be developed to understand and evaluate the feasibility of the design in accordance with human factors. The requirements for building a sustainable product were assessed and used in the design requirements. Several design processes were used to determine a target model that met the requirements. These designs were refined using CAD and a physical model of the product. The end result was a product that will enable persons with arthritis to continue to participate in gardening.

Acknowledgements

I would like to thank some people for making this project possible, I could not have complete so much without you. First and foremost, I need to thank my thesis advisors Catherine Chong and Sandro Zaccolo, you two have been there since the beginning of my time at Humber, your feedback and mentorship will carry me into my career.

Next, I must thank some of my family members because without you, for all your love and support throughout the years. Thank you to my cousin Mitchel Owen who let me bug you for engineering advice and telling it to me straight when my design need major changes, those huge changes have brought my project to life. Thank you to my sister Brittany for being my ergonomics advisor for help me understand the pain points of people with arthritis, in a way that I could best understand. Thank you to my brother Chase for me laughed when I wanted to cry. Thank you to my Grandma Barbara for being my muse and inspiration in this project. Last thank you to my parents without you I would not be here. To my mom who through this project kept my workspace clean and made sure that I actually ate something each day. To my dad who was my editor and consultant when I was overwhelmed and wanted to quit.

Lastly, to any one I missed thank you from the bottom of my heart you have helped and inspired me in ways you do not even know.

Contents

CHAPTER 1
Problem Definition

This chapter will identify and define a problem that is significant, and that people will be willing to pay for a solution to. The chapter begins with a clear definition of the problem and then discuss why this is a problem and describe the significance. Finally, it provides some background on how the problem has come to be.

1.1 Problem Definition.

Gardening is an activity enjoyed by many people, but those with various forms of arthritis are not able to fully participate. For the average healthy person, gardening is a medium intensity activity (Park et al., 2011). People with arthritis often find this level of intensity is too high and stop the activity. In addition to people with arthritis other gardeners may experience impediments as they age or due to other conditions. This reduction in participation is a problem since gardening is a good form of exercise, provides a high level of enjoyment and has been shown to be therapeutic (SCOTT et al., 2015). The goal of this thesis is to create a product that makes the experience of gardening more accessible to everyone in a safe and unintrusive way.

1.2 Rational & Significance.

Gardening is a large market enjoyed by people of all ages across North America and Europe. It is becoming increasingly popular in Asia in recent years. The market is large in terms of people participating and money spent on equipment, tools, plants and other supplies.

While there are many people that own or work for landscaping companies the focus of this product is on community or residential gardeners.

In addition to enjoyment as a hobby gardening is a good moderate form of exercise and has therapeutic value. There is a further practical application with people growing food for themselves or their communities.

People with arthritis are limited or prevented from fully participating in gardening due to pain or limitations in movement. These people lose out on the substantial benefits described above.

There are an estimated 6,058,900 people in Canada that suffer from some form of arthritis(Stastitics Canada, n.d.). This number is expected to increase as the average age of the population increases.

There are other people who are restricted in their ability to fully participate in gardening due to limitations that come with age or other health related conditions. This number is also expected to increase as the population ages.

When there is a large market and a large and growing trend such as the incidence of arthritis there is a potential for product opportunities. The expectation is that people with arthritis or other impediments are willing to pay for a product that will enable them to participate more in the activity of gardening.

1.3 Background/ History / Social Context.

For much of human history the world was made up of agrarian communities. Most people worked on farms or grew their own food for survival. People with recreational gardens could afford to hire workers to tend to them. This structure of society existed until the early 20th century when industry took over from agriculture as the primary source of economic activity.

Throughout most of the 21st century people experienced increased lifespans and incomes. As income increased people were able to afford to own property and take on hobbies such as gardening. The number of people participating in gardening increased over the years along with the spend on gardening products. Increased lifespans meant people had several years after retirement to enjoy hobbies such as gardening.

As lifespans have increased so has the rate of chronic diseases such as arthritis. To address this trend the market for products intended to aid people with these conditions has grown substantially. People are willing to pay for products that increase their ability to function in day-to-day life.

CHAPTER 2
Research

This chapter will describe the methodology and results of user research and product research. User research will be used to develop a profile of a target user, their activities, and challenges. Product research will determine what products currently exist in the market to address the user needs and how they perform.

2.1 User Research.

Several methods were used to develop a profile of a typical user. Activity mapping was put together from interviews and online surveys. Due to Covid restrictions, technology problems, and the time of year proper observations could not be done. Literary articles that break down the activity of gardening into grouped tasks were used to fill in the gaps. Data from an online survey that was created to collect user information for gardening with arthritis will be referenced in this chapter. *See Appendix A for Survey Data.* Interviews were conducted with a person with expertise in the movement of the body and products made for people with arthritis.

2.1.1 User Profile

The purpose of the research was to build a profile of the following users:

	Gardener with Arthritis
PRIMARY USER	The main user of this product are gardeners that have one or more types of arthritis in one or more areas of the body. People with arthritis experience pain in various joints making the performance of certain tasks difficult.

SECONDARY USER	**Senior Gardener** These users do not have arthritis but still have difficulty doing some tasks that involve bending and kneeling like in gardening. As people age, they experience a deterioration in muscle strength and dexterity.
TERTIARY USER	**Other Gardener** These users do not have arthritis or any deterioration in strength and movement. But many people that garden experience back pain when doing the activity.

From the research the following profile of the user was created:

Demographics Information

AGE AND GENDER	Based on the survey done on gardening with arthritis (see Appendix A for data) out of 59 respondents 56 were female and 28 were aged 50-64 (this may be due to the survey being conducted using Facebook groups.) All respondents had one or more forms of arthritis and enjoyed gardening.
ARTHRITIS TYPE AND LOCATION	Osteoarthritis and rheumatoid arthritis are the most common types of arthritis. The first type is due to the deterioration of joints over time(CDC,OA). The latter is an autoimmune disease where the bodies cells attack itself (CDC,RA). The most common locations of arthritis are in the hands, knees, feet, hip and back. *See Appendix A*

Persona

Name: Margret Kay

Age: 65

Gender: Female

Occupation: Retired

Income: On a fixed income

Education: College

Relationship Status: Married

Location: Hamilton, On, CA

Frequency of Activity: 1-2 hours at a time with frequent breaks

Hobbies: gardening, baking, dancing

Type of Arthritis: rheumatoid arthritis (Hands, hips)

Figure 1: Retrieved from:
https://www.standard.co.uk/news/nhs-arthritis-patients-will-get-a-drug-originally-developed-to-treat-cancer-6607558.html

USER PROFILE	Margaret Kay is a 65 year old female that has been retired for two years from a sales job. She is married and has four children that have all grown up and have kids of their own. Her favorite hobbies are baking, dancing, and gardening but with her arthritis in the hands and hips those activities are getting difficult. Despite the pain she is motivated to stay active

2.1.2 User Observation- Current User Practice

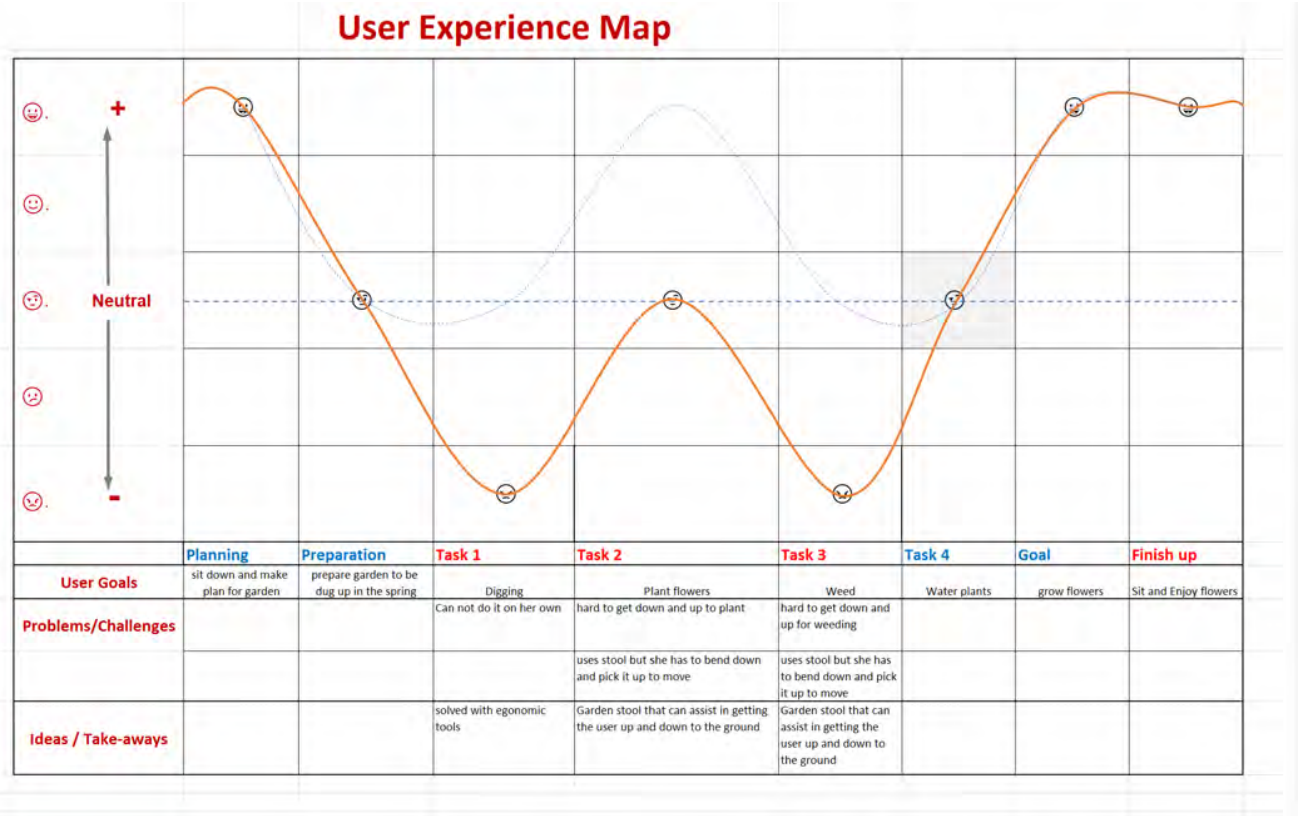
The research also provides data on the tendencies of people who garden:

FREQUENCY	Gardeners with arthritis tend to their gardens for more than two hours with frequent breaks and learn to stop before over doing it to avoid strain.

DURATION	Gardening starts at the beginning of spring with the planting of new plants. Gardeners in the northern regions of North America tend to the garden throughout the summer to the fall when the harvesting takes place.
MOTIVATION	Gardeners continue despite the pain of arthritis because the benefits of having a purpose and the pleasure it gives.
LIFESTYLE	For people with arthritis staying active is the best way to reduce the severity of the pain and the frequency of flare ups. (Arthritis Foundation, 2018)

2.1.3 User Observation- Activity Mapping

Activity Mapping of: Workflow Mapping and Experiential Mapping



Based on interviews the activity of gardening was broken down in to four main tasks: digging, planting, weeding, and watering. As stated in the section introduction above a proper observational

interview could not be done due to Covid restrictions and technology challenges of the interviewee. An article that breaks down the activities of gardening in more detail was used. The article divided the process into seven movements and described the risks of each movement along with the correct way to do them.

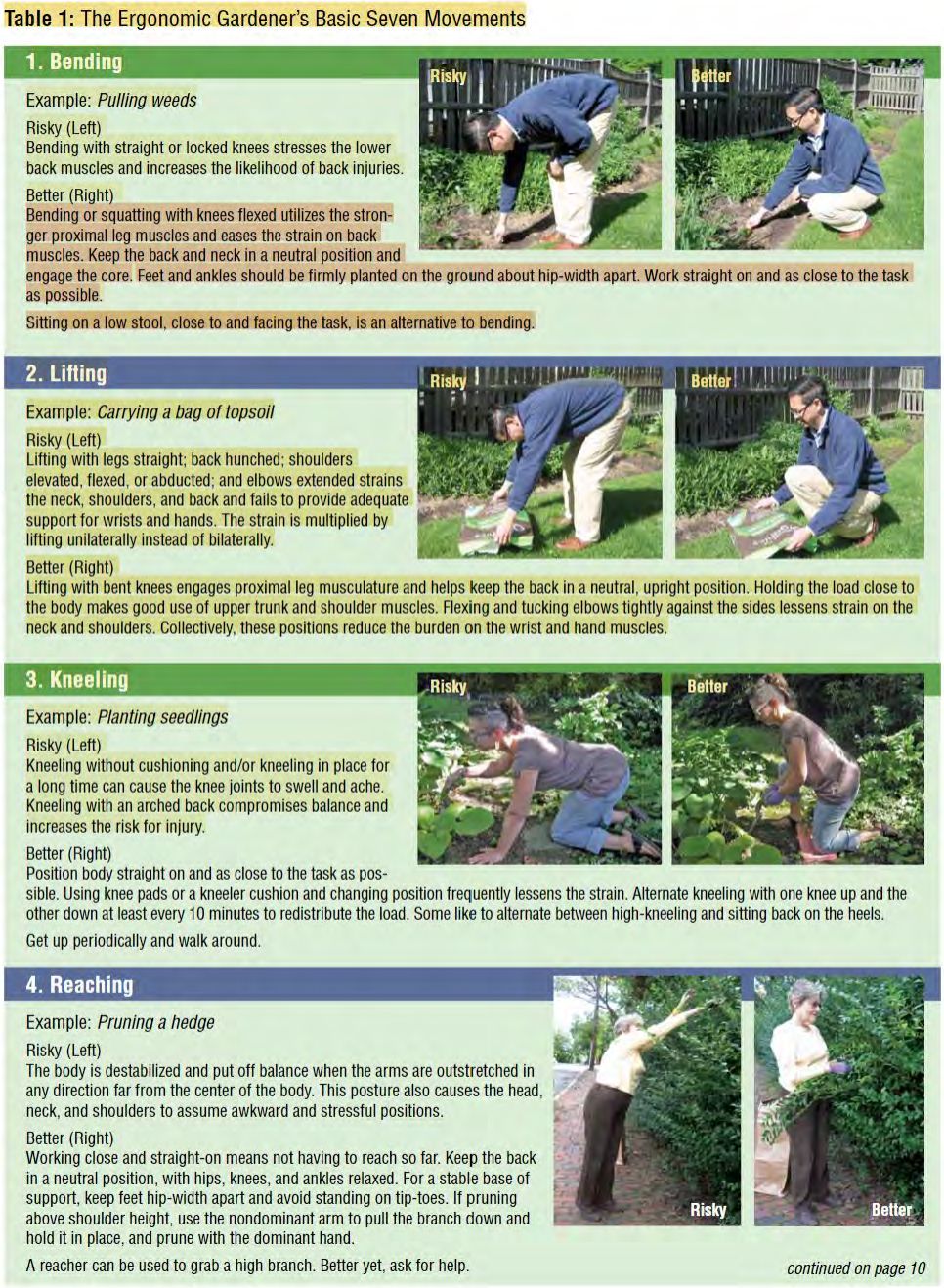


Table 1: The Ergonomic Gardener's Basic Seven Movements

1. Bending

Example: *Pulling weeds*

Risky (Left)
Bending with straight or locked knees stresses the lower back muscles and increases the likelihood of back injuries.

Better (Right)
Bending or squatting with knees flexed utilizes the stronger proximal leg muscles and eases the strain on back muscles. Keep the back and neck in a neutral position and engage the core. Feet and ankles should be firmly planted on the ground about hip-width apart. Work straight on and as close to the task as possible.

Sitting on a low stool, close to and facing the task, is an alternative to bending.

2. Lifting

Example: *Carrying a bag of topsoil*

Risky (Left)
Lifting with legs straight; back hunched; shoulders elevated, flexed, or abducted; and elbows extended strains the neck, shoulders, and back and fails to provide adequate support for wrists and hands. The strain is multiplied by lifting unilaterally instead of bilaterally.

Better (Right)
Lifting with bent knees engages proximal leg musculature and helps keep the back in a neutral, upright position. Holding the load close to the body makes good use of upper trunk and shoulder muscles. Flexing and tucking elbows tightly against the sides lessens strain on the neck and shoulders. Collectively, these positions reduce the burden on the wrist and hand muscles.

3. Kneeling

Example: *Planting seedlings*

Risky (Left)
Kneeling without cushioning and/or kneeling in place for a long time can cause the knee joints to swell and ache. Kneeling with an arched back compromises balance and increases the risk for injury.

Better (Right)
Position body straight on and as close to the task as possible. Using knee pads or a kneeler cushion and changing position frequently lessens the strain. Alternate kneeling with one knee up and the other down at least every 10 minutes to redistribute the load. Some like to alternate between high-kneeling and sitting back on the heels.

Get up periodically and walk around.

4. Reaching

Example: *Pruning a hedge*

Risky (Left)
The body is destabilized and put off balance when the arms are outstretched in any direction far from the center of the body. This posture also causes the head, neck, and shoulders to assume awkward and stressful positions.

Better (Right)
Working close and straight-on means not having to reach so far. Keep the back in a neutral position, with hips, knees, and ankles relaxed. For a stable base of support, keep feet hip-width apart and avoid standing on tip-toes. If pruning above shoulder height, use the nondominant arm to pull the branch down and hold it in place, and prune with the dominant hand.

A reacher can be used to grab a high branch. Better yet, ask for help.

continued on page 10

Figure 2: (Wagenfeld & Buresh, 2012)

Table 1 (Continued): The Ergonomic Gardener's Basic Seven Movements

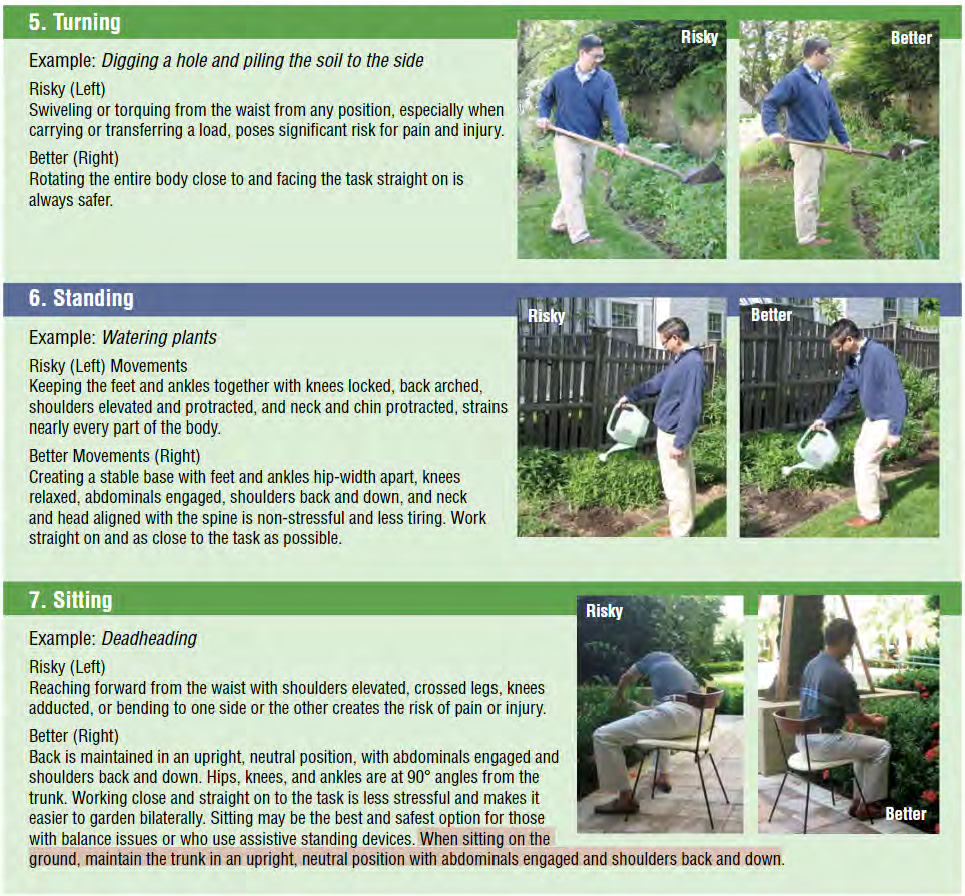


Figure 3: (Wagenfeld & Buresh, 2012)

2.1.4 Human Factors

The seven movements display the wide range of actions undertaken when gardening. The recommendations do not appear to account for persons with mobility problems or pain points that a person with arthritis would have. There are several actions that require a person to move from a standing position to kneeling or leaning and back to standing. There are other situations where a person must maintain a constant position for a prolonged period such as planting and weeding. While in a kneeling or crouching position the person needs to be able to have arms free to move objects or perform tasks. These movements effect the joints such as knees, hips and wrists and the back where people often feel pain or have a lower range of motion.

Tasks	Movements identified						
	Bending	Lifting	Kneeling	Reaching	Turning	Standing	Sitting
Digging	X	X			X	X	
Planting	X		X	X			X
Weeding	X		X	X			X

As the table above indicates that all identified movements are required for the three targeted tasks. Bending, kneeling, and sitting require a person to move up and down from a standing of sitting position. People are often in a crouched, kneeling or sitting position for prolonged periods causing strain on muscles and joints.

2.1.5 Safety and Health – Research of Existing Products

Gardening provides health benefits through exercise, mental stimulation and provides a sense of purpose and accomplishment. Products aimed at this market must retain these benefits while reducing pain, compensating for restricted movements, and preventing further injury.

2.2 Product Research.

Using information obtained from user research and desk research using web searches the following data was gathered on existing products in the market (Detailed product descriptions are attached as Appendix B):

2.2.1 Benchmarking – Benefits and Features

	Product Image	Description - *standout features and benefits*
1		Steerable Rolling Seat with Tool Tray -Tractor style seat, swivels 360 degrees -steerable -big pneumatic wheels -adjustable -tray to store tools and basket
2		Folding Kneeler Stool -storable -compact -can use for more than just gardening ex. Camping chair
3		Garden Kneeler and Seat with 2 Bonus Tool Pouches -comes with lots of add-ons - can use it as a seat or a kneeling pad -thick padding -storable -place to store tools - can use for multiple activities -legs can be used as handles to get up while the product is in the kneeling position

	Product Image	**Description - *standout features and benefits***
4		Miracle-Gro 4-in-1 Garden Stool -can use as a seat or a kneeling pad -lots of storage -has wheels - can use for multiple activities
5		Step 2 Corp The Step2 Company Garden Hopper -has wheels -lots of storage
6		Pure Garden 82-VY021 Garden Cart Rolling Scooter with Seat -big wheels -storage tray for tools -big, molded seat
7		Garden Rocker Rolling Seat -Unique wheels -rocks and rolls with body -adjustable and ergonomic

	Product Image	**Description - *standout features and benefits***
8		Rubi Ergonomic seat SR-1 -expensive -adjustable and ergonomic seat -kneeling pads -wheels no made for gardening
9		Marshalltown Racatac chest support -expensive -not made for gardening -chest support -kneeling pads -adjustable and ergonomic

The features and benefits listed for each of these products are captured in the tables below along with their frequency.

Comparative analysis of product features and benefits

Benefits Frequency Table	
Category	**Amount**
Comfort	13
Ease of Use	4
Useful	7
Size	3

Benefits Frequency Table Continued	
Category	**Amount**
Adjustable	4
Ergonomic	3
Other	5

Features Frequency Table	
Category	**Amount**
Product Dimensions	4
Weight Capacity	3
Tires	4
Storage	4
Materials and Finishes	14
Other (Build/ Durability)	9

Features Frequency Table (Materials and Finishes)	
Category	**Amount**
Metal	6
Plastic	2
Foam	2
Finish	4
Other	2

2.2.2 Benchmarking – Functionality

Functional, convenience of use, materials etc.

Most of the products benchmarked provide minimal support for the movements required for gardening. Products 1 to 7 support sitting with products 3 and 4 also supporting kneeling. There is no assistance in products 1 to 7 for moving out of and back into a standing position or any support for holding a position for a prolonged period. Product 8 provides sitting and kneeling assistance but is not designed for gardening. Product 9 provides chest support for maintaining a position in addition to sitting and kneeling but it also not designed for gardening. Products and 8 and 9 have wheels that are too small to enable maneuvering in the garden. Products 1 to 7 are inexpensive and seem to be targeted to people without pain or mobility problems.

2.2.3 Benchmarking - Aesthetics and Semantic Profile

The benchmarked products seem to favour function over form with aesthetics not being an important consideration. There is no attempt to appeal to any style or trends. They are offered in a limited number of colours and materials.

Colours: Gray & black. Green & black. Red & black. Blue & silver (Non- painted metal).

Shape: products that claim to be ergonomic have an organic shape or form and others have sturdy boxy shapes.

Materials and finishes: coloured durable plastics or powder coated or finished metals, With layered foam padding.

The design appears intended to provide a low function, inexpensive product.

2.2.4 Benchmarking – Materials and Manufacturing

The materials used in the comparative products are listed in the table below along with the frequency of use.

Features Frequency Table (Materials and Finishes)	
Category	**Amount**
Metal	6
Plastic	2
Foam	2
Finish	4
Other	2

Most gardening stools are made of metal with a paint finish or durable plastics, with a layered foam padding. No use of new sustainable materials or technologies are used to make these products.

The products designed for gardening have few parts for assembly. The parts are extruded plastics or stamped and formed metals.

2.3 Conclusion

The products designed for gardening in the market are made to solve one or two basic movements in gardening (i.e. sitting and kneeling). They do not support other more complex movements such as moving from standing to kneeling or sitting and back to standing or support for positions held for long periods of time. The products appear to be aimed at people with average capabilities. None of the products reviewed appear to support persons with arthritis.

CHAPTER 3
Analysis

This section will analyze the results of the user and benchmark product research to determine the requirements for a product designed to solve the problem identified.

3.1 Analysis – Needs

This section will list the needs identified and describe how they are currently being addressed in the market. Following this analysis the needs will be ranked and grouped to provide direction to the design process.

3.1.1 Needs/ Benefits Not Met by Current Products

Needs identified	How they are addressed by current products
Support for primary movements identified. E.g. standing to sitting and back to standing.	- No support for movements beyond sitting and kneeling
Support for positions held for prolonged periods	- Products support basic kneeling and sitting for person of average capabilities.
Unintrusive	- Simple product with no intrusiveness issues
Appearance	- No attempt to appeal to design requirements
Easy to use	- Simple product with no complex use issues

3.1.2 Latent Needs

In addition to those needs observed in the user study there are needs that are less visible but also important for the user.

Needs	Benefits
No appearance of disability	People often avoid products that make them appear disabled
No struggle to use product	Persons do not want to appear unable to utilize technology
Sustainability	People that garden often have a desire for sustainable products

3.1.3 Categorization of Needs

This section will rank the needs identified. High priority items are those that provide significant functionality and distinguish the product in the market. Secondary features are necessary in all products and do not provide a competitive edge. Latent needs are important since they address emotional needs and can be a major factor in a buying decision.

Highest priority (Product must address)	- vertical assist – moving out of and back into standing position - support for positions held for long periods - easy to use - does not take away from the experience or exercise
Secondary (Features expected in products that do not make a product distinct)	- Safety - Comfort - Light weight
Latent Needs	- Cannot cause user to feel like they have a disability - Person cannot struggle to use product - Sustainable

3.2 Analysis – Usability

This section will describe the workflow in the targeted tasks in gardening, describe the challenges and demonstrate the impact of a product that addresses the challenges.

3.2.1 Activity – Workflow Mapping

As described in the user analysis three task being targeted in the gardening process are digging to prepare garden, planting flowers and other plants, and weeding. The workflow described in the table below describes the steps in each task and the challenges faced by gardeners with arthritis.

Tasks	Steps in workflow	Challenges
Digging to plant flower	Move from standing to kneeling or crouching	Difficulty getting up and down
	Move any obstacles such as rocks or roots	Need for freedom of movement of arms and hands
	Using small digging tool create holes for plants	Need for freedom of movement of arms and hands
	Dig all holes within reach from current position	Must remain in position for extended period – strain on muscles and joints
	Move from kneeling or crouching to standing	Difficulty in getting up and down
	Reposition for additional digging and repeat steps until complete	

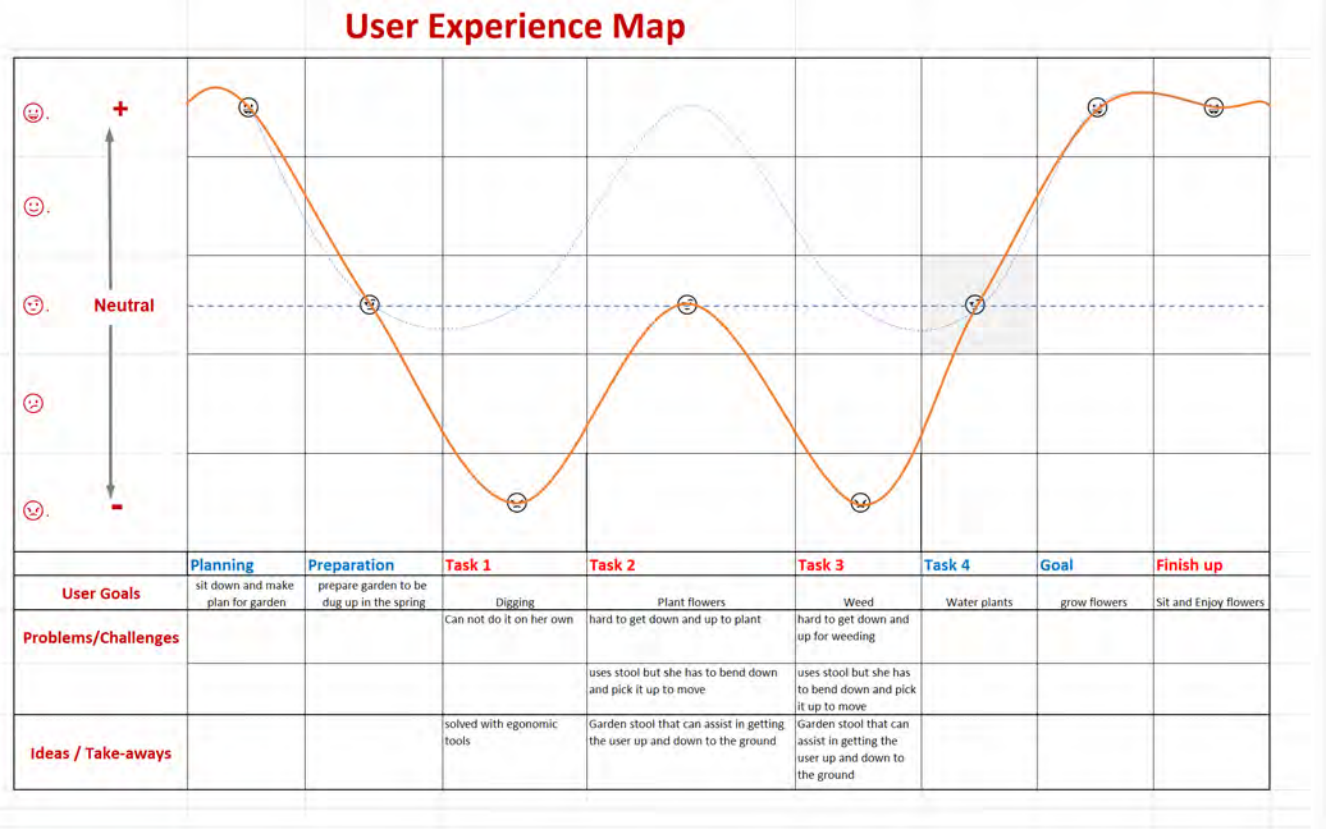
Tasks	Steps in workflow	Challenges
Plant flower	Move from standing position to kneeling or crouching	Difficulty getting up and down
	Pour water and any fertilizer into holes	Need for freedom of movement of arms and hands
	Reach for plants and place them in holes	Need for freedom of movement of arms and hands
	Cover holes with dirt	Need for freedom of movement of arms and hands
	Water plant	Need for freedom of movement of arms and hands
	Plant as many as can be reached from current position	Must remain in position for extended period – strain on muscles and joints
	Move from kneeling or crouching position to standing position	Difficulty getting up and down
	Reposition and repeat steps	

Tasks	Steps in workflow	Challenges
Weeding	Move from standing position to kneeling or crouching	Difficulty getting up and down
	Sift through plants within reach and remove weeds by the roots.	Need for freedom of movement of arms and hands
	Place weed into garbage bag	Need for freedom of movement of arms and hands
	Remove all weeds within reach	Must remain in position for extended period – strain on muscles and joints
	Move from kneeling or crouching position to a standing position	Difficulty getting up and down
	Reposition and repeat steps until complete	

The user has the most difficulty in Tasks 1 to 3 where there is movement to and from a standing position. These steps also require the user to stay in a single position for a period time stressing the back and other high-risk areas. While in a down position the user will need to have free movement of hands even while being supported.

3.2.2 Activity – Experience Mapping

The User Experience Map demonstrates how a tool to assist with Tasks 1 to 3 would provide the support for gardening movements while still permitting free movement of hands. This support also enables the user to enjoy the exercise benefits while eliminating most of the pain.



	Planning	Preparation	Task 1	Task 2	Task 3	Task 4	Goal	Finish up
User Goals	sit down and make plan for garden	prepare garden to be dug up in the spring	Digging	Plant flowers	Weed	Water plants	grow flowers	Sit and Enjoy flowers
Problems/Challenges			Can not do it on her own	hard to get down and up to plant	hard to get down and up for weeding			
				uses stool but she has to bend down and pick it up to move	uses stool but she has to bend down and pick it up to move			
Ideas / Take-aways			solved with egonomic tools	Garden stool that can assist in getting the user up and down to the ground	Garden stool that can assist in getting the user up and down to the ground			

3.3 Human Factors

Gardening is a therapeutic experience enjoyed by many people. It is a medium intensity activity that is a good form of exercise. For people with arthritis, it can keep them active and motivated to move despite the pain it may cause. Gardening has been known to cause back pain for most people due to repetitive movement and sitting in a position for long periods. With an assistive garden stool and extendable tool, they can improve the gardening experience in a safe and intrusive way.

3.3.1 Literature Review

An article about the ergonomics of gardening it broke down the activity of gardening into the actions and the proper postures and positions to use for each. (Wagenfeld & Buresh, 2012) For example to bend down to pull weeds it instructs to keep neck and back straight, bend at the kneed and waist, keeping your feet flat on the ground. Alternatively, a low sitting stool can reduce the incidence of injury. Combining this information from this article to the dimension with tips from “The Measure of Man and Woman”(Tilley & Dreyfuss, 1993), provides a good framework for gardening ergonomics.

Methodology

The considerations for the ergonomic evaluation and analyses for the design of a gardening reaching tool and stool for arthritis are as follows:

Objectives

The goal of this process is:

to explore and investigate the full-bodied ergonomic challenges and interactive design of a gardening stool and extendable tool for people that have arthritis.

To understand how to create a safe and unintrusive gardening product, that uses three parts of the human body.

Decisions to be made

The following actions use three or more parts of the body and will be evaluated to find out how to assist in performing these actions without being intrusive:

Assisted bending/ leaning (Hips)

Assisted reaching with an extendable tool (Shoulders, arms)

Assisted standing (Knees, arms)

Description of Users Targeted by Product

The target demographic is females between the ages of 55-70 with arthritis that like to garden and secondarily individuals in general that like to garden.

Evaluation process

The evaluation process used a mock-up made of scrap material and found objects made to a 1:1 scale to enable observation of:

Whether proper posture is produced when leaning forward. ‘Keep the back and neck in a neutral position and engage the core. Feet and ankles should be firmly planted on the ground about hip-width apart.’ (Wagenfeld & Buresh, 2012)

Whether the product is interrupting the activity,

Whether there is support for person while leaning, and assistance with getting from a sitting to standing position, and

Human factor dimensions.

Description of User Observation Environment Used in this Study

Due to the season and weather this study was conducted indoors overlooking a garden where the product would be used.

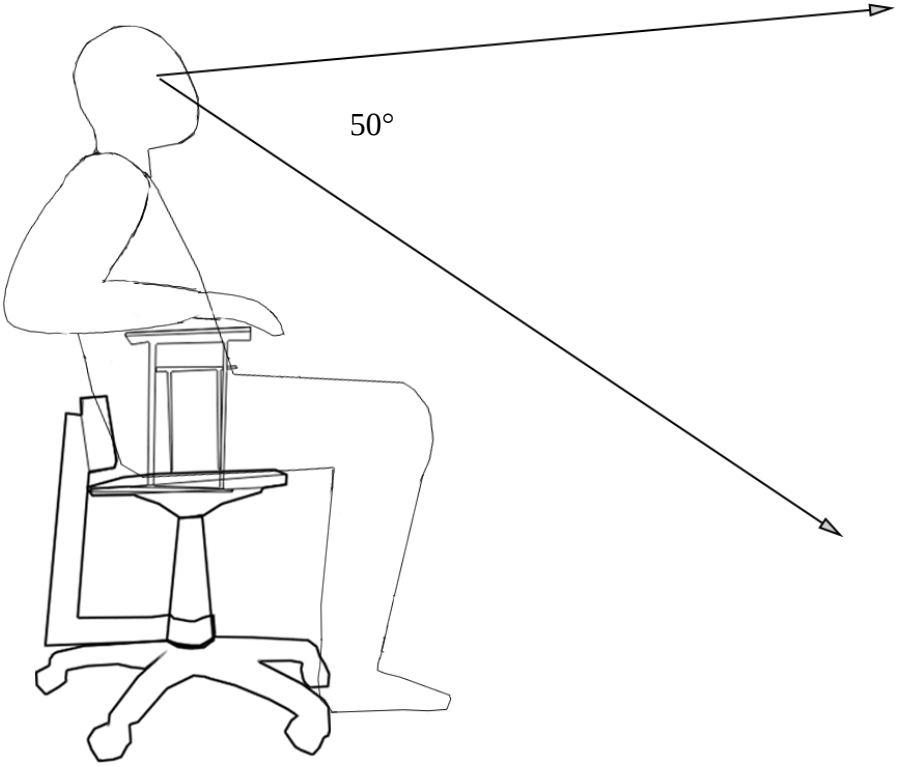
Location and Timeframe

Date of Observation(s): 01/17/21 (Observation 1)

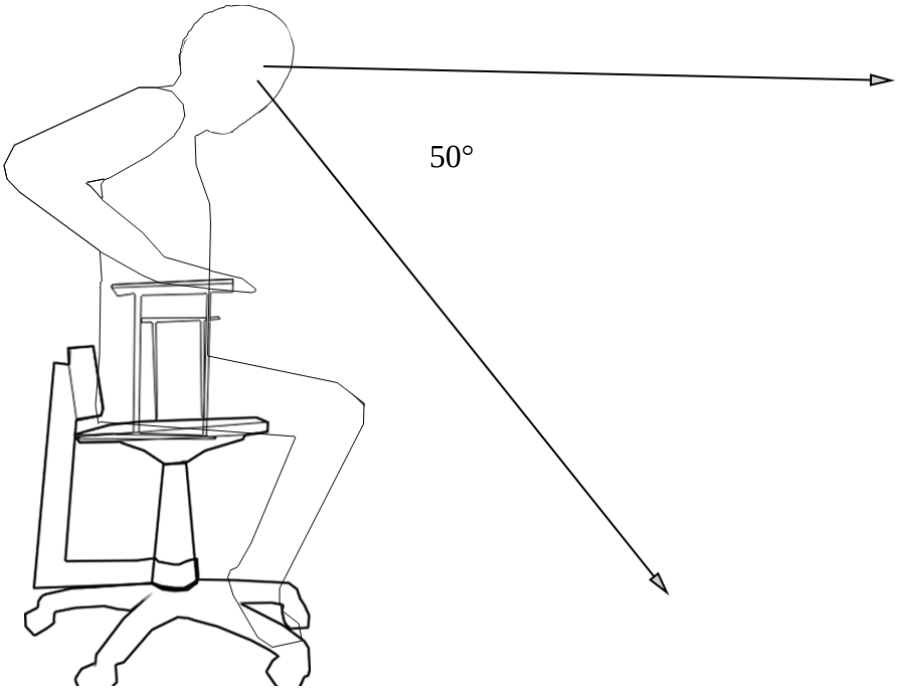
Location of Observation(s): Investigators Residence (Observation 1)

3.3.2 Results

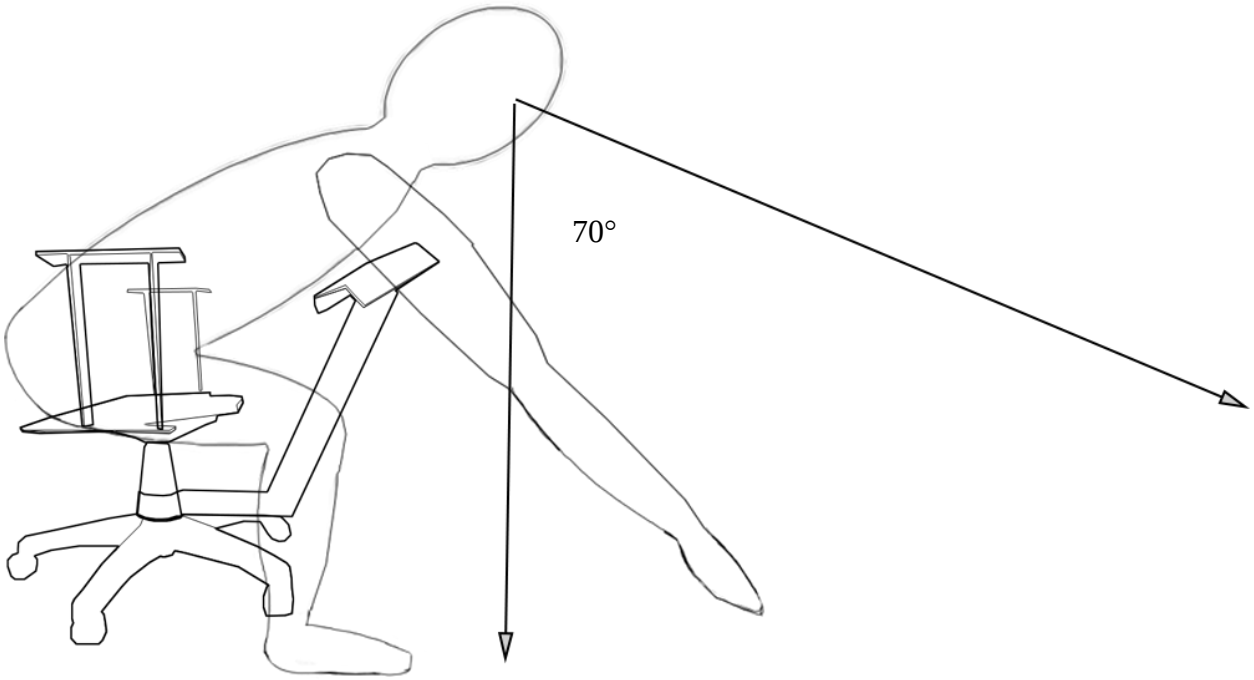
Ergonomic Diagrams



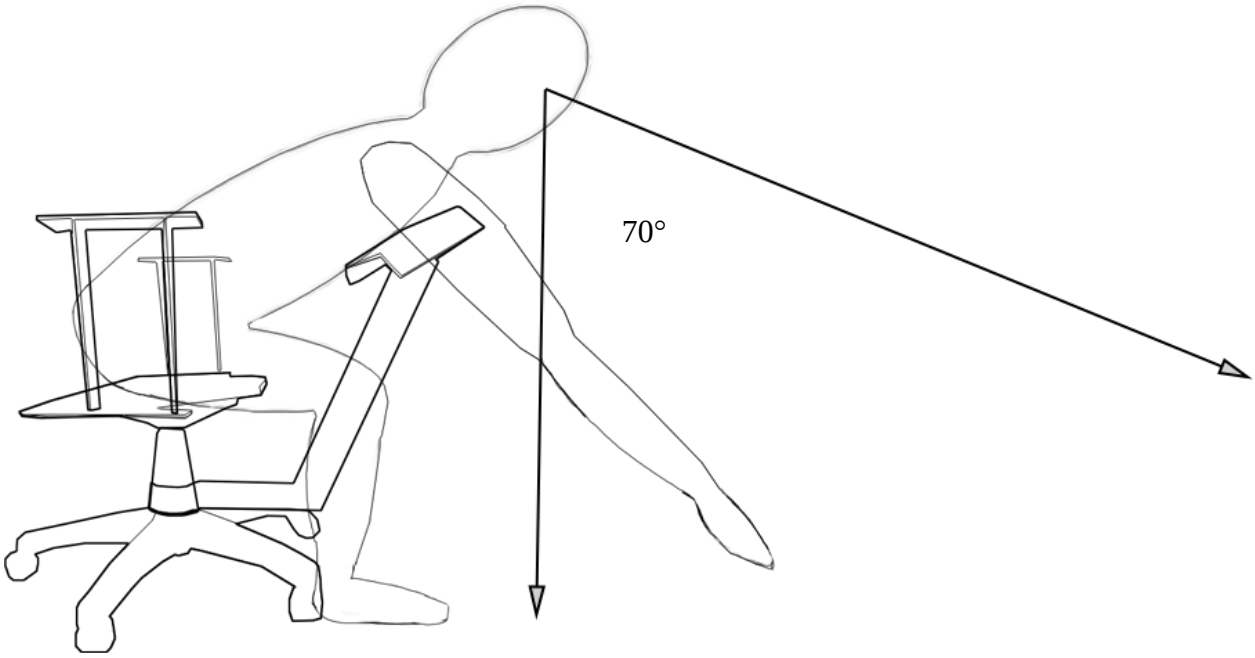
91st Percentile Male



50th Percentile Female



91st Percentile Male reaching with chest rest



50th Percentile Female reaching with chest rest

3.3.3 Mock-up

91th Percentile Male

Seat up

Seat down

Reaching with tool and chest rest

50th Percentile Female

Seat up

Seat down

Reaching with tool and chest rest

3.3.4 Analysis

Product Dimensions

Seat height up from ground: 20”

Seat height down from ground: 15”

Arm rest height from seat: 10.25”

Base diameter: 25”

Back rest/ chest rest length to base pole 14”

Back rest height: 26”

Length of Back rest/chest rest pole: 20”

Seat depth: 13.75”

Seat back: 15.75”

Seat front: 9”

Back rest/ chest rest length: 6”

Back rest/ chest rest width: 5.5”

User Interaction Evaluation

Interaction	**Evaluation**
Assisted Standing	Using the handles and the adjustment pedal to simulate how the assisted standing would work but stopping at 20” did not help to fully stand. Will need to add more height to the seat that will be appropriate for most percentiles. As well as tilt to the seat while rising to help user up and out of the chair instead off the ground. Arm rests also got in the way while doing tasks. They will need to fold out of the way. Hand pedal needs to be relocated or changed into a button
Assisted Leaning (Chest Rest)	The back rest swivels and tilts to move to the front to use as a chest rest to lean on when getting closer to activity. The length needs to be adjusted or allowance made for handles to be folded in and out. It was found that chest rest was more intrusive than helpful which could be fixed by making it adjustable.
Unintrusive	As stated above the chest rest was intrusive in that it got in the way while doing tasks. For the 91st Percentile male it stuck in his arm pits and blocked reach. For the 50th percentile female it wasn’t as intrusive but was still not helpful. In the case of the arm rest the problem could be solved by having them fold down or away. With those problem solved the swivel chair, wheels and seat height when down allow for freedom to do tasks.

Interaction	Evaluation
Safe	The initial design had knee pads on the base while creating the mockup, it was discovered that it may be safer to discard them. Having the user do tasks from a position close to the ground while leaning over the chest support is safer to get up from. It also works better with the extendable handle. Wheel lock must be incorporated somewhere for sitting and standing.
Dimensions (Adjustablility)	More height needs to be investigated for the seat for standing. As well as making the backrest/ Chest rest height adjustable.

3.3.5 Limitations and Summary

Some Ergonomic Issues That Are Still Not Yet Resolved

There were several problems identified that require adjustments such as making the backrest/chest rest height adjustable and adding height for the standing assist. Decisions also need to be made on placement of handles on the chest rest and how the arm rests will fold away.

Alternate possibilities for the future

A possibility is looking into adding a large gauge dome spring to the bottom of the seat to allow for more freedom of movement.

3.4 Aesthetics & Semantic Profile

Several familiar products were reviewed to determine alternatives to achieve the desired movements needed to support the user. Combined with the benchmark gardening seats above an analysis was done to try to find an aesthetic that was desired.

3.4.1 Benchmarking

Floor Gaming Chairs

The gaming chairs achieved the idea of providing comfort and support while being on the ground for long stretches of time.

	Product Image	Product Description
1		360 Degree Swivel Floor Gaming Chair Folding -Foldable for storage -360-degree swivel -couchlike looks cushiony -neutral colours
2		Buddy the Gaming Chair -Comes a bunch of fun colours -adjustable to maintain good back posture while gaming -couchlike looks cushiony

Analysis

Chair one has a more neutral look which would fit in with the western living areas where gaming is usually done in the household. Unfortunately, this does not fit with the idea and look desired for this product. Chair two is more playful with its look and colours, it provided more inspiration for the possibilities for providing good back support and sitting backwards in a chair.

Office kneeling chairs

These office chair provided an interesting solution for providing good posture while sitting for long periods of time.

	Product Image	Product Description
1		Flash Furniture 26-Inch Kneeling Chair in Black -Handle bars - the aesthetic give off the idea of workout equipment
2		Mobile Wooden Ergonomic Kneeling Chair in Black Fabric - Light wood with construction gives off a modern elegant look.
3		Ergonomic Kneeling Chair Rocking Wooden 330lbs Load Posture Correct Office Stool -dark wood gives a classic elegant feel - looks like a rocking chair

Analysis

The only problem was that for the demographic of ages 65 and old this might scare away users because just looking at it by itself it can be confusing on where the user sits and where the knees go. It was also discussed that these seats are for sitting at a desk at an office not down lower to the ground leaning over gardening.

Chairs that Offer Assistance or Support

These chairs provide exactly what is needed to support and assist the user while doing the gardening tasks.

	Product Image	Product Description
1		Marshalltown Racatac chest support - Chest support - Bicycle style seat - Built in knee pads - Wheels - Tray for tools
2		Carex Uplift Premium Seat Assist - Seating assist for any chair - Uses hydraulics

Analysis

The problem with these items is like the gardening benchmarked products discussed above the focus is clearly on just the function with no thought for the aesthetics.

3.4.2 Result

The conclusion so far is that the desire for the product being designed is that it will not look like assistive equipment or a tool. Instead, it should look like a high-end elegant product that provides assistance and support to the user and also provides joy to the experience of gardening. Since the beginning of the project the goal was to make the experience of gardening more accessible to everyone in way that does not intrude and that extends to the look and how it makes the user feel. The idea is

that the user should not feel like they are using medial equipment but just another gardening tool in the vast ecosystem.

3.5 Sustainability – Safety, Health and Environment

The target market has physical limitations that will require the product to be lightweight. It should also be priced reasonably to make it affordable to a bigger market. People who garden tend to also have a passion for looking after the ecology. It will be important for the product to source materials, use manufacturing and end of life processes that support these needs. This report will describe the approach to achieving these targets.

3.5.1 Literature Review

Based off of articles from the Cradle to Cradle website all products should be designed with sustainability in mind. They have a six-step process to help designers find materials for a product and outlines the processes for manufacturing (cradle to cradle, n.d.-a) Herman Miller follows many of the principles being proposed and serve as a good benchmark for the sourcing and manufacturing of the product.

3.5.2 Materials and Manufacturing

Materials

This section compares the initial materials and processes to more sustainable alternatives. The current materials are from the benchmarked products. The new materials were found when researching parts of the F(lower)’s design, cradle to cradle’s product registry, and other research.

Current Materials

Most gardening stools are made of metal with a paint finish or durable plastics, with a layered foam padding. No use of new sustainable materials or technologies are used to make these products.

New Materials

- Airless tires made from thermoplastic resin is good alternative to the rubber tires out there because they will be flexible, durable and recyclable. Going airless will eliminate the need to add suspension because the flexible design can go over rough terrain smoother. Eliminating suspension reduces that number of parts required. (Boyer, 2011)

- Aluminum is not a new material but it is light weight and durable. This metal will be used for the base. adjustable arms for the seat and backrest/chestrest, arm rests and other parts. Aluminum is a great sustainable material that manufactures love because it is infinitely recyclable and 100% recyclable. (Aluminum Association, n.d.)
- Plastic made from reused plastic from the ocean can be used for any plastic parts in the stool. (cradle to cradle, n.d.-b)
- Fabric made from reused plastic or reused from other product scraps. Herman Miller donates their scraps to small business in Haiti instead of the pieces ending up in landfills. (Editor, n.d.) There are other companies that turn old billboard posters or old sailboat sails into bags, this makes each piece unique.
- Foam made from mushrooms can be used for the padding of the armrests and backrest/chestrest.

Manufacturing

- Metal bending, metal casting and tooling for the base, adjustable arms mentioned above, and other parts of the stool
- Injection molding for the airless tires
- Powder coating for metal finishes. This part can be toxic but with the filtration system and safety procedures the added protection and durability from this process is a reasonable trade off to make a long lasting product.
- Stamping for foam padding.

3.5.3 Sustainability

Benchmark Sustainability Initiatives

The sustainability initiatives for this project are based off of articles from the cradle to cradle website, personal experience working with their methods as well as a case study from Herman Miller, the following was are part of the plan:

- Based on cradle to cradle articles, making a product that is easily taken apart so pieces can be replaced or the whole product can be taken apart and each part can be easily recycled or reused (e.g. kitkat being made of other broken kitkat).
- Make manufacturing localized to reduce emissions from traveling to different factories around the world for materials sourcing and manufacturing. Pick a location that can process the

materials and manufacture the parts or has the least amount of distance between these processes.

- Use materials that can be easily recycled or reused back into the product and don't give off toxic gases when processed and manufactured. We will responsible renewable resource (e.e. no forests have to be cut down for farming). Indonesia cleared animal habitat to produce palm oil for bio-diesel.
- Ensure the materials are available in sufficient supply to produce to the demand and that the cost of materials and manufacturing is within the budget for the product.
- Select a manufacturing facility that uses renewable energy to reduce the amount of emissions from the various manufacturing processes.
- The health of the people that make the F(lower) stool must be taken into consideration when planning the materials and manufacturing of the product. The workplace environment must be a safe, with no toxic fumes being worked with at without protection equipment. Fairness and equality must be insured for a good work environment without exploitation of workers. (Herman Miller Group, 2019)

3.5.4 Health and Safety

The current gardening stools have weight recommendations for their health and safety measures. For F(lower) a lot of research and design went into ensuring the safety of the user such as brakes for the wheels when standing or sitting. The proportions of the stool were designed to be a good fit for most percentiles.

3.5.5 Result

F(lower) is a stool that helps people who are sensitive to the environment to work with the earth. Sustainable sourcing of materials and manufacturing of the product in addition to proper handling at end of life will be important features. Products that are made from recycled materials and can be handled easily at end of life can reduce the cost of producing the product. Easily replaceable parts extend the life of the product, adds revenue sources and enables reuse.

3.6 Feasibility & Viability

Since the product is designed to support people with arthritis and has multiple functions it does not compete directly with the products reviewed in this analysis. It will be a more complicated product and will have a higher cost than the simple, single use products. But the cost must still enable the product to be sold for a price in the range of $400 to $500.

3.7 Design Brief

Functional design brief

1. Need to be ergonomic for people with arthritis, for example big grippy handles, avoid knobs that twist or triggers that require squeezing to activate.
2. Must provide assistance with moving from standing to sitting or kneeling and back to standing
3. Must provide support for positions held for prolonged periods
4. Needs to be unintrusive, doesn't take away from the exercise gardening provides
5. Is sustainable in manufacturing, materials, and cost (demo. Living on a fixed income)
6. The appearance must look modern or even futuristic not like medical equipment.
7. Needs to fit gardening trend aesthetic.
8. Must be light weight
9. Easy to use
10. Thinking about possibly gardening trends 5-10 years in the future
11. Design something that will entice more people to want to go out and garden

CHAPTER 4
Design Development

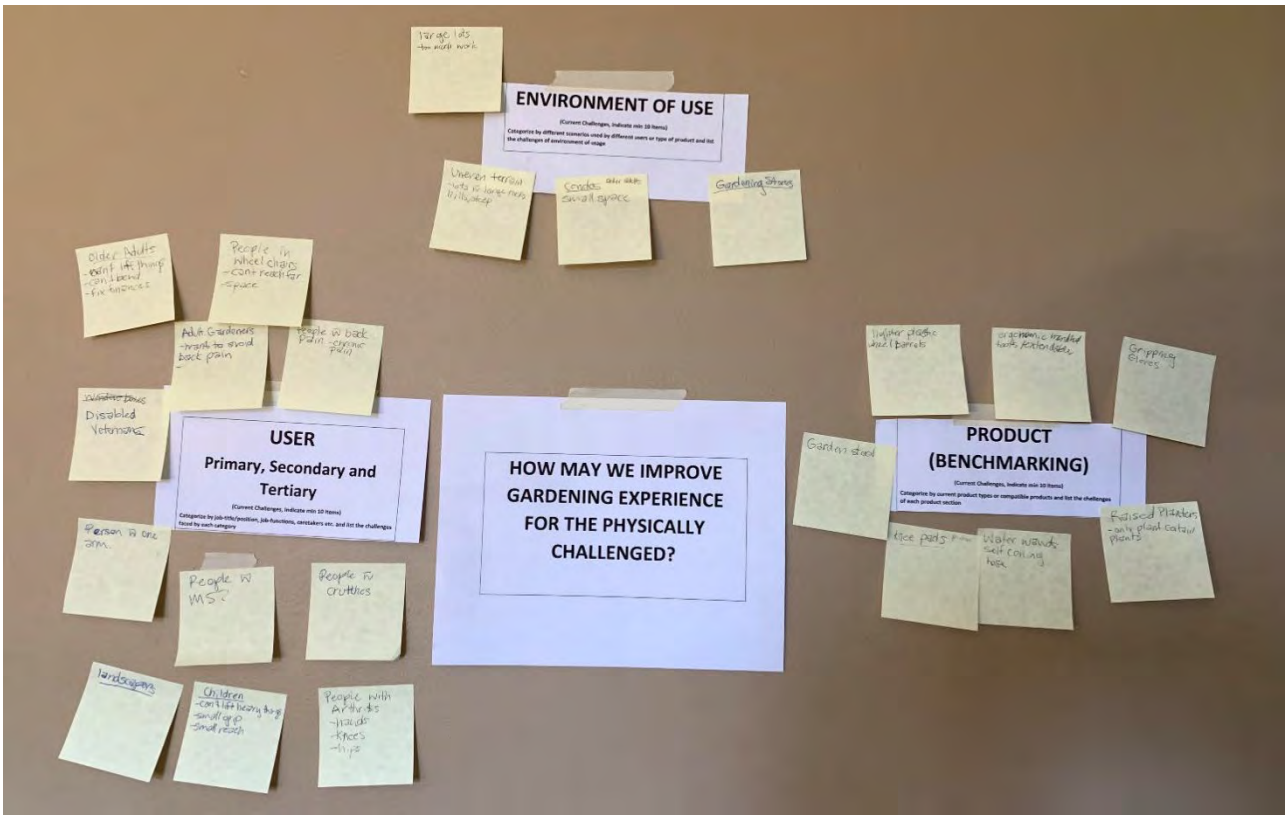
Using the Functional design brief as a guide several approaches were used to arrive at a chosen product design.

4.1 Idea Generation

The process of idea generation used a number of steps starting with mind mapping and moving into ideation sketches to expand on ideas generated.

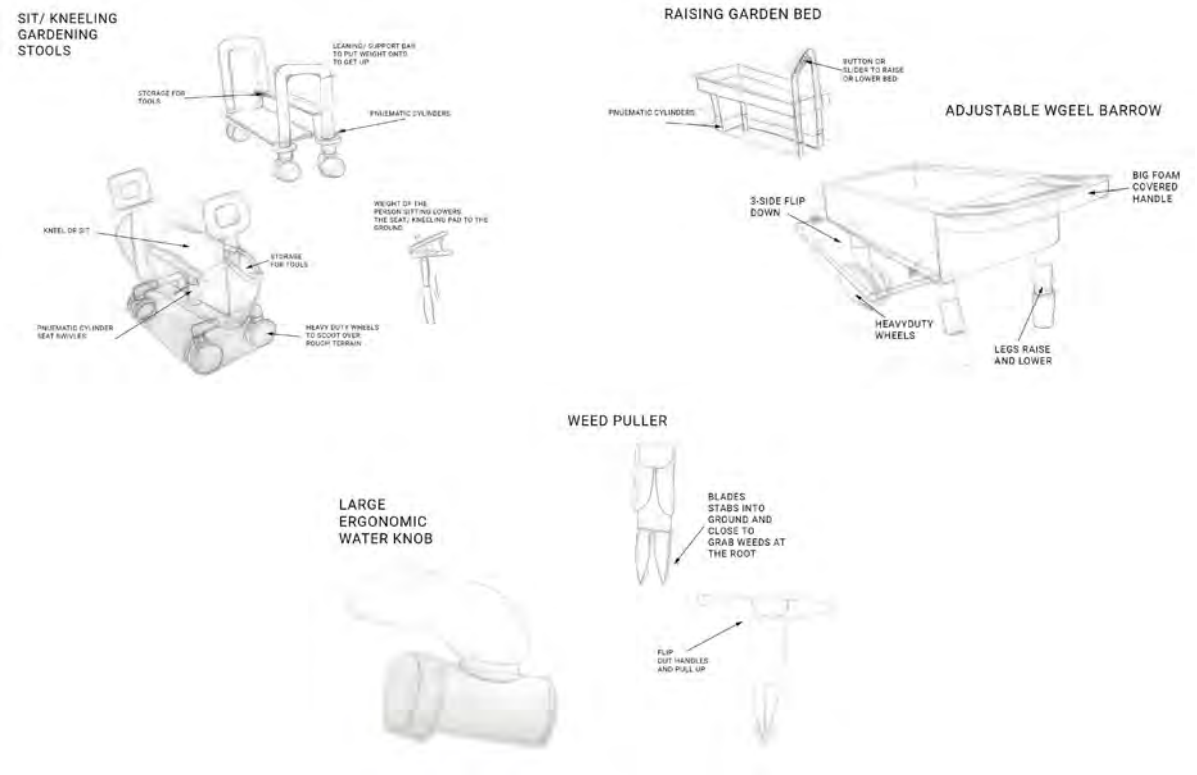
4.1.1 Mind Mapping

Mind mapping is brainstorming ideas and then arranging them into categories that can be used to build product concepts.



4.1.2 Ideation Sketches

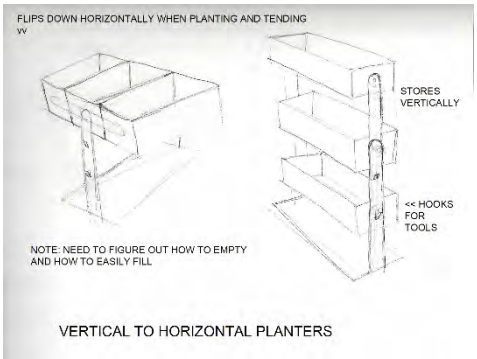
Ideation sketches transform the ideas into a visual form to better enable which concepts to explore further.



4.2 Preliminary Concept Explorations

Concept 1

Explored the possibility of garden beds that can be raised and lowered for people that have difficulty moving from standing to kneeling and back to standing. This product would restrict the structure of the garden and may be expensive for a large garden.

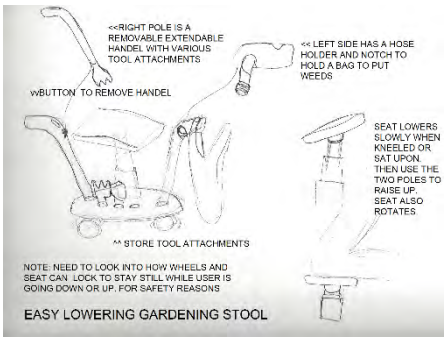


Concept 2

A garden with a vertical structure taking away the need to bend of kneel. This design would also restrict the structure of the garden and may not be suitable for all plants.

Concept 3

Build a chair like device that would assist the user in getting from standing to sitting to kneeling and back to standing. There could also be support for tasks where a position is held for extended periods.



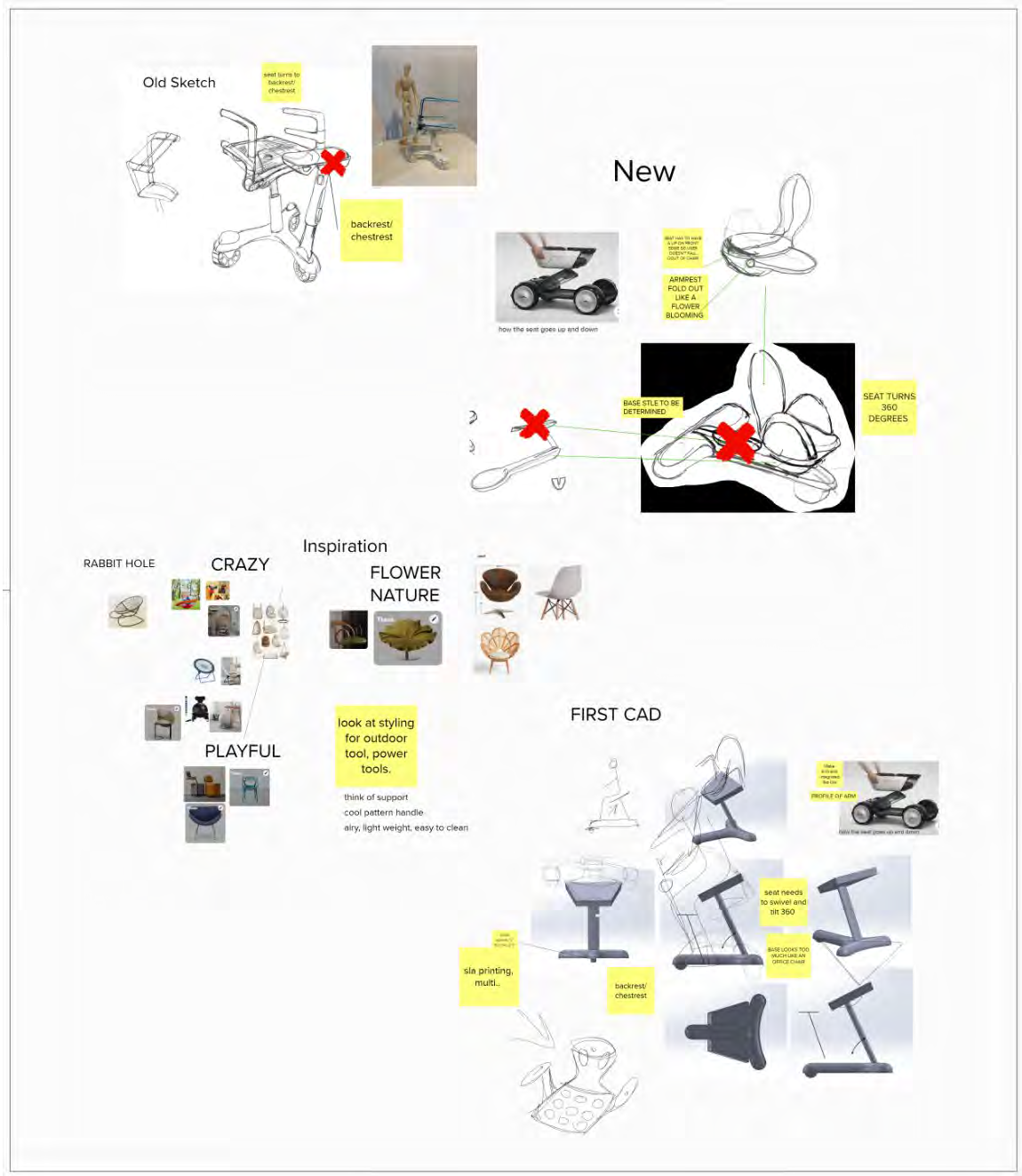
1.3 Concept Strategy

The product must directly address the problem statement of assisting people with arthritis to enjoy gardening safely while also receiving the benefits. The specific targets identified from the analysis will guide the design:

- Assist the user to get from a standing position to sitting, crouching or kneeling and back to standing
- Provide support for positions being held for prolonged periods
- Allow freedom of movement of arms and hands
- Aesthetically appealing
- Sustainable
- Would not make the user feel as though they have a disability

1.4 Concept Refinement

Once the most viable concept has been identified it is necessary to expand and refine the form of the product.


Old Sketch
seat turns to backrest/ chestrest
backrest/ chestrest
New
how the seat goes up and down
ARMREST FOLD OUT LIKE A FLOWER BLOOMING
BASE STLE TO BE DETERMINED
SEAT TURNS 360 DEGREES
Inspiration
RABBIT HOLE
CRAZY
FLOWER
NATURE
PLAYFUL
look at styling for outdoor tool, power tools.
think of support
cool pattern handle
airy, light weight, easy to clean
FIRST CAD
PROFILE OF ARM
how the seat goes up and down
seat needs to swivel and tilt 360
BASE LOOKS TOO MUCH LIKE AN OFFICE CHAIR
sla printing, multi..
backrest/ chestrest


F(LOWER)
GARDENING STOOL THAT HELP USER GET FROM A STANDING TO A SITTING POSITION CLOSE TO THE GROUND AND VIS-VERSA
PARTS
WANTS
Newest CAD
SEAT DOWN
TURTABLE FOR SEAT TO TURN
BACKREST/ CHESTREST DOWN SEAT TURNED


F(LOWER)
GARDENING STOOL THAT HELP USER GET FROM A STANDING TO A SITTING POSITION CLOSE TO THE GROUND AND VIS-VERSA
PARTS
WANTS
CAD
ARMREST COLLAPSES DOWN TO MOVE OUT OF THE WAY
UPPER SEAT PART SWIVELS AROUND
SEAT HEIGHT PEDDLE
FOOT BREAK
BACKREST/ CHEST REST LEANS BACK
PADDED PART SLIDES UP OR DOWN

4.5 Design Realization

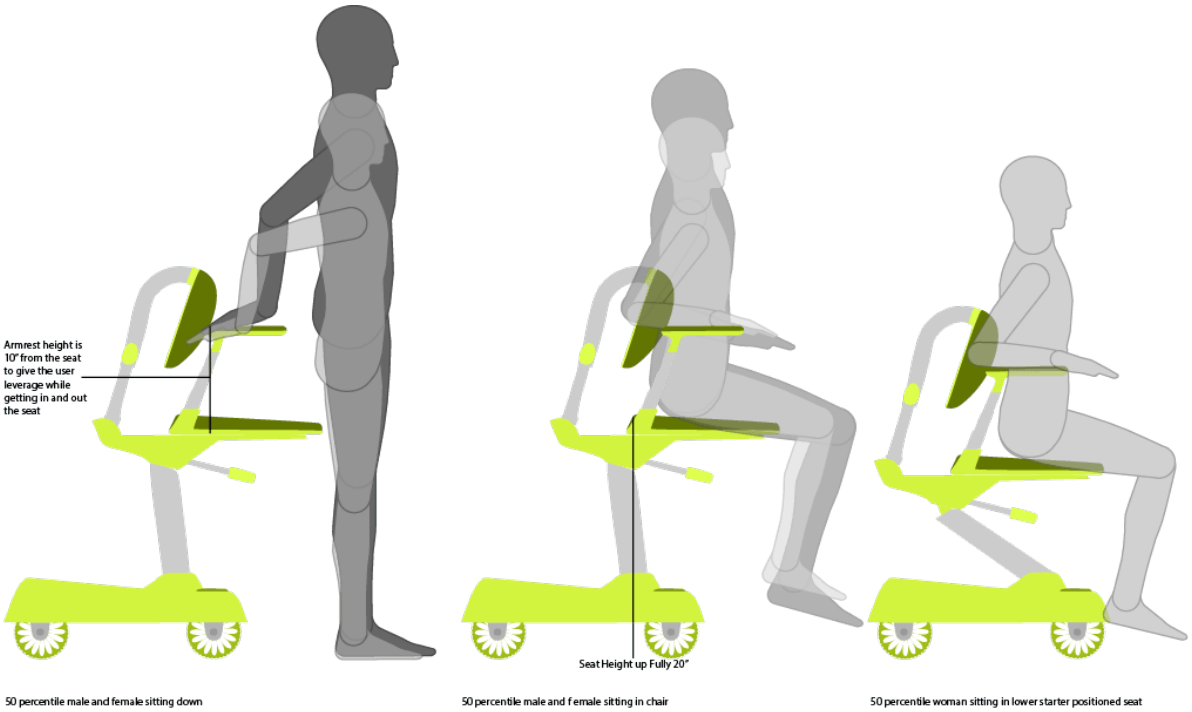
The design is then sized and structured by using a physical model to study the movements and ergonomics of the user.

4.5.1 Physical Study Models

A buck model is created to assist in developing real life measurements and functionality.

4.5.2 Product Schematic

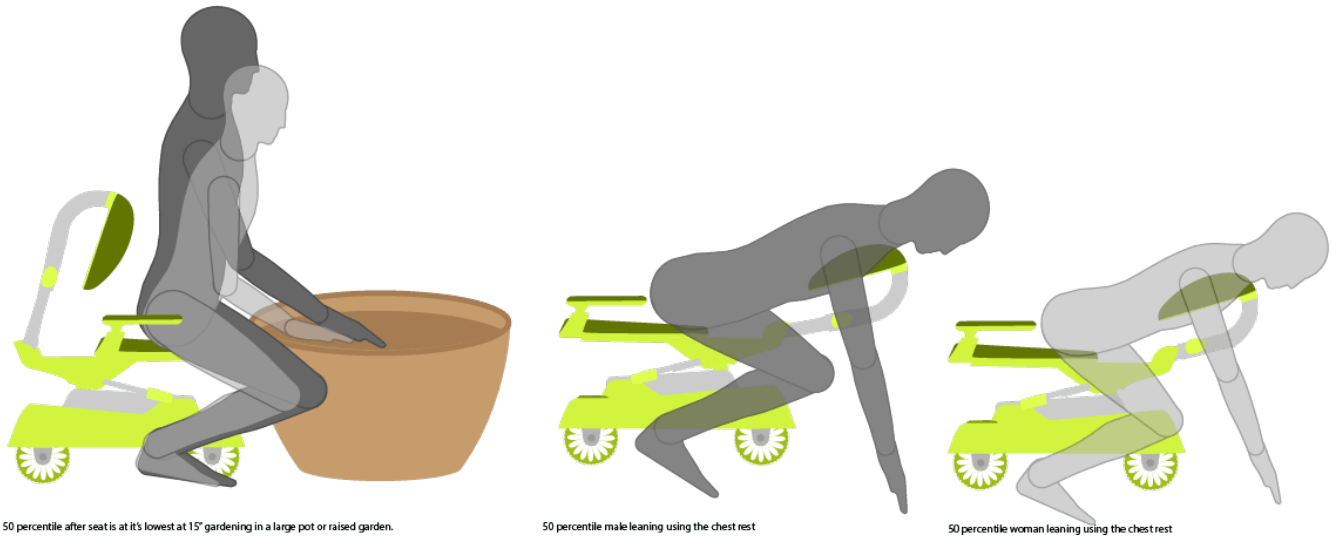
Product schematics are diagrams based on the tests performed on the buck model.



50 percentile male and female sitting down

50 percentile male and female sitting in chair

50 percentile woman sitting in lower starter positioned seat



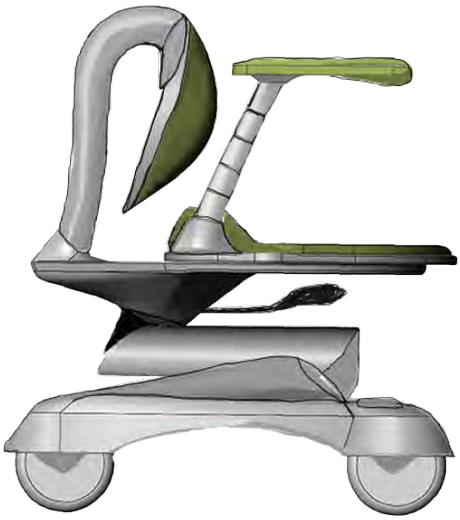
50 percentile after seat is at it's lowest at 15" gardening in a large pot or raised garden.

50 percentile male leaning using the chest rest

50 percentile woman leaning using the chest rest

4.6 Design Resolution

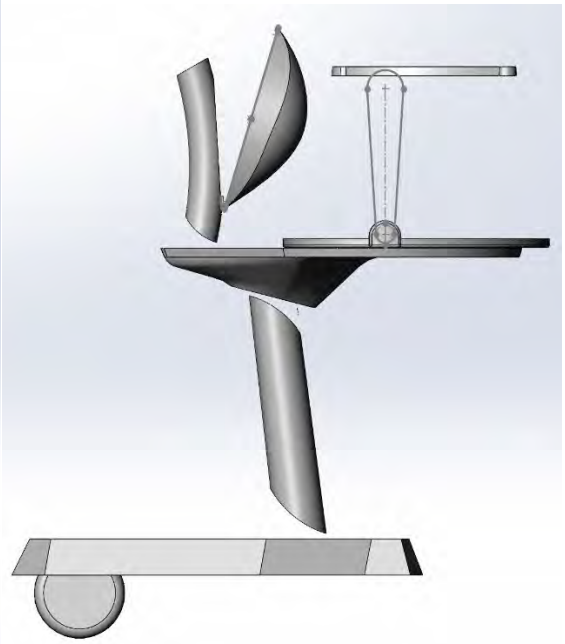
The design resolution is the stage where the overall look of the final product is developed from the structure and testing of the buck model.

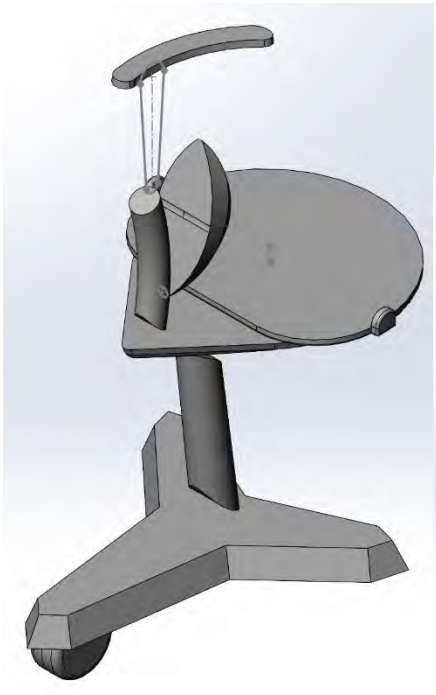


4.7 CAD Development

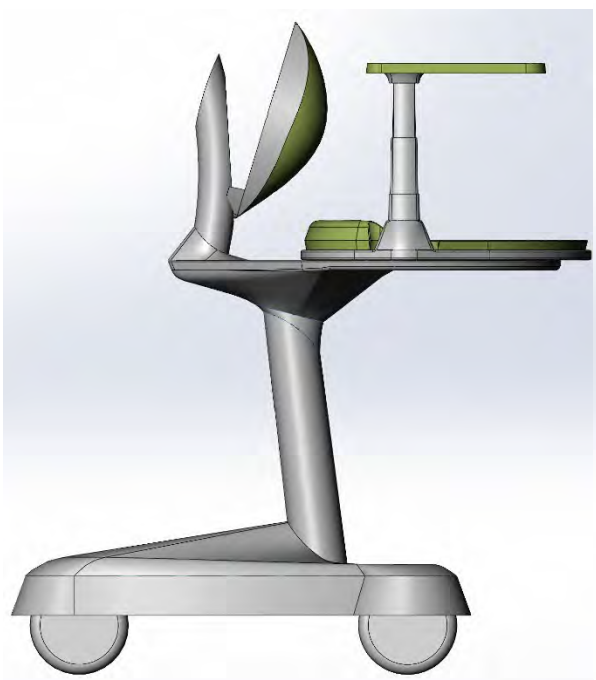
Several iterations of the design are done in CAD to develop the exact specifications for the product.

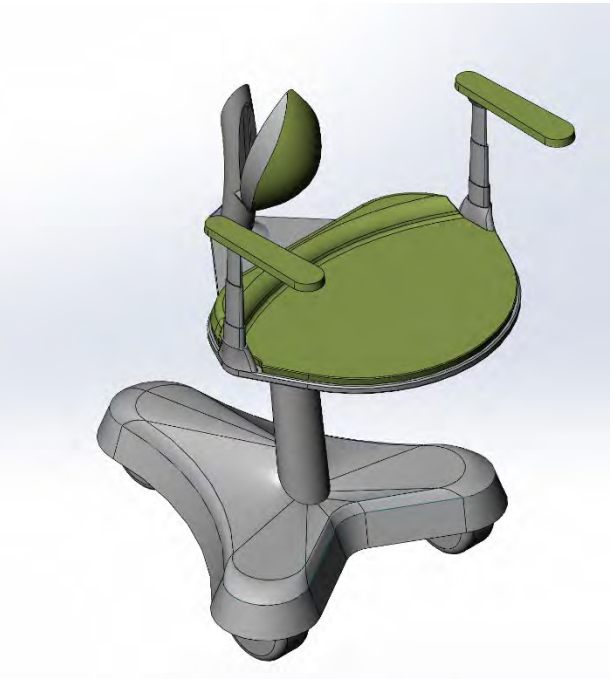
F(lower) CAD Phase 3.0

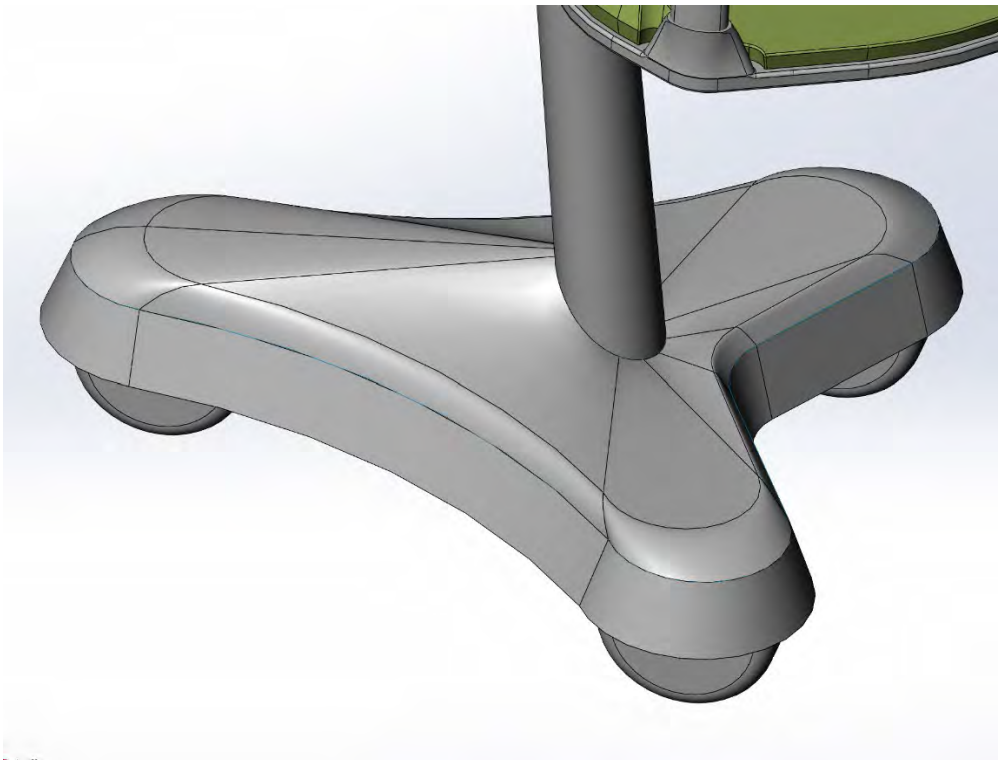




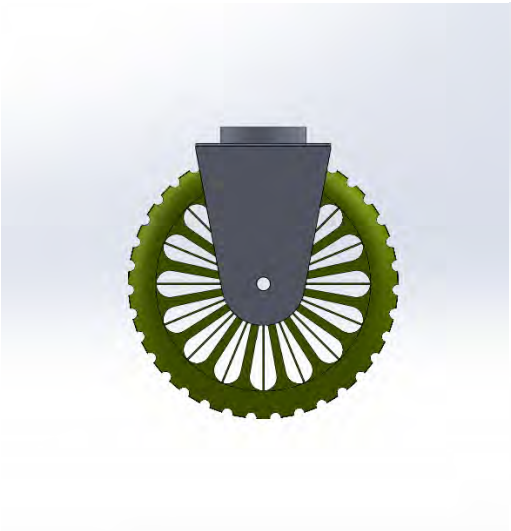
F(lower) CAD Phase 3.1

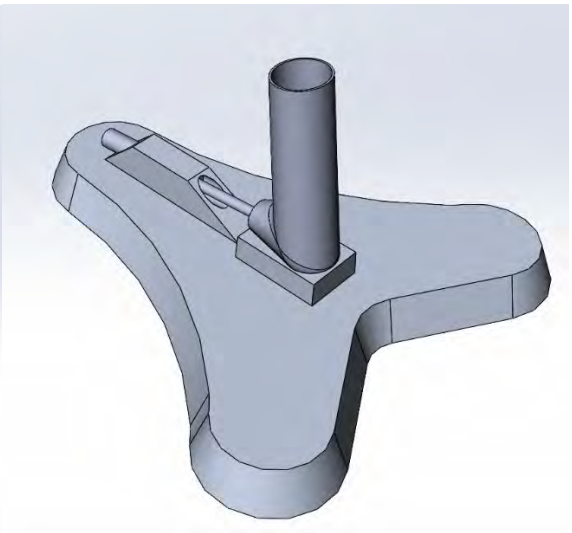




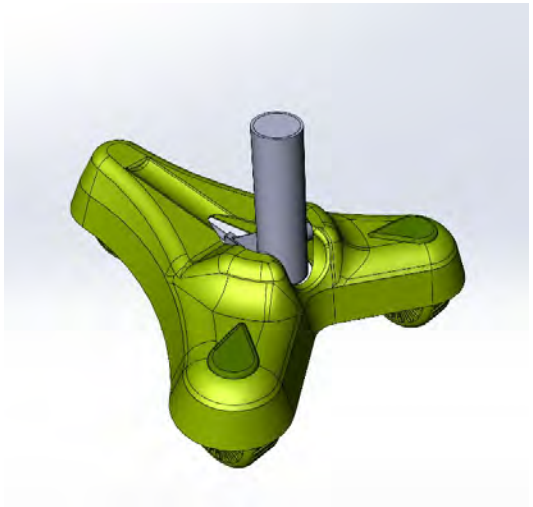


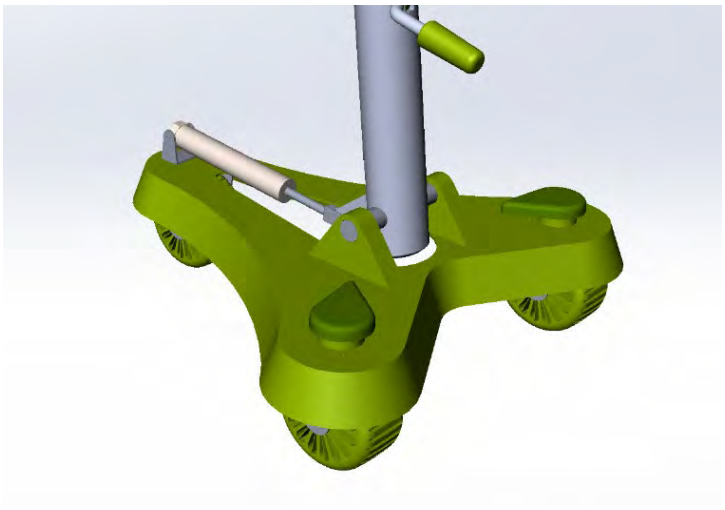
F(lower) CAD Phase 3.2





F(lower) CAD Phase 3.25





4.8 Physical Model Fabrication

A decision was made that 3D printing was the best approach to creating a physical model in 1:5 scale.

Model Parts

Model Assembled

CHAPTER 5
Final Design

5.1 Summary

The product met the overall design requirement of enabling people with arthritis to continue to enjoy

5.2 Design Criteria Met

The product met the overall design requirement of enabling people with arthritis to continue to enjoy gardening. The product assists the user in moving from standing to sitting to kneeling and crouching and back to sitting or standing. The product also supports the user when they are holding a position for prolonged periods of time. The user's arms and hands can always move freely enabling the gardening tasks to be completed unimpeded.

The product's functionality is provided using mechanisms that will be suitable for people with arthritis such as levers for raising and lowering. There are few actions required to operate the product making it easy to use. The assistance provided is sufficient to alleviate strain on joints and muscles while still allowing the user to gain the benefits of the exercise.

The product is aesthetically appealing and is the familiar form of a chair. This provides the user with a product that looks stylish and does not resemble a medical device. This factor prevents the person from feeling as though they have a disability. The direction for the look and feel for F(lower) came from empathizing with the fact that the users do not want to feel like they are using a product that was only made to assist and support them while gardening. The desire was to create a product that was unintrusive to the tasks of gardening but also sensitive to the thought of the users' feelings of independence. The idea is that F(lower) is not just another tool in the vast ecosystem of gardening stools. It is one that cuts those roots of function of looks and gives users a high-end elegant chair inspired by nature, that will add to the experience of gardening.

F(lower) though its namesake is that of a flower stems more from a tree, the roots being the base with all the parts branching out from there. The namesake comes in with all the petal motifs sprinkled throughout the design, from the subtle hints in the armrests and backrest. To the more obvious ones in the seat base, patterned seat cushion, and foot breaks.

The product will be made from sustainable materials that can be recycled. The product will also enable parts to be easily replaced as they wear out to prevent scrapping the entire product.

5.2.1 Full Bodied Interaction Design

The product impacts both the lower and upper parts of the body. Specifically, it assists the knees, hips and back in moving from and back to a standing position. It supports the back while in a leaning position while also taking pressure off the knees. Full range of motion of the arms and hands are enabled during gardening activities.

5.2.2 Materials, Processes and Technology

The components for the product will be purchased from outside suppliers with an emphasis on local companies. By sourcing locally, the cost and environmental footprint of shipping will be reduced. There will also be a positive impact on employment locally. Assembly will initially be done by an outside fulfilment company that can store an inventory of parts and then assemble and ship the final product to order. The use of an outside fulfillment company will reduce up front investment costs and enable flexible delivery by an experienced provider.

Off the shelf products will be used where they are available. By ordering in sufficient quantities, the unit cost of these parts will decline. Continual improvement on the design will also look for ways to reduce the cost of parts.

The base will have to be stamped, welded, and machined to the products design specifications. There is an upfront cost for dies and set up that will be recovered as the volumes increase. This part is made from aluminum that is a highly recyclable metal. This will be a factor in the end of life of the product.

The airless tires will be molded from recycled rubber. Since the tires are airless, they will have a longer life than traditional tires. They will also be more durable for use in gardens. The cost of custom-made tires will decrease as the volume increases. Attempts will be made to source tires already being produced for stock to reduce the cost.

Many of the parts are molded plastic that will be made from recycled materials. The unit cost of these parts will decrease as the volume increases. The product is designed so that parts can be easily replaced if they break or wear out.

Seat covers, arm rests and the back rest are covered with foam and fabric. These will be fabricated in one location for shipment to the fulfillment provider. Once again, the cost of these parts will decrease as volumes increase. Attempts will also be made to locate suitable parts already being produced in volume.

5.2.3 Implementation – Feasibility & Viability

Initial cost of parts

Part	Quantity	Unit Cost	Extended Cost	Source
Seatbase	1	$ 6.00	$ 6.00	
Underseat	1	$ 6.00	$ 6.00	
Seat Cushion	1	$ 8.00	$ 8.00	
Backrest/CR Back	1	$ 4.00	$ 4.00	
Backrest/CR Cushion	1	$ 5.00	$ 5.00	
Backrest/CR upper arm	1	$ 1.00	$ 1.00	
Backrest/CR lower arm	1	$ 1.50	$ 1.50	
Chassis	1	$ 170.00	$ 170.00	https://www.mcmaster.com/88895K108-88895K78/
Base Arm top a	1	$ 5.00	$ 5.00	
Base Arm top b	1	$ 5.00	$ 5.00	
Base Arm bottom	1	$ 25.23	$ 25.23	https://www.mcmaster.com/9056K41-9056K411/
Armrest Cushion	2	$ 3.00	$ 6.00	
Armrest bottom	2	$ 4.00	$ 8.00	
Telescoping Armrest Arms	2	$ 8.00	$ 16.00	https://www.mcmaster.com/4568T18/
Airless Tires	3	$ 10.00	$ 30.00	
Front Wheel Caster	1	$ 6.00	$ 6.00	https://www.mcmaster.com/8973K846-8973K775/
Fixed Wheel Casters	2	$ 5.00	$ 10.00	https://www.mcmaster.com/8973K846-8973K775/
Wheel Bolts	3	$ 2.85	$ 8.55	https://www.mcmaster.com/23595T43/
Pnuematic Cylinder	1	$ 84.55	$ 84.55	https://www.mcmaster.com/6498K545/
Large Arm Pin	1	$ 12.50	$ 12.50	https://www.mcmaster.com/9062K21-9062K211/
Pivot Bracket	1	$ 11.25	$ 11.25	https://www.mcmaster.com/6498K73/
Rod Clevis	1	$ 10.52	$ 10.52	https://www.mcmaster.com/6498K44/
hand pull grip	1	$ 5.00	$ 5.00	https://www.mcmaster.com/62385K67/
hand pull arm	1	$ 10.00	$ 10.00	https://www.mcmaster.com/6750K16-6750K161/
Backrest controls	1	$ 3.00	$ 3.00	
fasteners, c-clips		$ 10.00	$ 10.00	https://www.mcmaster.com/c-clips/
		Total	**$ 468.10**	

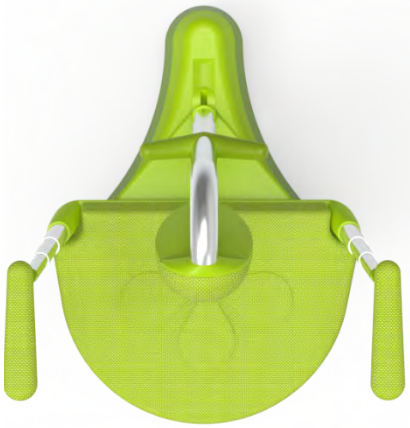
The product cost can be compared to a high-quality ergonomic office chair or a good quality lawn mower and not the low-cost single use products reviewed in this report. This comparison will make the product viable at higher price points. Estimate for the parts were based on the purchase of a single unit of each part. Once volumes can be estimated it will be possible to substantially reduce the cost of parts. This reduction will bring the cost of the product down to a level that will be feasible for the market.

5.3 Final CAD Rendering

The final CAD rendering shows the full range of product movements and the texture of the materials used.

Seat up all of the way

Seat down



Seat is turned with backrest/ chest-rest down

Seat is turned with armrest and backrest/ chest-rest down.

Close-ups

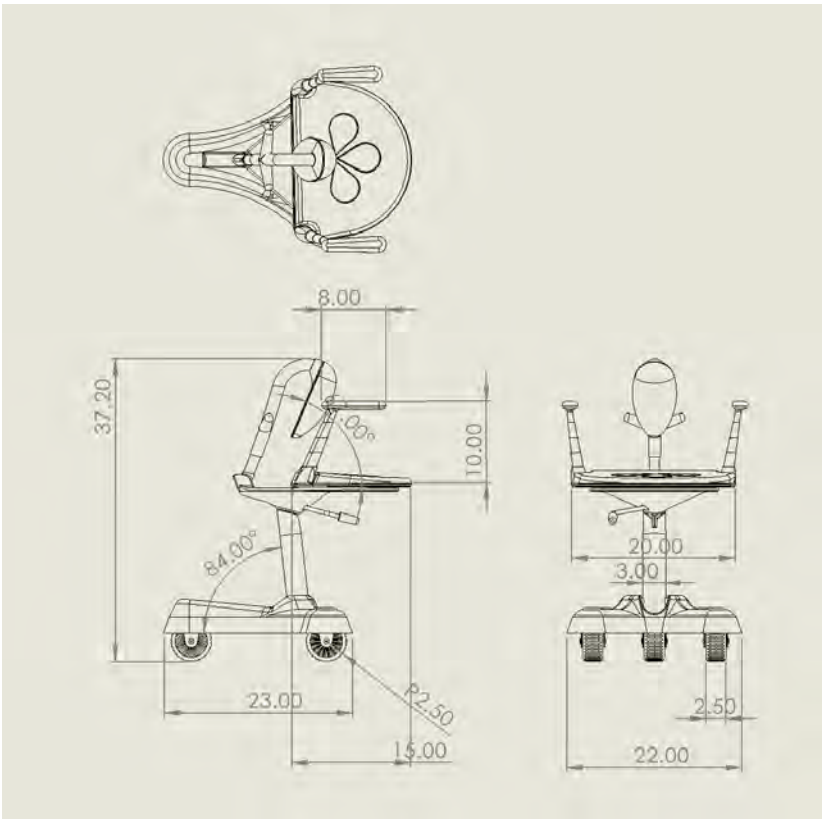
Outdoor Institution Render

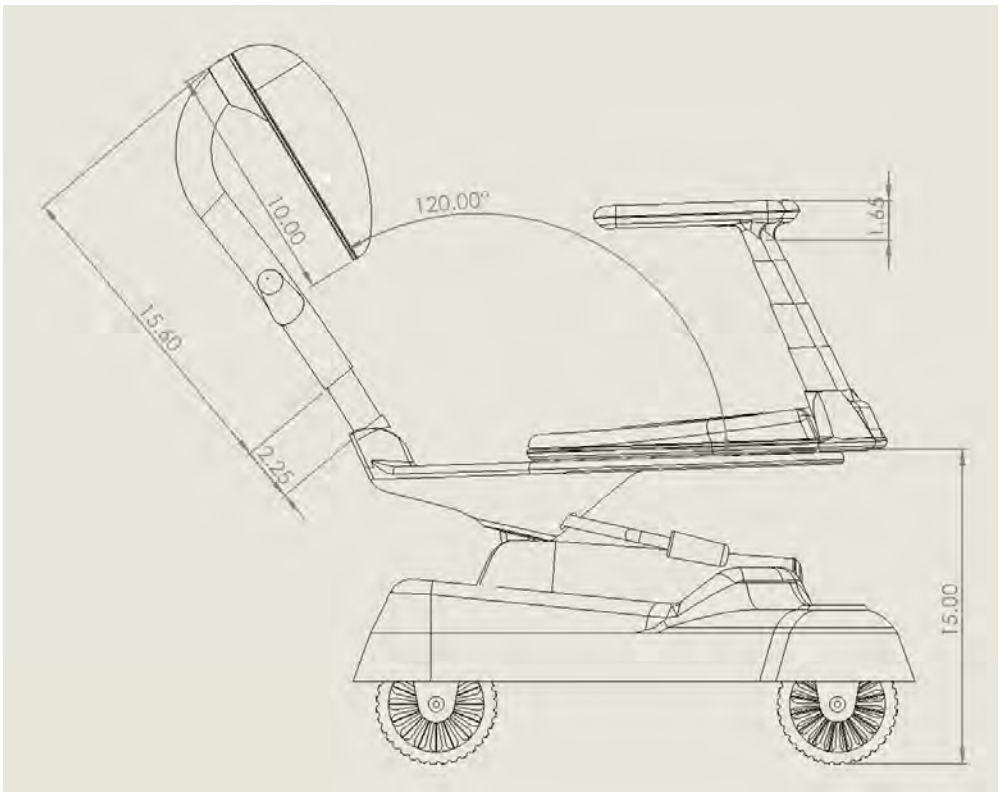
5.4 Physical Model

The physical model was 3D printed in 1:5 scale and painted.

5.5 Technical Drawings

Technical drawings display the actual measurements of the product.





5.6 Sustainability

The product is designed so that parts can be replaced easily and the whole unit can be disassembled and recycled at the end of life. Users can order and replace parts themselves to extend the useful life and eliminating the need to dispose of the product. The product can be returned at the end of its life so that reusable parts can be salvaged, the product rebuilt, or the damaged parts recycled. The materials will be sourced from ethical producers and be made from recyclable materials. By assembling and recycling the products locally jobs are created for the community. By monitoring the supply chain the working conditions and sustainable actions of the suppliers can be assured. Research will be carried out to identify new materials as they are developed to be incorporated into the product.

CHAPTER 6
Conclusion

Gardening is a hobby for many people providing exercise, peace of mind and a sense of purpose. For those people with arthritis, they are forced to stop or curtail their gardening activities or suffer through the pain and mobility problems. Products on the market to address comfort issues in gardening appear to be directed towards people with average capabilities and do not address the most significant challenges of people with arthritis. F(Lower) is a product that will provide the assistance needed to materially reduce the pain and mobility issues while still enabling the user to gain the benefits of exercise. The product is also designed to be aesthetically pleasing so it is stylish and does not look like a medical support device. The use of sustainable materials and ease of replacement of parts appeals to the desire amongst gardeners for sustainable products and practices. A major challenge in product development is to find a problem people feel strongly about and then create a solution to that problem. F(Lower) is the solution to the problem that has been identified.

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Appendix

Appendix A: Discovery

Preliminary Information Search Problem Finding / Problem Framing Why Should We? Expert Interviews / Surveys

User Interviews

Interview 1 (Respondent 1)

Results (Transcribed by https://otter.ai)

Interviewer

So, like I said I will start with some basic questions. And then ask you more about gardening. In the second part. Okay, so what type of arthritis, do you have,

Respondent 1

I have rheumatoid. rheumatoid. Yeah, it affects my hands and my arms and basically on and off all over my body.

Interviewer

You have to have a second one that you were talking about.

Respondent 1

yes i do i have the other one, but it's not as bad that's just in my spine. And I kept, you know, I have the other arthritis and I always forget what it is. Just a sec grandpa will help me with this one. What is my secondary arthritis? Osteoarthritis. In my back.

Interviewer

Yeah, sounds very common.

Respondent 1

But other than that, it's. I'm fine.

Interviewer

I mean, that seems that seems like a lot.

Respondent 1

It is. It is somedays, if you wonder. But anyway, that's the way it is. I'm 80 years old now. So, I've got to expect these things

Interviewer

I mean. I mean, you guys are doing pretty good.

Respondent 1

Yeah, yeah, I said that around a lot. Yeah, you have to, when you have things like this. You can't just sit you have to keep moving.

Pains? Probably something else too? *Should have asked more when asking about steps may need to revisit*

Interview 2 (Respondent 2)

Respondent 2

I actually had a I had a part time job as well at the start of the seizing season at a local garden store, but I had to stop because it was it was it was too It was too much on me like when I, when I garden I'm, I do it in short spurts to avoid the pain, and this was not short spurts so it just got to be too much for me, but I do love gardening at home.

Interviewer

Yeah, okay. That's great. Um, so, what size gardening, what kind of garden Do you have like do you have a backyard garden.

Respondent 2

Yeah, I did. I've got several backyard gardens they're perennial gardens, mostly. Okay.

Interviewer

Do you do vegetable gardens herb gardens or flower.

Respondent 2

Um, when, So we

just moved here a little over a year ago and the place

where we were at before in Cambridge I did do a vegetable garden there, and I haven't done one here yet. Only because like we've got more wild animals here. Not quite sure if I should be doing that I just I sort of grew I grew some herbs and pots and I also grew, some cherry tomatoes in pots, but nothing actually in the ground, since we've been here.

Interview 3 (Respondent 3)

Interviewer

Taking notes because I can't read my own notes. So can you tell me what kind of arthritis you out,

Respondent 3

rheumatoid arthritis.

Okay, so, I don't know, do you need board description.

Interviewer

Not that no I've. I actually I've done some research into the different types so I understand it. Can you tell me where you have arthritis.

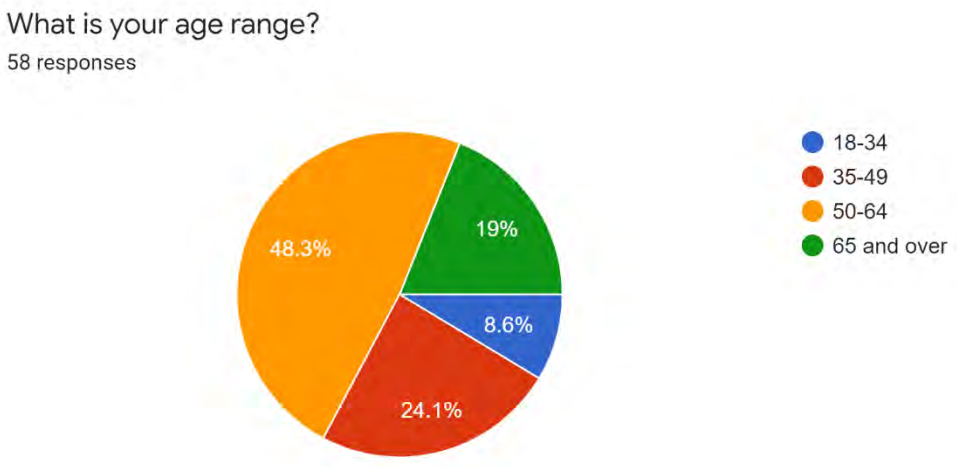
Respondent 3

So I actually have it mostly in

my wrists and my fingers. But I also if I'm having a flare up. I will also experience it in my ankles feet, and my knees.

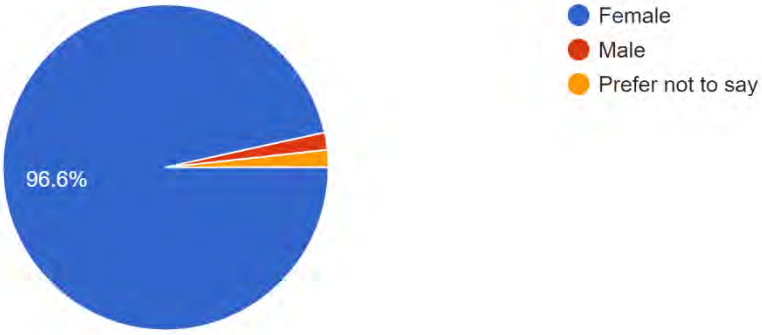
Yeah, hasn't happened in a while.

Survey Meta Data



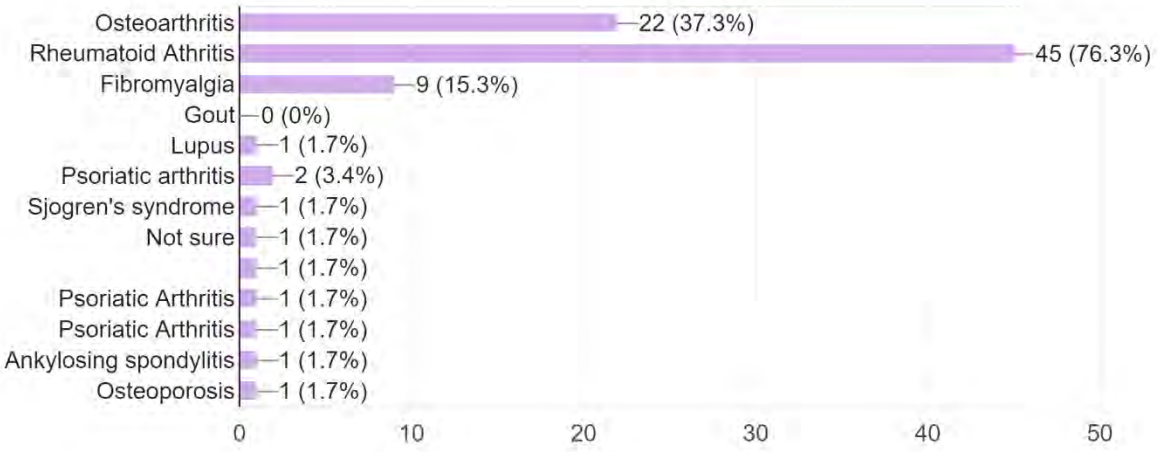
What is your gender?

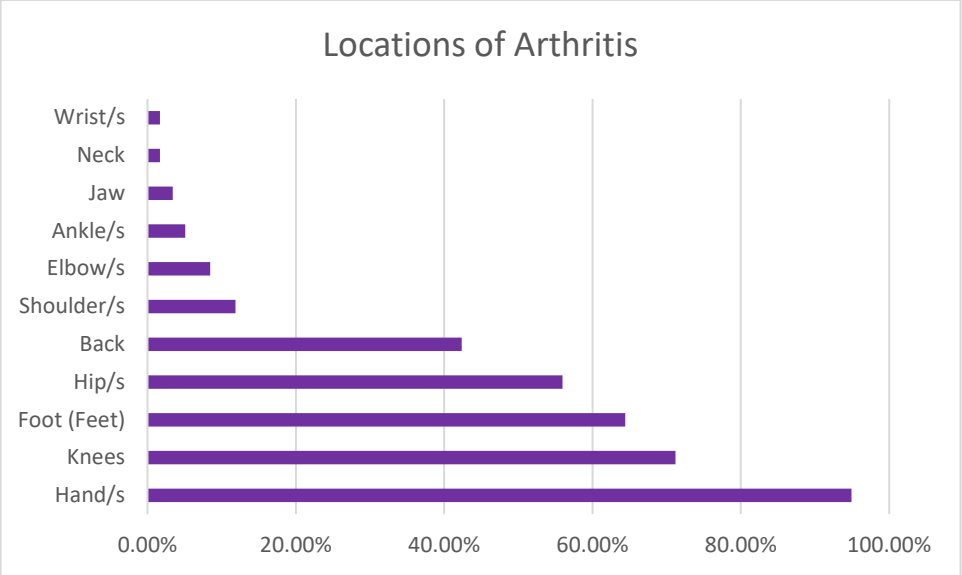
58 responses

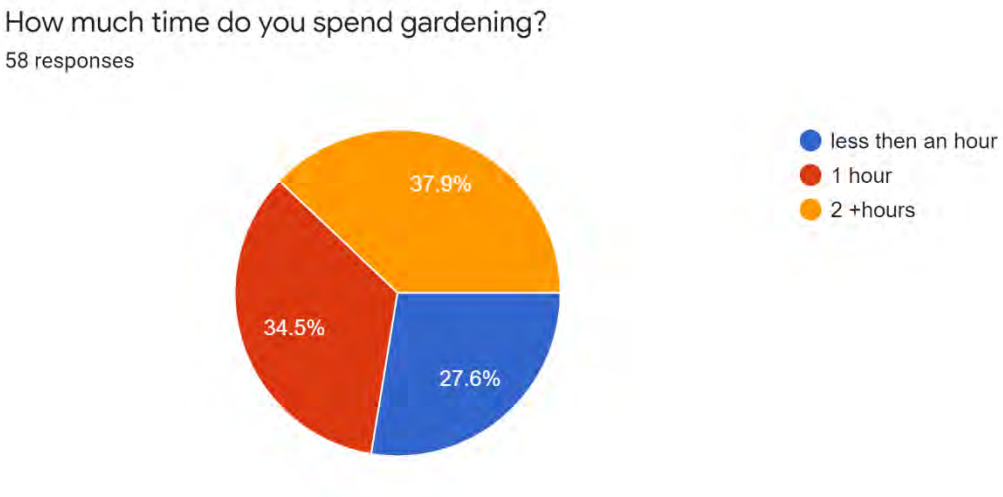


What type of arthritis do you have? Choose one or more?

59 responses







Appendix B: Product Research

Product Research – Benchmarking

Product 1: Steerable Rolling Seat with Tool Tray
https://www.leevalley.com/en-ca/shop/garden/garden-care/stools/45921-steerable-rolling-seat-with-tool-tray?item=PS211&utm_source=free_google_shopping&utm_medium=organic&utm_campaign=shopping_feed&gclid=CjwKCAiAtK79BRAIEiwA4OskBp0FnByrVVcEZRkAkAo91V5rLlDsWDxur8nabMxlLvmxNu-_69AI4hoCDrYQAvD_BwE
Search: Google: gardening stools for seniors

Description

If you've ever had to crouch for long periods in the garden, you will appreciate the value of a rolling seat. This one has the added convenience of steering to maneuver around the garden.

The comfortable metal tractor-style seat is adjustable from 17" to 20" high and swivels 360° so you can position your body comfortably while working. The rolling base, constructed of 1" diameter powder-coated steel tubing, has four wide pneumatic tires that move easily through soil without sinking.

Includes an under-seat poly tool tray and a rear storage basket to keep supplies and tools handy. In addition to planting, maintenance and harvesting, this rolling seat is useful for low-to-the-ground chores such as washing cars and painting.

Measures 31" long by 18" wide and weighs 35 lb. Some assembly required.

Specification

Size: 31” long by 18” wide
Weight: 35lb
Construction: powder coated metal seat and frame, poly tool tray, pneumatic tires

Other features: added convenience of steering, adjustable seat, swivels 360 degrees, rear storage basket

Product 2: Folding Kneeler Stool
https://www.leevalley.com/en-ca/shop/garden/garden-care/stools/45632-folding-kneeler-stool?item=EB410&utm_source=free_google_shopping&utm_medium=organic&utm_campaign=shopping_feed&gclid=CjwKCAiAtK79BRAIEiwA4OskBs_nDqfD-R3Pe7rNeWA1wTKxS4A9RvmXgWIIY4pSaRxbTMfQCcFhmxoCppEQAvD_BwE
Search: Google: Best gardening stools for seniors

Description

The only way to thoroughly weed flowerbeds or vegetables is on your knees, low to the ground. This often means wet, cold, dirty and stiff knees. This kneeler solves the problem and, when turned over, provides a handy seat as well.

The frame (22" × 10" × 17") is made of tubular steel with a green enamel finish. The platform is hardwood and has a comfortable, waterproof kneeling and sitting pad attached. The two handles give support for raising and lowering the body and the platform isolates you from the ground. Turn the kneeler over and the handles become legs, and the platform a handy seat for weeding raised borders or just for resting. When you are finished your work, the whole unit folds down flat for compact storage. A great knee and back saver.

Product 3: Garden Kneeler and Seat with 2 Bonus Tool Pouches
https://www.amazon.ca/Sunix-Garden-Kneeler-and-Seat/dp/B07YKCHN86/ref=asc_df_B07YKCHN86/?tag=googleshopc0c-20&linkCode=df0&hvadid=459571690717&hvpos=&hvnetw=g&hvrand=13253908913970998844&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9000762&hvtargid=pla-853122594421&th=1
Search: Google: Best gardening stools for seniors
About this item

• 【UPGRADED VERSION WITH DETACHABLE BELT】It comes with a adjustable belt that can be connected to one of the pouches. You can hang the pouch on your garden kneeler, or attach it to the belt. Unique and functional design makes your garden work easier.
• 【BETTER COMFORT AND HIGH QUALITY MATERIAL】 The Upgraded Folding Garden bench is made of high quality steel tubing and padded with thicken EVA foam cushion. The weight capacity up to 330 lb /150KG. 3 x Soft form pad cushions provides more comfortable gardening work and help to reduce the pressure on knees.
• 【TWO GARDENING TOOL POUCHES& FOUR DETACHABLE PROTECTORS】Different form other products on the market, We selected high density 600D polyester fabric for the two tool pouches. Four detachable protectors can prevent from sliding on and damaging hard floor surfaces.
• 【EASY TO STORAGE AND FOLDING】The kneeler can also be folded flat in just a blink ¨C this makes it even more convenient to carry around and store. The folded kneeler occupies very little space and can be carried even in your car for an outing. Tool-free assemble. This is a mandatory tool to have for every garden keeping enthusiast,great for household chores, auto, garage, etc.

Description
The upgraded garden kneeler made of 3 x soft foam pad, coming with 2 x large pouches (one of them can be a hip tool bag), 4 x protective clips, 1 x seed organizer,1 x Pruning Shear
• is much thicker and wider (1" thick and 8.1" wide pad) so that it'll be more comfortable and softer to kneel on/ sit than ordinary garden stools.
• And the stronger handles are sturdier to support up to 330lbs without slipping or wobbling.
• Much Easier to fold flat and lightweight to carry, it is a must have gardening stool for every garden keeping enthusiast, great for household chores, auto, garage, etc.

Specifications Frame Material	Metal
Brand	Sunix
Shape	Rectangle
Max Weight Recommendation	330 Pounds
10	

Product 4: Miracle-Gro 4-in-1 Garden Stool
https://www.amazon.com/dp/B0785KB56Y/?ots=1&linkCode=ogi&tag=housebeautiful_auto-append-20&ascsubtag=[artid|10057.g.27585117[src|[ch|[lt|
Search: Google: Best gardening stools for seniors
About this item
• Large garden scooter with carry handle and oversize easy rolling wheels!
• Large and comfortable garden seat - 225Lb capacity!
• Garden kneeler with foam padding and side uprights for easy standing back up!
• Large storage Bin with dual locking sides
• UV protected - no assembly required!
• This is an aftermarket of generic part

Specifications Color	Blue/Green/Yellow
Frame Material	Plastic
Brand	Miracle-Gro
Item Dimensions LxWxH	23.2 x 9.6 x 10.6 inches
Shape	Rectangle

Product 5: Step 2 Corp The Step2 Company Garden Hopper
https://www.amazon.ca/dp/B0029DN4BS?tag=mobilitywithlove-20&linkCode=ogi&th=1&psc=1
Search: Google: Best gardening stools for seniors

Description

As any gardener knows, even the best-laid plans for spending a day with the soil can be ruined by the necessity for repeated trips to the house or shed for the proper equipment. With the Step 2 Garden Hopper, however, it's possible to pack everything you need for a full day's gardening and take it all wherever you go. The Garden Hopper features an extremely sturdy seat that's just high enough to offer a comfortable perch yet low enough to keep you close to your garden. While a molded carrying handle is included within the seat itself, the Hopper's 7-inch wheels make it simple to scoot about without rising. With its sturdy double-wall construction, the Garden Hopper is strong enough to take a lot of rugged treatment. Beneath the seat is a large storage space, perfect for holding your gloves, tools, seeds, cellular phone, and other accessories you may need. In addition, this handy garden helper includes a built-in holder for a 12-ounce beverage, eliminating the need to run back into the house for refreshment. The Garden Hopper measures about 14 inches tall, 12.5 inches wide, and about 22 inches long. Weight limit on hoppper: 250 lbs (113.6 kg).

Specifications Colour	Green/Tan
Brand	Step 2
Item Dimensions LxWxH	33 x 58.4 x 31.8 centimeters
Item Weight	8.5 Pounds
Manufacturer's suggested maximum weight	250 Pounds

Product 6: Pure Garden 82-VY021 Garden Cart Rolling Scooter with Seat
https://www.amazon.com/Pure-Garden-Rolling-Scooter-Gardening/dp/B00NR1X42K?ref_=ast_sto_dp
Search: Google: Best gardening stools for seniors

Description

Protect your knees and back from pain commonly caused while gardening by continuous bending, twisting, and kneeling with the Garden Cart Scooter with Seat by Pure Garden. The rolling wheels and lightweight build provide exceptional portability around the yard, while the durable plastic and stainless-steel construction stand up to harsh weather and long-term use. This garden accessory features an added tool tray underneath the seat to keep tools organized and at your fingertips, making it ideal for both kids and adults with green thumbs! SATISFACTION - Pure Garden is committed to providing the consumer with the absolute best price and value on our entire line of products, which we ensure by applying a rigorous quality control process.

Specifications Color	Green/Black
Material	PVC, Metal
Brand	Pure Garden
Item Dimensions LxWxH	17.5 x 19 x 13 inches

Appendix C: Approval Forms

Thesis Topic Approval (signature approved)

IDSN 4002
SENIOR LEVEL THESIS ONE

Humber ITAL / Faculty of Applied Sciences & Applied Technology
Bachelor of Industrial Design / FALL 2020
Catherine Chong / Sandro Zaccolo

FTA-4 THESIS TOPIC APPROVAL (TEMPLATE)
This project/assignment constitutes 5% of total mark for the course

Start: Week #4 / Sep-28
Due: Week #5 / Oct-05

THESIS TOPIC APPROVAL:

Student Name:	Kristie / Bulbrook
Topic Title:	How may we improve the gardening experience for people with arthritis?

Abstract

Gardening is an activity enjoyed by many, but for people with deterioration in mobility and strength or experiencing chronic pain the activity is not fully accessible. For the average healthy person, gardening is a medium intensity activity. People with deterioration conditions and pain may find this level of intensity is too much and stop the activity. This is a problem since gardening is a good form of exercise and has shown to be very therapeutic. The goal of this thesis is to create a way that makes the experience of gardening more accessible to everyone in a safe and unintrusive way. Using data collection methods for user research like interviews, observational study and analyzing existing data will support the design approach. A one-to-one ergonomic scale model will be developed to understand and evaluate the feasibility of the design in accordance with human factors. The results from this research and analysis will create a design solution that include a set of tools and processes that enable people to continue gardening.

Student Signature(s): Kristie Bulbrook	
Date:	05 / 10 / 2020

Instructor Signature(s): Catherine Chong Sandro Zaccolo	
Date:	07 / 10 / 2020

Chong, Kappen, Thomson, Zaccolo

Thesis Design Approval (signature approved)

IDSN 4502
SENIOR LEVEL THESIS TWO

Humber ITAL / Faculty of Applied Sciences & Technology
Bachelor of Industrial Design / WINTER 2021
Catherine Chong / Sandro Zaccolo

CRITICAL MILESTONES: APPROVAL FOR CAD DEVELOPMENT & MODEL FABRICATION

Student Name:	**Kristie Bulbrook**
Topic / Thesis Title:	**Improving Gardening Experience for Arthritis**

THESIS DESIGN APPROVAL FORM

Thesis design is approved to proceed for the following:	X	**CAD Design and Development Phase**
Comment:	Initial CAD progress well as of week #8/March 17th, continue with detailing and refinement.	

Thesis design is approved to proceed for the following:	X	**Model Fabrication Including Rapid Prototyping and Model Building Phase**
Comment:	Design development progress well as of week #8/March 17th, once CAD is completed, can move forward to model fabrication from week #9 onward.	

Instructor Signature(s):

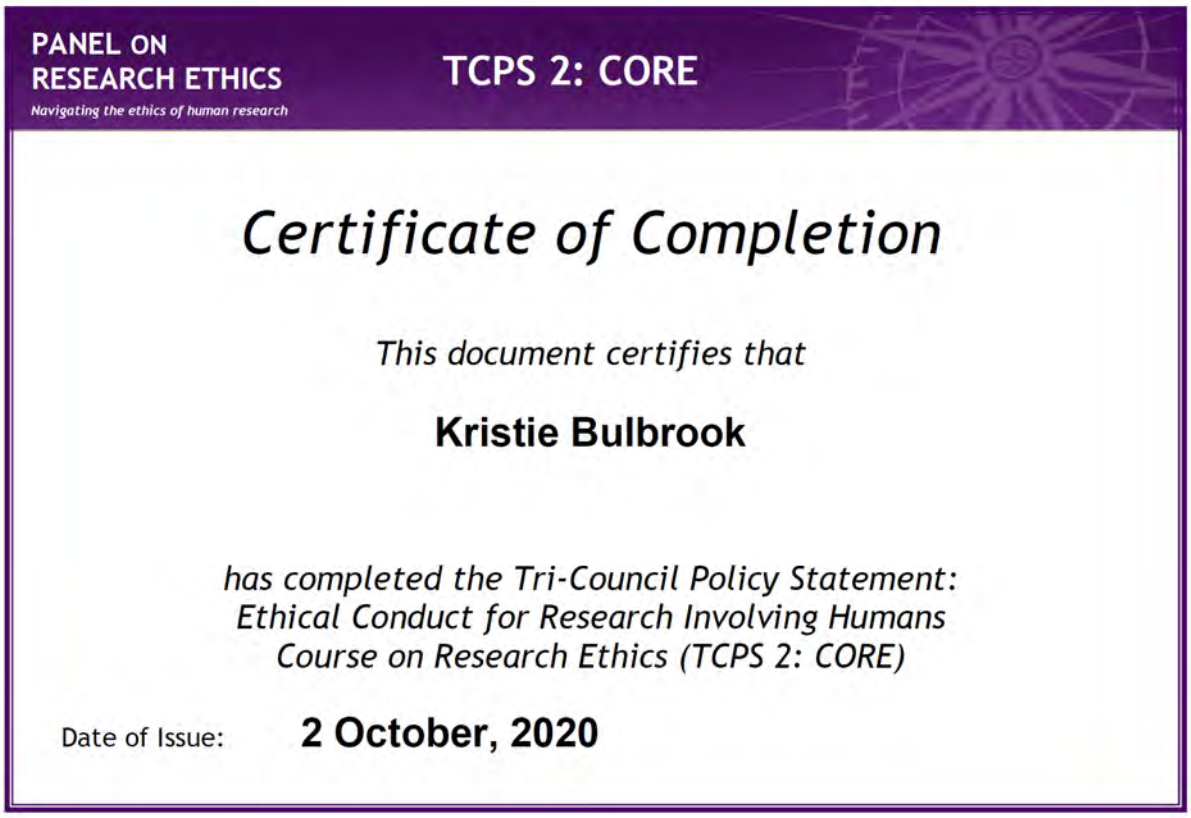
Catherine Chong Sandro Zaccolo

Date:	17th March 2021

1

Chong, Kappen, Thomson, Zaccolo

Proof of TCPS-2-CORE certificate



PANEL ON RESEARCH ETHICS
Navigating the ethics of human research

TCPS 2: CORE

Certificate of Completion

This document certifies that

Kristie Bulbrook

has completed the Tri-Council Policy Statement:
Ethical Conduct for Research Involving Humans
Course on Research Ethics (TCPS 2: CORE)

Date of Issue: **2 October, 2020**

Appendix D: Advisor Meetings & Agreement Forms

Informed Consent Form (signature approved)

IDSN 4002 / 4502
SENIOR LEVEL THESIS ONE & THESIS TWO

HUMBER
Faculty of Applied Sciences & Technology
Bachelor of Industrial Design / FALL 2020 & WINTER 2021

PARTICIPANT INFORMED CONSENT FORM

Research Study Topic: How may we improve the gardening experience for those with arthritis?
Investigator: Kristie Bulbrook / (905) 903 - 3124 / kristiebulbrook@gmail.com
Courses: IDSN 4002 & IDSN 4502

I, Brittany Bulbrook *(First Name/Last Name)*, have carefully read the Information Letter for the project "*How may we improve the gardening for people with arthritis?*", led by **Kristie Bulbrook**. A member of the research team has explained the project to me and has answered all of my questions about it. I understand that if I have additional questions about the project, I can contact **Kristie Bulbrook** at any time during the project.

I understand that my participation is voluntary and give my consent freely in voice recording, photography and/or videotaping; with the proviso that my identity will be blurred in reports and publications.

Consent for Publication: Add a (X) mark in one of the columns for each activity

ACTIVITY		YES	NO
Publication	I give consent for publication in the Humber Library Digital Repository which is an open access portal available to the public	☒	☐
Review	I give consent for review by the Professor	☒	☐

Privacy
All data gathered is stored anonymously and kept confidential. Only the principle investigator /researcher, **Kristie Bulbrook** and Prof. Catherine Chong or Prof. Sandro Zaccolo may access and analyze the data. All published data will be coded, so that visual data is not identifiable. Pseudonyms will be used to quote a participant (subject) and data would be aggregated.

I also understand that I may decline or withdraw from participation at any time, without negative consequences.

I understand that I can verify the ethical approval of this study, or raise any concerns I may have by contacting the Humber Research Ethics Board, Dr. Lydia Boyko, REB Chair, 416-675-6622 ext. 79322, **Lydia.Boyko@humber.ca** or Kristie Bulbrook / (905) 903 - 3124 / kristiebulbrook@gmail.com .

Verification of having read the Informed Consent Form:

☑ I have read the Informed Consent Form.

My signature below verifies that I have read this document and give consent to the use of the data from questionnaires and interviews in research report, publications (if any) and presentations with the proviso that my identity will not be disclosed. I have received a copy of the Information Letter, and that I agree to participate in the research project as it has been described in the Information Letter.

Brittany Bulbrook — Participant's Name
BHB — Participant's Signature
07 May 2021 — Date

3

Information Letter

HUMBER
Faculty of Applied Sciences & Technology
Bachelor of Industrial Design / FALL 2020 & WINTER 2021

IDSN 4002 / 4502
SENIOR LEVEL THESIS ONE & THESIS TWO

INFORMATION LETTER

Research Study Topic:	**How may we Improve the Gardening Experience for People with Arthritis?**
Investigator:	**Kristie Bulbrook / (905) 903-3124 / kristiebulbrook@gmail.com**
Sponsor:	Humber ITAL, Faculty of Applied Sciences & Technology (IDSN 4002 & IDSN 4502)

Introduction
My name is **Kristie Bulbrook**, I am an industrial design student at Humber ITAL, and I am inviting your participation in a research study on various problems that people with arthritis have while gardening. These problems include experiencing pain in joints such as hands, knees, back, ect, which make it hard to bend, kneel, twist or handle objects. The results will be contributed to my Senior Level Thesis project.

Purpose of the Study
This study is being conducted as an aid in designing a product solution that is capable of alleviating the stress on joints when gardening by either avoiding bending, kneel, or twisting all together or less frequently. Improving the gardening experience in a safe and intrusive way. With your help, I plan to address problems that people garden with arthritis face on a regular basis. This study is primarily based on understanding ergonomics, human interaction design activities, and user experience aspects of the research area.

Procedures
If you volunteer to participate in this study, you will be asked questions pertaining to your arthritis and how it affects the way you garden. An observational interview will also be done to get a look at what steps you take well gardening, due to covid restrictions this maybe done virtually. You will either be asked to gather your favorite tools and explain how they improve your gardening experience or watch a video of someone gardening and explain the pain points of each step. *Your activities will be documented using a transcription recording app (an phone application that records conversations and then transcripts, and possibly video recording or pictures.*

Confidentiality
Every effort will be made to ensure confidentiality of any identifying information that is obtained during the study. In the case of being recorded visually, your face will be masked /blurred or hidden. The information and documentations (photographs) gathered are all subject to being used in the final presentation of the study.

Participation and Withdrawal
Your participation in this study is completely voluntary and you may interrupt or end the study and the session at any time without giving a reason or fear of being penalized.

If at any point during the session, you feel uncomfortable and wish to end your participation, please let the moderator know and they will end your participation immediately.

Humber Research Ethics Board
This research project /course has been approved by the Humber Research Ethics Board. If you have any questions about your rights as a research participant, please contact Dr. Lydia Boyko, REB Chair, 416-675-6622 ext. 79322, **Lydia.Boyko@humber.ca**

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Bachelor of Industrial Design / FALL 2020 & WINTER 2021

IDSN 4002 / 4502
SENIOR LEVEL THESIS ONE & THESIS TWO

INFORMATION LETTER

Conditions of Participation

- ✓ I understand that I am free to withdraw from the study at any time without any consequences.
- ✓ I understand that my participation in this study is confidential. (i.e. the researcher will know but will not disclose my identity)
- ✓ My identity will be masked.
- ✓ I understand that the data from this study may be published.

☑ **I have read the information presented above and I understand this agreement. I voluntarily agree to take part in this study.**

Brittany Bulbrook	BHB2	07May2021
Participant's Name	Participant's Signature	Date

Project Information

Thank you very much for your time and help in making this study possible. If you have any queries or wish to know more about this Senior Level Thesis project, please contact me at the followings:

Phone: **(905) 903-3124**
Email: **kristiebulbrook@gmail.com**

My supervisors are:

Prof. Catherine Chong, **catherine.chong@humber.ca**
Prof. Sandro Zaccolo, **sandro.zaccolo@humber.ca**

Highlighted record of correspondent

Advisor
Essentially, at the bottom of the page there's a bunch of links. Yeah. So the first is arthritis society, and then you can get if you need stats for like a write up or something to talk about why your research, or why your product is important, you can get some stats from there it just talks about how he talks about the prevalence of arthritis in Canada, about how many people can't do daily, daily living tasks and stuff like that. Oh that's cool I was doing preliminary research and I never found that one. So yeah, so, um, the Arthritis society is something that we use in research they actually have their own, they have the source at the bottom of it. If you need to cite it specifically, okay, but they're a good resource. They also have something called a symptom tracker. So you can play around with it it's kind of like a choose your own adventure. It's like a bus quiz. Can you remember those like you choose one or the other. So you put in your symptoms and then it will tell you like if you're at risk of having arthritis or something that would just give you a little bit more information about what kind of symptoms, people with arthritis have Arthritis Foundation is more of like a national thing. And so is the National rheumatoid arthritis is UK based but I figure they'll have some stuff about rheumatoid arthritis, which is what I think grandma and Jordan have.

Interviewer
Okay, I think grandma says that she has two forms of arthritis. No. No. Yes, common two. So what I've found. I've learned for my research that I am going to butcher this osteo arthritis. No, that's right. Um, is the most common. But I, the Arthritis group that I posted my thing to was for rheumatoid arthritis. So my, my

Advisor
son rheumatoid arthritis is also very common, the difference between. So, there are two main branches of arthritis. So osteoarthritis is actually another subcategory of arthritis, so if you have arthritis, you'd have osteoarthritis and then you have something called inflammatory arthritis, even though all of them are inflammatory. This one is more of it has an auto immune. Yeah. So, it's more like attack that your body's attacking itself, where osteoarthritis is more of a wear and tear the tissue inside the joint capsule is degrading. So you have bone rubbing against bone. Yeah. Okay. And that's, it's painful.

Interviewer
So, mom has arthritis so hers would be from her from her honor lit their ankle. So, I think, so

Advisor
it can be from injury, and it can just be from overtime. Okay. And it can be from nothing, you can just get it could be hereditary. Yeah