Fall 2016

Universal Pitter

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This universal pitter is designed to be a simple kitchen gadget for the everyday household. Our objective is to create a fruit pitter that could be used on multiple types of fruit, especially peaches, plums and nectarines.

MEMS 411 Design- Universal Pitter

Universal Pitter

Authors: Rachel Venn and Angelica Price

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1 INTRODUCTION

1.1 PROJECT PROBLEM STATEMENT

Similar pitter products are on the market but are either completely mechanical or too large for an everyday kitchen. The automatic pitter is an industrial size pitter which is too large for an everyday kitchen. Our project needs to be able to fit conveniently in kitchen cabinets and should be no larger than the size of a blender which is a standard powered kitchen tool. Our design must have food safe materials and a design that does not put the user at risk since there will be sharp moving parts to grasp the pit. This includes covering or shielding the sharp components and electrical components from the consumer. The material we use to grasp the fruit must be soft enough to not damage the fruit but durable to be able to withstand use and washing. The material also must be food and water safe to comply with the above standard. Our universal automatic pitter will be for the everyday kitchen and can pit any peach, nectarine, plum or avocado without damaging the delicate fruit.

1.2 LIST OF TEAM MEMBERS

Rachel Venn and Angelica Price

2 BACKGROUND INFORMATION STUDY – CONCEPT OF OPERATIONS

2.1 A SHORT DESIGN BRIEF DESCRIPTION THAT DESCRIBES THE PROBLEM

We will create a universal semi-automatic pitter. This pitter will feature a comfortable handle and a button that will activate at least two programmed movements to de-pit various types of fruit including peaches, nectarines, plums and avocados. Once you have sliced your fruit in half and exposed the pit, let our pit extractor do the rest. Small enough for any kitchen and easy to use for any consumers.

2.2 SUMMARY OF RELEVANT BACKGROUND INFORMATION

Our most likely competitor is found in patent US3179139 which is the method of pitting freestone peaches. This is an industrial size pitter for peaches that is used to mass produce peaches without the pit. It is the most mechanical and universal product on the market.

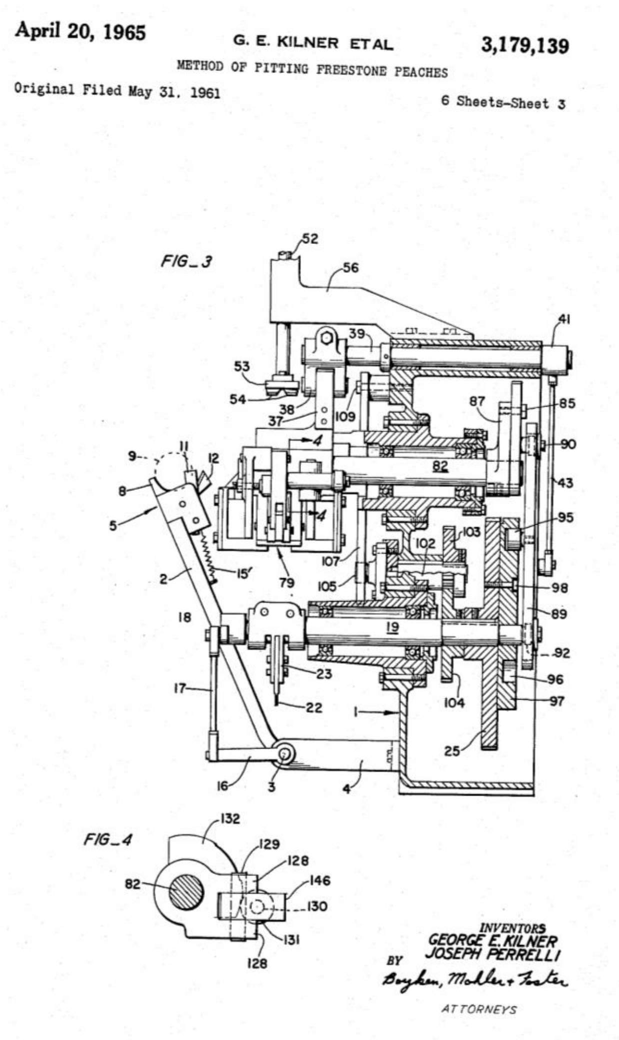

Figure 1 One of seven patent figures from an industrial sized peach pitter.

Our second competitor would include a mechanical peach pitter this mechanical pitter slices the fruit for you whilst removing the pit. However, it is all mechanical.

http://www.williams-sonoma.com/products/peach-pitter-slicer/

Figure 2 Mechanical Peach pitter

In our design process, one of the significant risks to the design process is creating enough torque to take the pit out of a piece of fruit without damaging or bruising the delicate nature of the fruit. This article link below explains the difficulties of carrying fruit and demonstrates how delicate peaches, nectarines, plums and avocados are. In our design process, we must figure out a way to grasp the fruit to apply enough torque to pit the fruit without damaging or bruising it.

http://www.alhambrasource.org/news/peaches-and-plums-aplenty

Codes and Standard from:

http://proceedings.asmedigitalcollection.asme.org/proceeding.aspx?articleid=1750632

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A Device for Performing Controlled Cutting Operations

Another Standard and probably more relevant is below from:

http://www.nsf.org/services/by-type/standards-publications/food-equipment-standards

Our pitter is not commercial, but the protection and sanitation requirements for the materials, design and construction are most relevant to our project because our tool must be safe and able to be rewashed and reused even though it will be a powered food preparation tool.

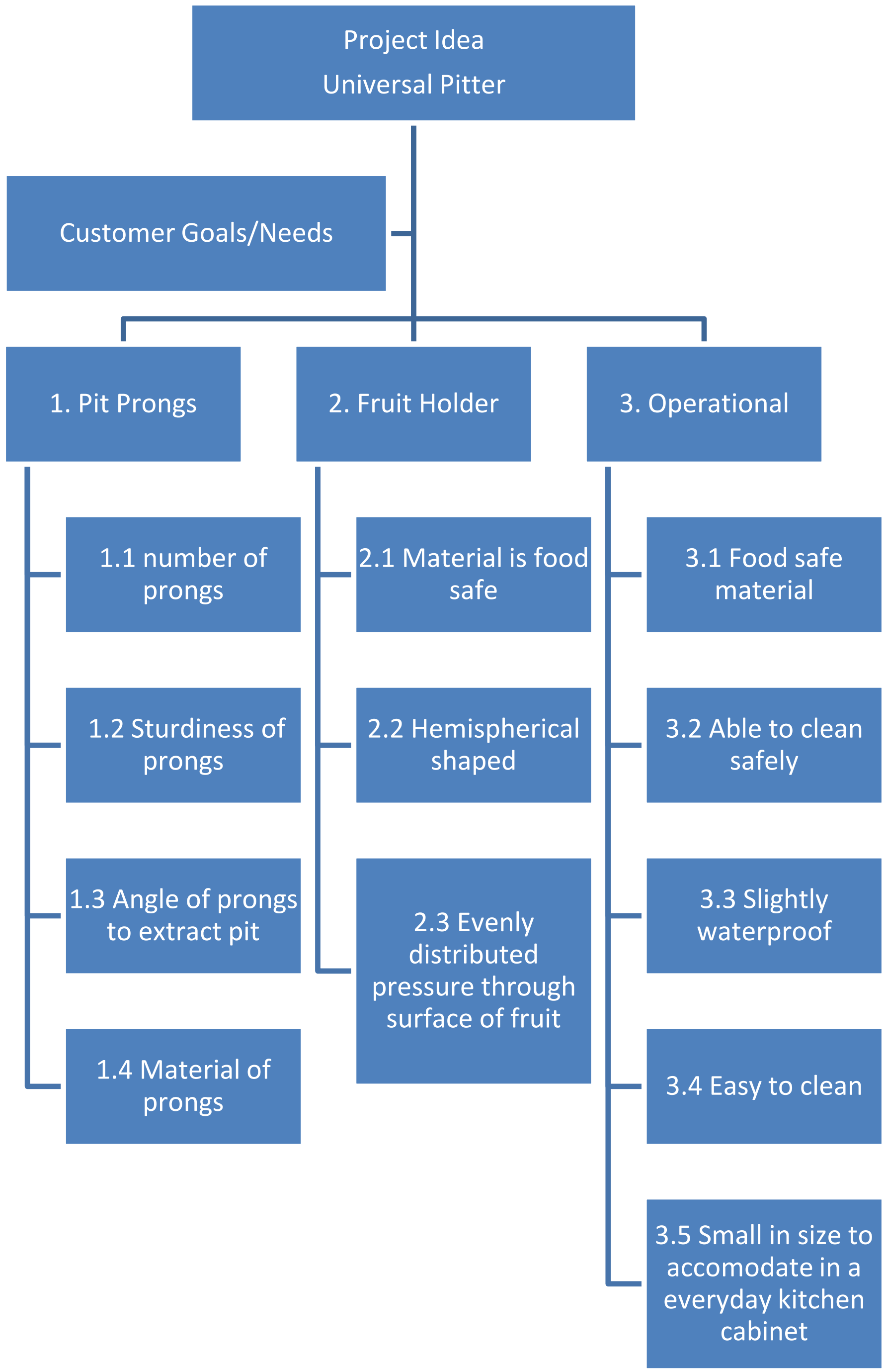
NSF/ANSI 8: Commercial Powered Food Preparation Equipment

NSF/ANSI 8 establishes minimum food protection and sanitation requirements for the materials, design and construction of power-operated commercial food preparation equipment such as grinders, mixers, pasta makers, peelers, saws, slicers, tenderizers and similar equipment.

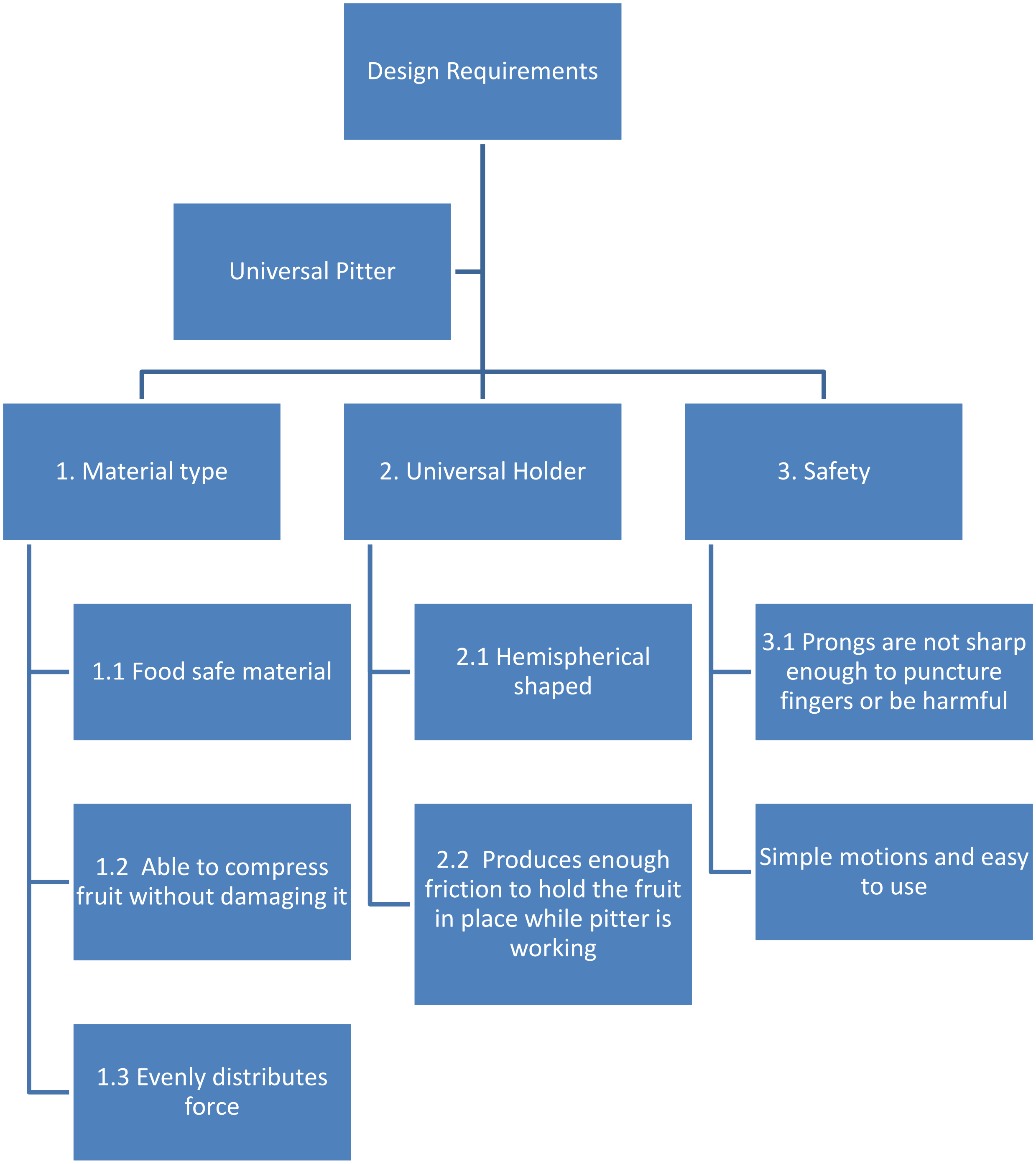
2.3 OPERATIONAL REQUIREMENTS ALLOCATED AND DECOMPOSED TO DESIGN REQUIREMENTS

Similar pitter products are on the market but are either completely mechanical or too large for an everyday kitchen. The automatic pitter is an industrial size pitter which is too large for an everyday kitchen. Our project needs to be able to fit conveniently in kitchen cabinets and should be no larger than the size of a blender which is a standard powered kitchen tool. Our design must have food safe materials and a design that does not put the user at risk since there will be sharp moving parts to grasp the pit. This includes covering or shielding the sharp components and electrical components from the consumer. The material we use to grasp the fruit must be soft enough to not damage the fruit but durable to be able to withstand use and washing. The material also must be food and water safe to comply with the above standard. Our universal automatic pitter will be for the everyday kitchen and can pit any peach, nectarine, plum or avocado without damaging the delicate fruit.

2.3.1 List of identified operational and design requirements



2.3.2 Functional allocation and decomposition



BreakdownStructure.pdf

2.4 FOUR CONCEPT DRAWINGS

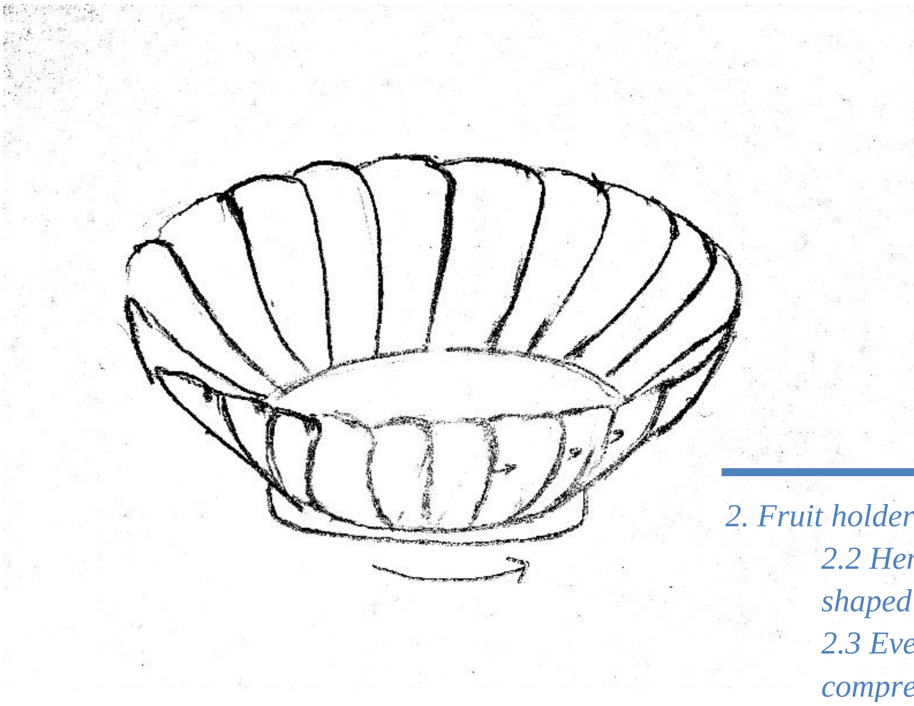


Figure 4 Compressive Base

2. Fruit holder
2.2 Hemispherical shaped
2.3 Evenly distributed compressive force

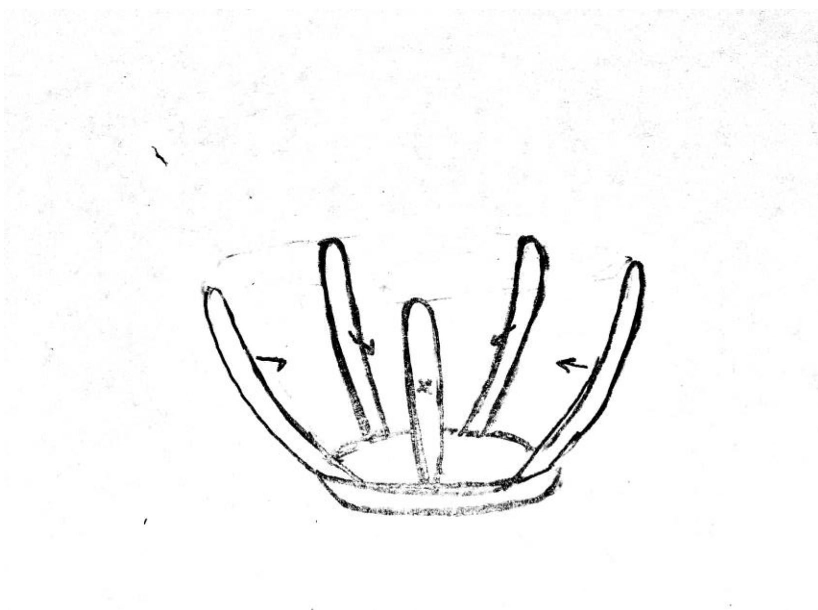


Figure 3 Grasping Base Concept

2. Fruit holder

2.2 Hemispherical shaped

2.3 Evenly distributed compressive force

3. Operation

3.1 Simple motion

3.2 Easy to use

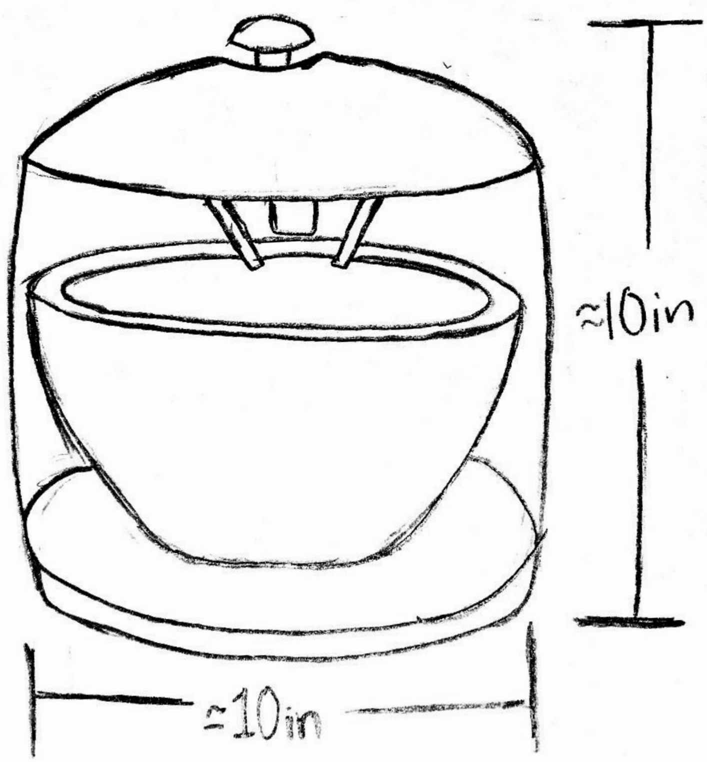


Figure 5 Main Body Exterior View

1. Pit Prongs
- *1.1 Number of prongs*
- *1.2 Sturdiness of prongs*
- *1.3 Angle of prongs*
- *1.4 Material Prongs*

3. Operation
- *3.1 Simple motion*
- *3.2 Easy to use*

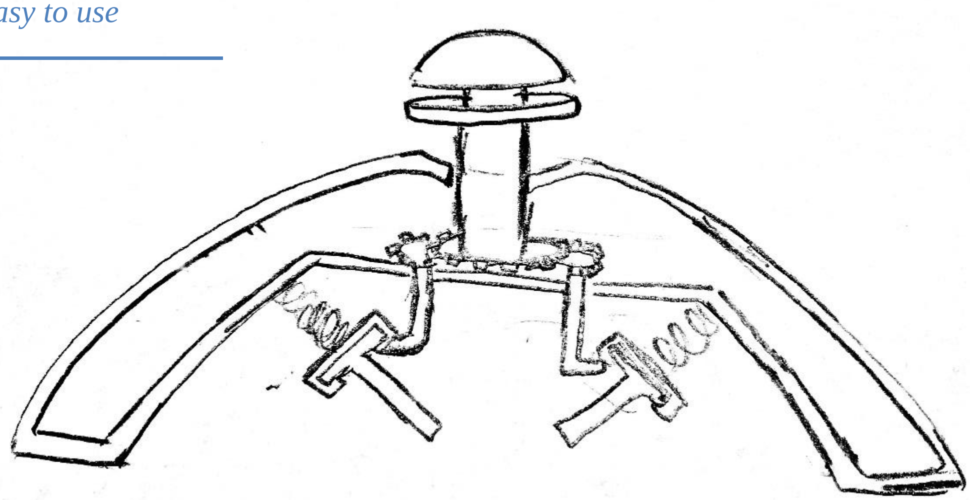


Figure 6 Spring Release Arms Concept

1. Pit Prongs
- *1.1 Number of prongs*
- *1.2 Sturdiness of prongs*
- *1.3 Angle of prongs*
- *1.4 Material Prongs*

3. Operation
- *3.1 Simple motion*
- *3.2 Easy to use*

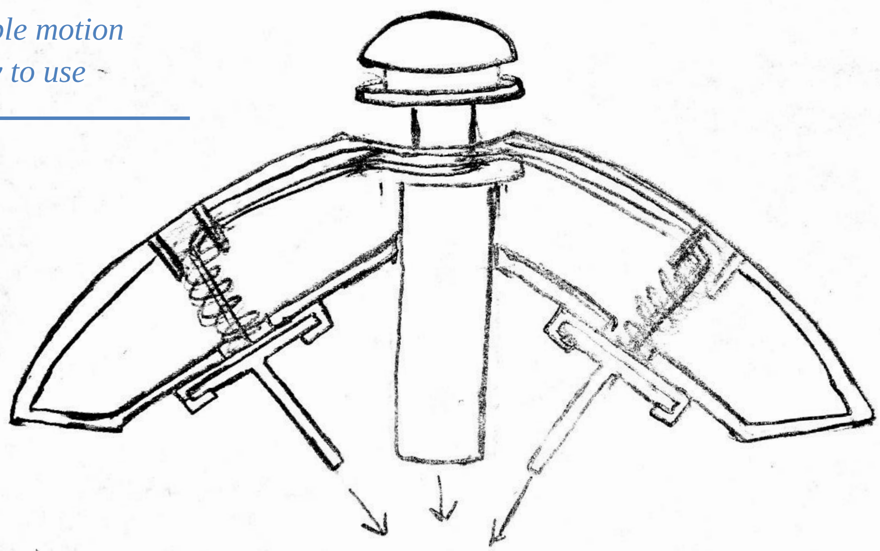


Figure 7 Gentle Spring Release Concept

2.5 CONCEPT SELECTION PROCESS

2.5.1 Concept Physical Analysis: Concept 1 – Hemispherical holder versus grasping holder

The grasping holder would be comprised of a rotating base such that the rotational motion will translate into a reduction in diameter between holding "fingers". The holding fingers will be five to six finger-sized pieces of material would grasp the fruit to hold it while the pitter is working. These fingers would mimic the motion of a hand and fingers grasping a hemi-spherically shaped piece of fruit very like the manual process. This design would put point pressure on the fruit and would bruise the fruit easily as we found through our manual testing.

A hemispherical holder would work better than a grasping holder. With a hemisphere, it is ergonomically shaped such that a large variety of circumferences of fruit would be able to fit within the holder. With a food-safe and washing-safe foam within the holder slightly smaller than an average size of a peach or nectarine would be able to exert a compressive force over the entire hemispherical surface of the fruit. This design is advantageous because it avoids point forces that would damage the fruit.

2.5.2 Concept Physical Analysis: Concept 2 - Spring Release Arms

The spring release arms would be powered through a manual rotation device. Through the rotational motion arms would be released from their resting position. In their resting position the arms would house a coiled spring ready to be released to inject the prongs in the fruit. These springs would need to be recoiled after each use so that the arms could fit back into place to hold the prongs above the pit of the fruit.

This design is not advantageous because it requires too much manual motion to retract the prongs. The process needs to be more automated and easy to use. This design also does not address the functionality of the design and would be cumbersome.

2.5.3 Concept Physical Analysis: Concept 3 – Gentle Spring Release

This design would feature wire that would attach to the prong and a spring also attached to the prong. The wire would be housed in cylinder shape similar to a yo-yo. On top of our design would have a rotating handle that the user could rotate to dispense wire and elongate the spring. The spring would be coiled and housed within the top structure so that when the rotational motion will release the wire slowly, again similar to a yo-yo the spring will expand moving the prongs such that they pierce the fruit.

This design is advantageous because of the rotational motion and the springs being housed, the reverse of the motion would be easily accomplished because the rotational motion can simply be reversed to retract the prongs by compressing the spring.

2.5.4 Concept Physical Analysis: Concept 4 – Grasping Pit mechanism

The grasping pit mechanism would be similar to the grasping base mechanism in that the prongs would be attached to a top such that the translational spring motion would translate to the finger-shaped prongs to expand and contract around the pit. These prongs would be angled outward in their original orientation when the double button is pressed on the top. The outer button would trigger the spring to compress and the outer would press the whole enclosure down. The prongs will be hinged to the top. The reduction of the diameter between the finger-shaped prongs will be caused when the spring is retracted and the prongs are held up in the housing while holding the pit. Again, this motion will be similar to fingers grasping the pit.

This design is not advantageous because through our manual testing taking the pit out from the top of the fruit or from the exposed part of the pit is extremely difficult and would require a lot of force to remove the pit. With a lot of force to remove the pit, the fruit is easily damaged and bruised which is one of the requirements of our design: the fruit must not be damaged or bruised. This design is also difficult to manufacture because there would be a lot of moving parts on the top to be able to move the finger-shaped prongs. This design would also make it difficult to reverse the motion to extract the pit.

2.5.5 Concept scoring

Table 1 Concept Scoring tables of each respective concept

Concept 1

Need Number	Need Description	Importance (1-5)	Is need met?
1	Easy to use	5	Y
2	Simple motion	3	Y
3	Able to retract prongs	4	N/A
4	Springs need to be housed	3	N/A
5	Compressing material in holder	4	Y
6	Able to extract pit	5	N/A
7	Fruit is not damaged	4	Y
8	Fruit is not bruised	4	Y
9	Pit is extracted	5	N/A
10	Pit is able to be lifted out of the fruit	4	Y
11	Rotational motion needs to be converted into mechanical motion through a motor	3	N

Concept 2

Need Number	Need Description	Importance (1-5)	Is need met?
1	Easy to use	5	N
2	Simple motion	3	N
3	Able to retract prongs	4	N
4	Springs need to be housed	3	Y
5	Compressing material in holder	4	N/A
6	Able to extract pit	5	Y
7	Fruit is not damaged	4	N

8	Fruit is not bruised	4	N
9	Pit is extracted	5	Y
10	Pit is able to be lifted out of the fruit	4	N
11	Rotational motion needs to be converted into mechanical motion through a motor	3	N

Concept 3

Need Number	Need Description	Importance (1-5)	Is need met?
1	Easy to use	5	Y
2	Simple motion	3	Y
3	Able to retract prongs	4	Y
4	Springs need to be housed	3	Y
5	Compressing material in holder	4	N/A
6	Able to extract pit	5	Y
7	Fruit is not damaged	4	Y
8	Fruit is not bruised	4	Y
9	Pit is extracted	5	Y
10	Pit is able to be lifted out of the fruit	4	Y
11	Rotational motion needs to be converted into mechanical motion through a motor	3	Y

Concept 4

Need Number	Need Description	Importance (1-5)	Is need met?
1	Easy to use	5	N
2	Simple motion	3	N
3	Able to retract prongs	4	N
4	Springs need to be housed	3	N
5	Compressing material in holder	4	N/A
6	Able to extract pit	5	Y/Maybe
7	Fruit is not damaged	4	Y

8	Fruit is not bruised	4	Y
9	Pit is extracted	5	Y/Maybe
10	Pit is able to be lifted out of the fruit	4	N
11	Rotational motion needs to be converted into mechanical motion through a motor	3	N/A

2.5.6 Final summary

We began our prototype design with manual testing on actual peaches. We assumed that the user of our product would know to slice the piece of fruit longitudinally to expose the pit of the fruit. We found that a ripe peach had a pit that was easily dislodged. So again, we assumed that the user would chose a piece of fruit that is ripe enough to eat which means that the pit is easily removed. Under this assumption, we found that it does not take a large force to remove the pit.

We decided that the pit was easily extracted with prongs at a forty-five-degree angle such that they touch at the end of the motion to completely enclose the pit. we also found that two flat prongs would be sufficient to grasp the pit because the fruit is delicate and easily punctured so a very sharp prong is unnecessary. We also found that shields on either side of the prong are necessary because otherwise the pit would slide up the prong and bounce out of the enclosure. We need a design with shields on the prongs about an inch and a half up the prong to hold the pit. We also found that a third shield is necessary to come down on the pit on the top to hold the fruit against the sides of the prongs. This prevents the pit from moving during the extraction process. Some parts of the peach are more attached to the fruit than other parts, therefore the top shield is necessary to prevent the fruit from moving during the pitting process.

We also decided that the holder needs to be spherically shaped. The user puts the half of the fruit with the part of the pit exposed in the holder so that our pitter can perform its task of removing the pit. The holder will be hemi-spherically shaped such that the diameter is similar and uniform to most peaches and nectarines. Through our manual testing our circumferences ranged from 8 7/8” to 9 7/16”. Therefore, the inner diameter of our holder needs to be able to accommodate these circumferences.

Through our manual testing we found that we needed to create a holder that evenly distributes the forces over the hemisphere of the peach so that the delicate fruit is not damaged. We came up with the idea to use a food-safe foam that would exert a compressive force over the entire surface of the fruit. We also decided that the foam needs to be rough enough to hold the fruit while the pitter is working so the fruit does not slip out.

We decided that a rotating handle at the top of the pitter is the best way to release the prongs into the fruit to extract the pit. The rotating handle would be connected to wire that would be attached to the prongs at the given forty-five-degree angle. Also attached to the prongs would be springs. In the retracted position the springs would be in compression so that when the handle is turned releasing the wire the spring would move the prongs such that the rotational motion would be transferred into linear motion.

This process can be later automated through Arduino and powered by a small motor to create the rotational motion.

2.6 PROPOSED PERFORMANCE MEASURES FOR THE DESIGN

2.6.1 Business Need

Fruits with pits in them have been cumbersome to eat due to the delicate quality of the fruit and the rigid structure of the pits that must be removed. Many types of pitters already exist, but any are for small pits such as cherries and olives or involve to much manual action. This pitter will remove the pit out of multiple types of fruit while holding the fruit in a manner that does not damage the fruit. This projected was initiated by Rachel Venn, an engineering student at Washington University in St. Louis, who took a pole amongst family and friends to discover that a multi-fruit pitter is the next necessary kitchen gadget invention. We anticipate this product to be beneficial to the everyday domestic kitchen user in the following way:

* Having to do less manual work
* Removing the pit without waste of fruit
* Less damage to consumed part of the fruit

2.6.2 Project Goals

* Extracting pit without harming the fruit significantly
* Able to hold the fruit without damaging the consumed part
* Take less time to remove the pit or be a less frustrating experience
* The prototype must be completed by 21 September 2016

2.6.3 Product Description

Similar pitter products are on the market but are either completely mechanical or too large for an everyday kitchen. Our project needs to be able to fit conveniently in kitchen cabinets and should be no larger than the size of a blender which is a standard powered kitchen tool. Our design must have food safe materials and a design that does not put the user at risk since there will be sharp moving parts to grasp the pit. This includes covering or shielding the sharp components and electrical components from the consumer. The material we use to grasp the fruit must be soft enough to not damage the fruit but durable to be able to withstand use and washing. The material also must be food and water safe to comply with the above standard. Our universal automatic pitter will be for the everyday kitchen and can pit any peach, nectarine, plum or avocado without damaging the delicate fruit.

2.6.4 Project Customer, Project Sponsor, Project Manager

	Name	**Organization**
Project Customer	Domestic Everyday kitchen user	Any online or TV infomercial to show how our product is used such as QVC or a YouTube ad.
Project Sponsor	Mechanical Engineering Department	Washington University in St. Louis
Project Manager	Mechanical Engineering Department	Washington University in St. Louis

2.6.5 Project Boundaries

In Scope
Creating a prototype that extracts the pit
Creating a holder that fits multiple kinds of fruit
Finding a material that compresses the fruit enough to hold it without damaging it

Out of Scope
Creating a project that does not extract a pit from a piece of fruit
Extracting the pit whist significantly damaging the fruit

Completely automating the process of cutting and splitting the fruit before pit extraction
Removing the pit from the machine
Turning the fruit to disconnect the pit from one side and exposing it on the other
Oriented such that the pit is exposed to the extracting pins

2.6.6 Critical Success Factors

- To learn how to use arduino in a timely fashion and to program the pitter to perform its task.
- Creating effective CAD simulation and drawings that would be able to present to companies as a project design.
- Finding a material to hold the fruit in a compression manner

2.6.7 Project Assumptions

We are assuming that the consumer has already cut the fruit longitudinally in a way to expose the pit. We are assuming the fruit is almost perfectly hemispherical. We are assuming the customer has chosen a good piece of fruit. We are assuming the consumer knows a good piece of fruit is ripe. We are assuming the pits are relatively the same size, shape and dimension.

2.6.8 Project Constraints

- Cost of production of the product
- Durability of the materials used
- Cleanliness of the material used
- Able to wash so non-corrosive material
- Food safe and hygienic materials

2.6.9 Project Deliverables

Deliverable	Description
Prototype	Two components: a working and programmed pitter with a base that holds the fruit
CAD drawings and simulations	Measured and to scale drawings of design able to be used in solid works, show boundary conditions of product and able to show companies
Presentation	Communicating the demonstration of prototype, background information, costs associated with the project and future work to improve and refine design
Written Project	Written documentation of product presentation along with codes and standards

2.7 DESIGN CONSTRAINTS

Include at least one example of each of the following

Refer to presentation below (delete from final version of report). **Source:** "Product Design Constraints and Requirements", web.ewu.edu/.../Design_Constraints.ppt, Eastern Washington University.

2.7.1 Functional

A functional constraint in our project is not having the parts fit together since we plan to 3D print most of our parts. It is key to understand the tolerances on parts that must slide past one and other.

2.7.2 Safety

A safety constraint is being able to find materials that are food safe to comply with our chosen standard. It is also important to have prongs that are safe for the user to use since we found that the prongs do not have to be very sharp to extract the pit.

2.7.3 Quality

Our prototype is being 3D printed so the quality and clarity of the drawings depends on the 3D printers, however for another prototype it will be advantageous to have the parts flash-molded like PVC pipe or PVC shapes.

2.7.4 Manufacturing

We do not have access to a flash-mold machine so we are limited to 3D print our parts besides the springs and prongs.

2.7.5 Timing

Because other groups are constrained to 3D print as well, timing allocated to our parts and sharing the printers on campus makes it pertinent that we print our parts over two weeks in advance to allow for reprinting.

2.7.6 Economic

We decided not to use Arduino which decreases the cost of our project. We decided to get most of our parts from Home Depot which allowed us to save on the cost of our project.

2.7.7 Ergonomic

Our design features two buttons to make the motion simple for the user and easy to use just like a lot of similar kitchen gadgets like the slap chop. We also used a filet on the edges of the buttons so that there are no sharp edges on the exterior of the body.

2.7.8 Ecological

Our ecological constraint is creating an outer body to our project because before our original designs are open and flimsy.

2.7.9 Aesthetic

We decided to enclose our project because that way the aesthetic is more streamline. In a second phase we might change our outer body to be Plexiglas so the user can see the pit being extracted similar again to the slap-chop.

2.7.10 Life cycle

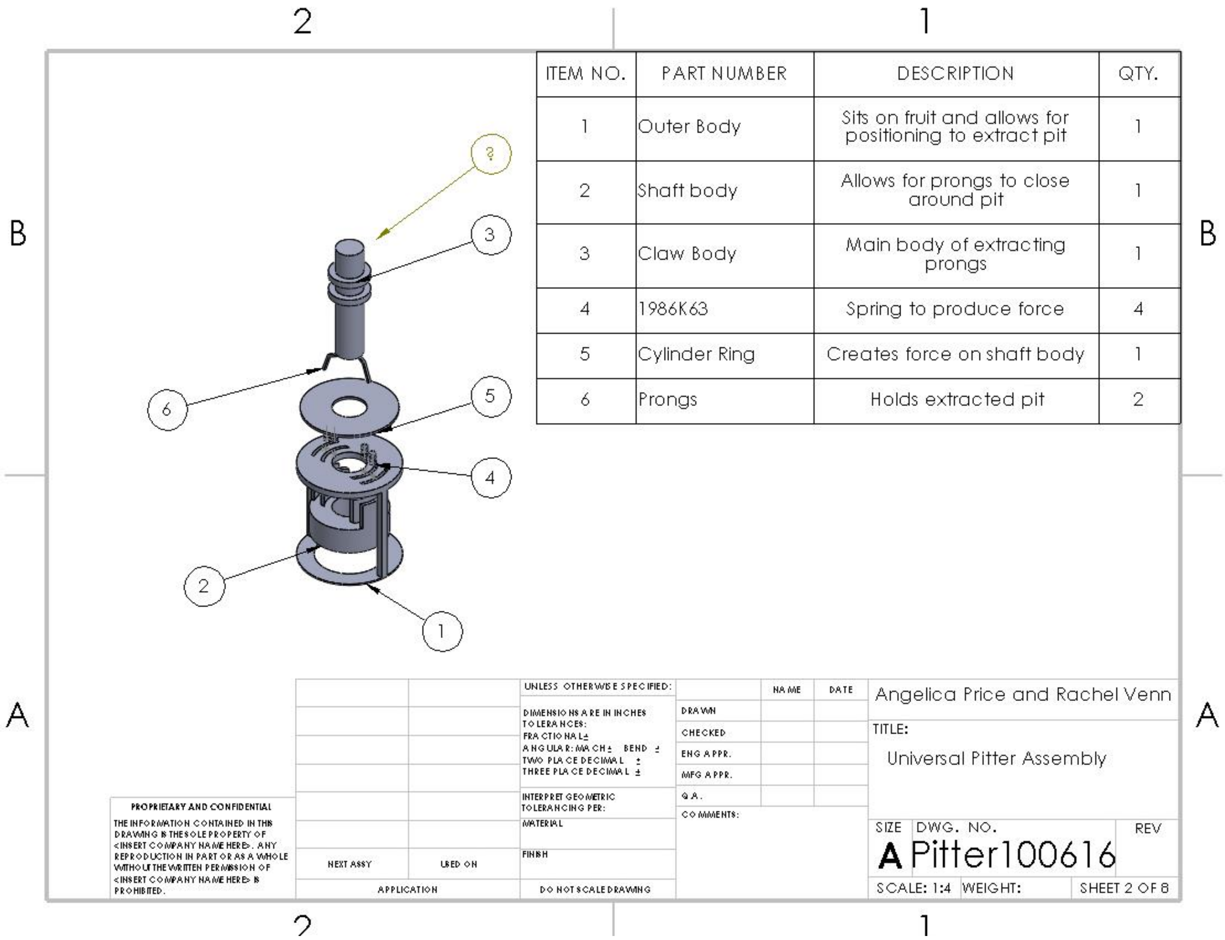
We will test the prototype on multiple kinds of fruit with multiple trials so that we are sure that the prongs and parts can sustain cyclic loading.

2.7.11 Legal

We have checked our standard to make sure our materials are food safe.

3 EMBODIMENT AND FABRICATION PLAN

3.1 EMBODIMENT DRAWING



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	Outer Body	Sits on fruit and allows for positioning to extract pit	1
2	Shaft body	Allows for prongs to close around pit	1
3	Claw Body	Main body of extracting prongs	1
4	1986K63	Spring to produce force	4
5	Cylinder Ring	Creates force on shaft body	1
6	Prongs	Holds extracted pit	2

Figure 8 Pitter Assembly - This version will not be printed because the structure is flimsy however, this gave us a basis for modifications for our next models.

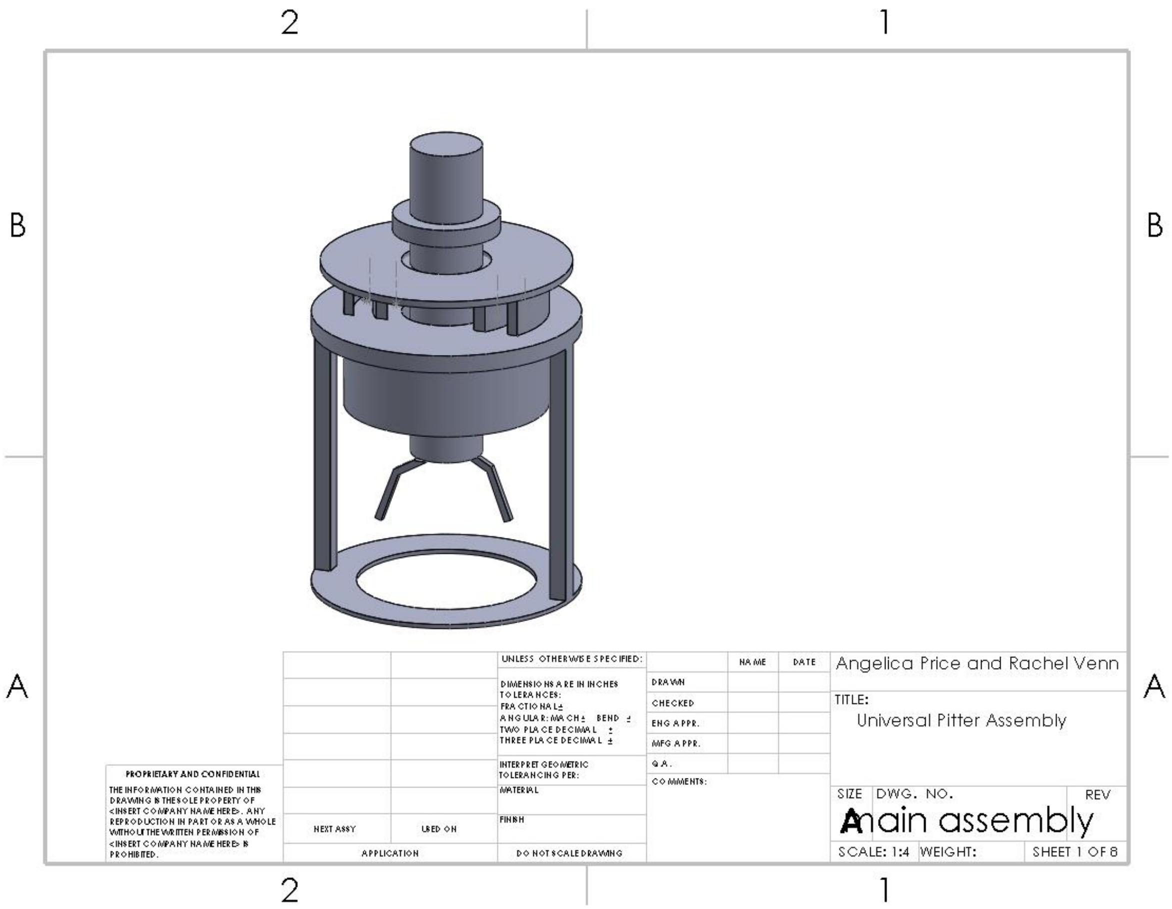


Figure 9 Complete Assembly

3.2 PARTS LIST

Table 2 Parts List with source - This version of our parts list we ended up buying parts and adhesives later on to assemble our prototype.

Part	Model Number	Source Model	Quantity	Unit Cost
HIPS 3D PRINTER FILAMENT	3mm (2.85mm) HIPS filament	http://gizmodorks.com/hips-3d-printer-filament/	1	$24.95/1kg
Springs	1986K63	http://www.mcmaster.com/#1986k63/=14hi6la	4	$0.83/spring
Springs	1986K64	http://www.mcmaster.com/#1986K64	4	$0.83/spring

Table 3 Parts list to be 3D printed - For our purposes this was necessary to keep track of what parts needed to be printed or reprinted.

Parts that will be made using HIPS 3D Printer Filament:	
QUANTITY: 1	OUTER BODY
1	SHAFT BODY
1	CLAW BODY
1	CYLINDER RING
4	PRONGS

3.3 DRAFT DETAIL DRAWINGS FOR EACH MANUFACTURED PART

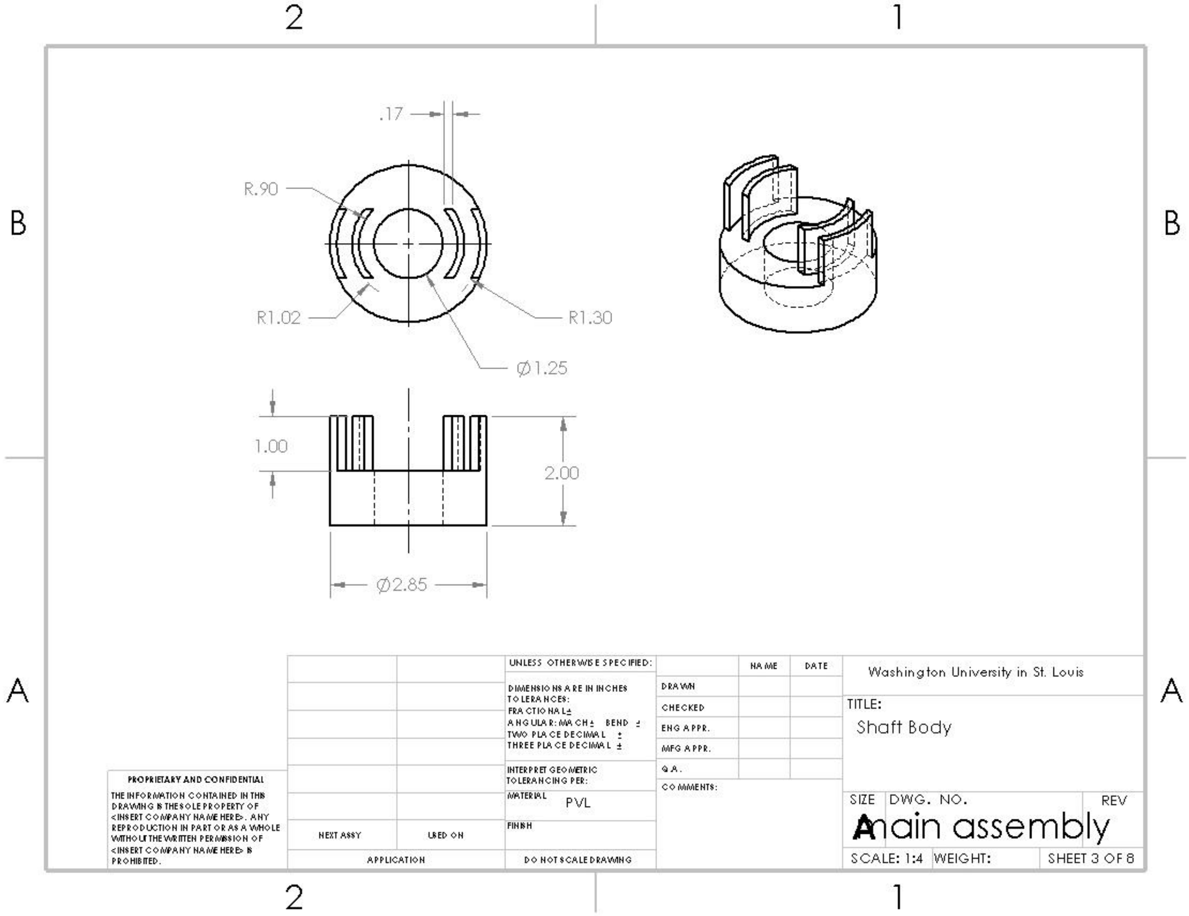


Figure 10 Shaft body part - this part was modified and the new version is shown later on in the report.

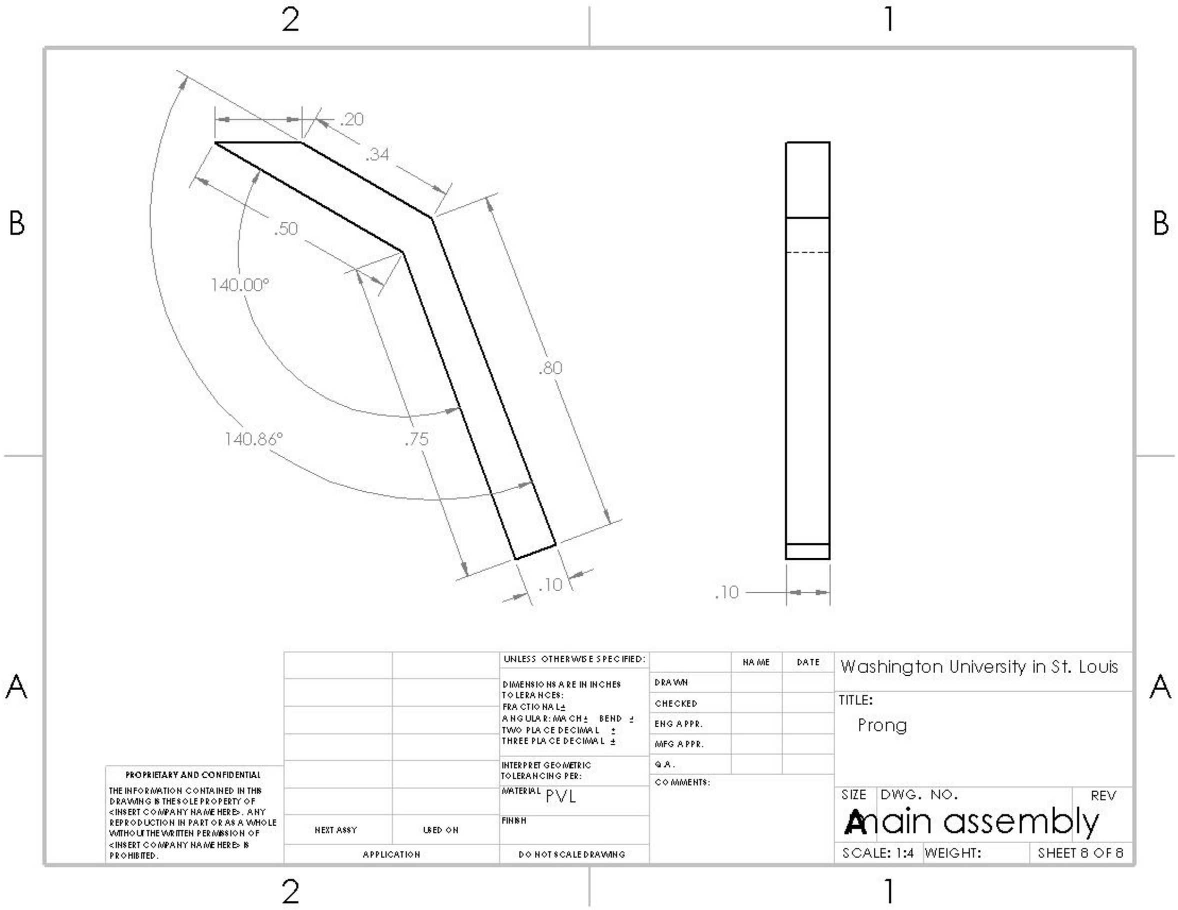


Figure 11 Prong - this part was modified and the new version is shown later on in the report

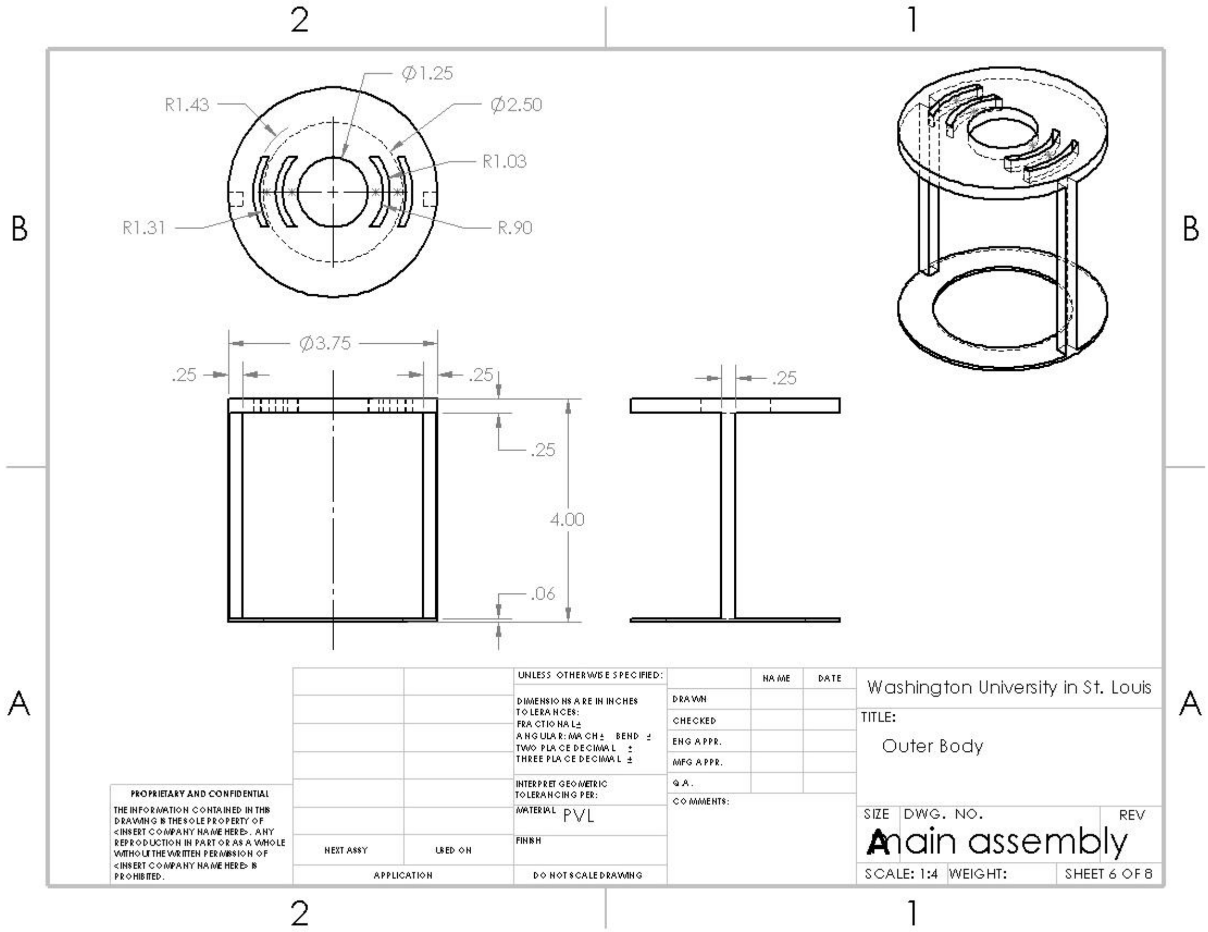


Figure 12 Outer Body - this part was modified and the new version is shown later on in the report

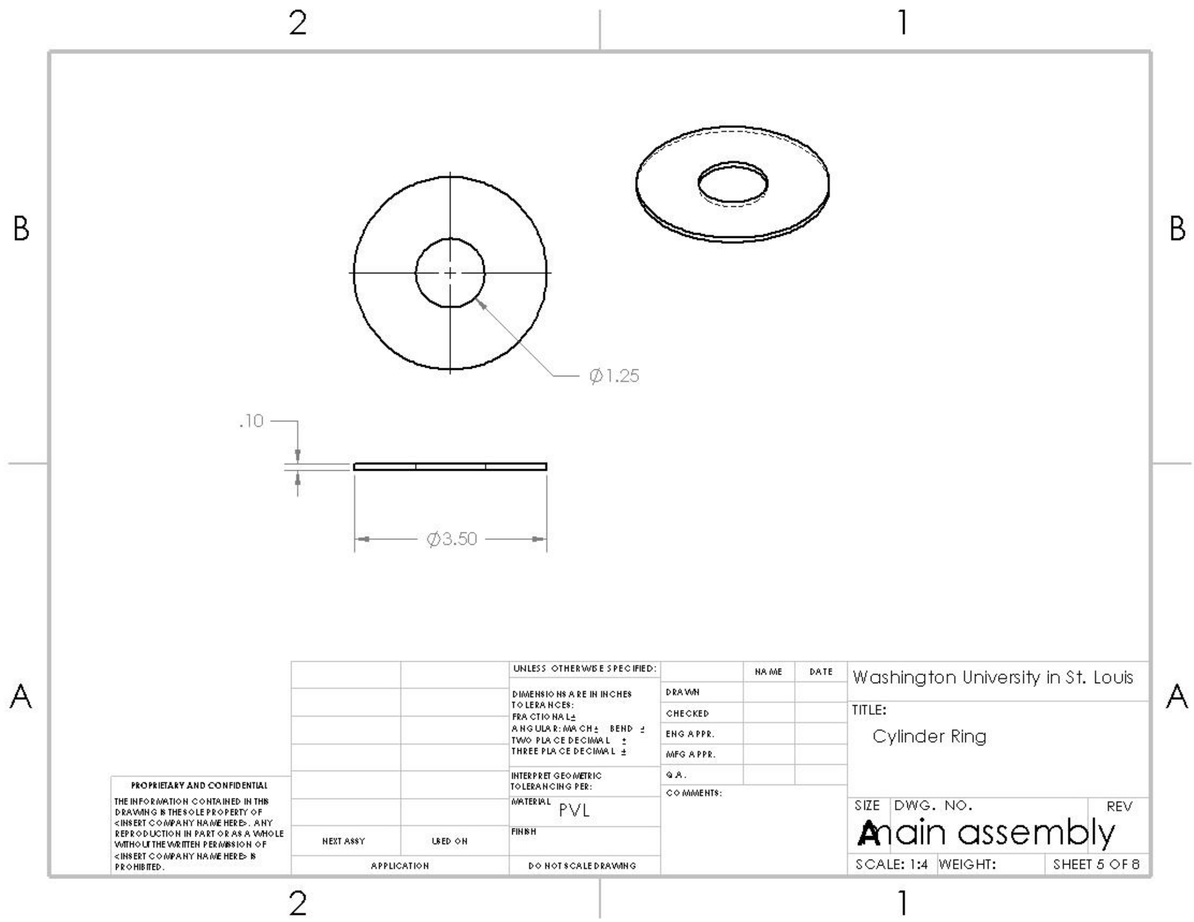


Figure 13 Cylinder Ring - this part was modified and the new version is shown later on in the report

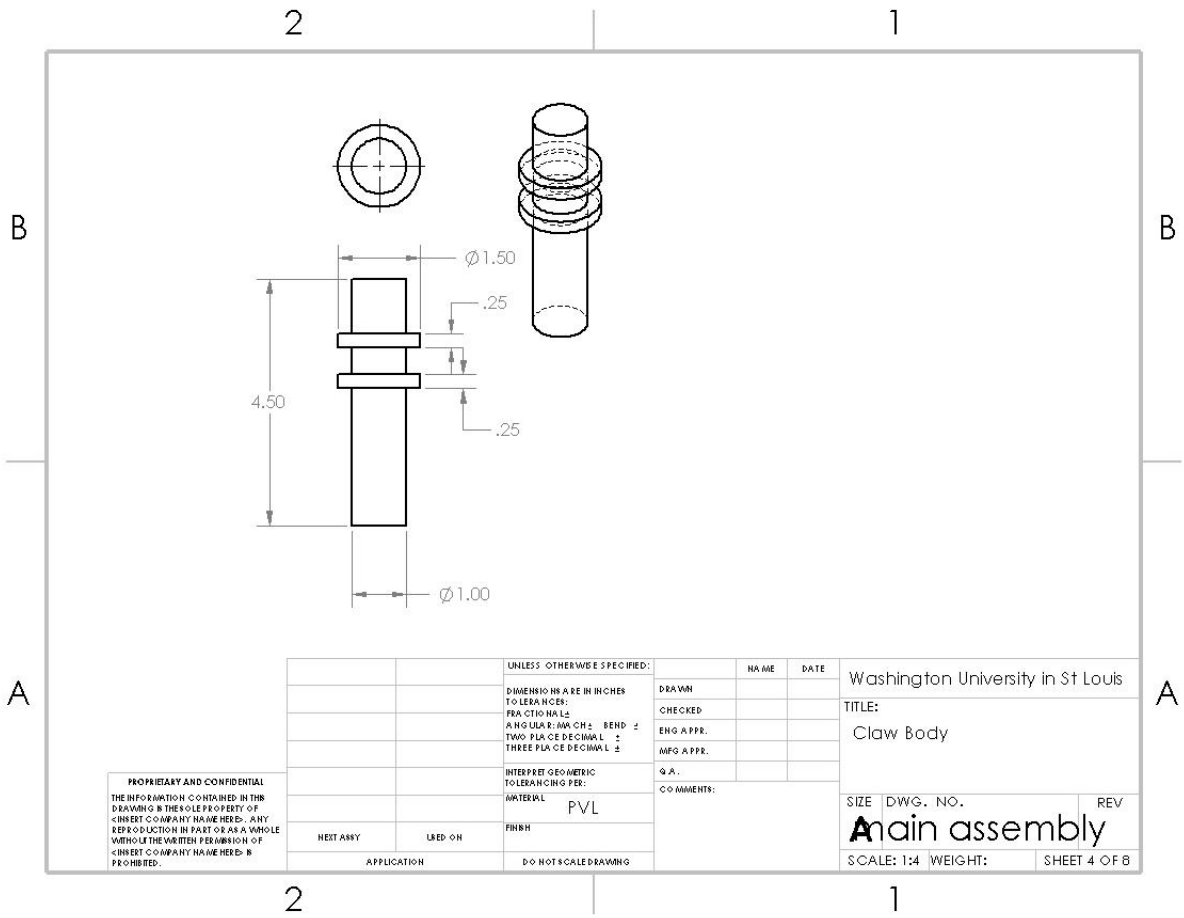


Figure 14 Claw Body - this part was modified and the new version is shown later on in the report

3.4 PARTS LIST

Table 4 List of parts for a cost accounting worksheet – This parts list is more accurate and what we used when assembling our prototype

Part	Model Number	Source Model	Quantity	Unit Cost
Multi Pack of Springs	30699135547	Home Depot	1	$4.37
Gorilla Glue Proxy	1818179	Micro Center	1	$4.99
Multipurpose Gorilla Glue	52427500045	Home Depot	1	$6.47
Foam Tape	43374022537	Home Depot	2	$2.42
Depth Finder 25' Wide Steel Fish Tape	92644560057	Home Depot	1	$12.24
Middle Hobby Hinge	30699197243	Home Depot	1	$1.98
Stretch and Seal tape	742366006295	Home Depot	2	6.98
			Total	$53.55

Table 5 Parts to be 3D Printed

Parts that will be made using HIPS 3D Printer Filament:	
QUANTITY: 1	OUTER BODY
1	SHAFT BODY
1	CLAW BODY
1	CYLINDER RING
4	PRONGS

3.5 DESCRIPTION OF THE DESIGN RATIONALE FOR THE CHOICE/SIZE/SHAPE OF EACH PART

Assembly is Critical:

Due to pieces having to fit into others, the breakup of the parts was a crucial part in our design. Though some pieces would have been easier to be made into one piece, they had to be split apart to correctly fit together.

Critical Spacing In between Parts:

The motion of extracting the pit, requires a chain reaction between the parts and the spacing between them needs to be perfect in order for the extracting prongs to work together.

DESIGN RATIONAL BY PART NUMBER

1. **Outer Body:**

   The outer body is designed to sit on top of the fruit, so that the extracting prongs are the correct distance from an average pit. The top portion has slits in it that allow the Shaft Body to be assembled. The sides that connect to the top portion of the body are designed to orient the user so that the prongs are oriented towards the smaller diameter of the pit.

2. **Shaft Body:**

   Creates friction between the prongs and causes them to bend inward and close around the pit.

3. **Claw Body:**

   This is where the prongs are attached to. The top part also creates a button for the user to push down and extract the pit.

4. **Spring:**

   The springs allow the chain reaction movements to return to their original position after extracting the pit. The springs provide an upwards force once the pit has been grabbed to reverse the motion.

5. **Cylinder Ring:**

   After the Shaft Body is inserted into the Outer Body, the Ring can be attached to the Shaft Body to create the force with the springs and remove the possibility of the Shaft body falling off.

6. **Prongs:**

   These prongs are made so that when the chain reaction happens, the prongs will be forced to close around the pit at a 45-degree angle from the face of the fruit. The angle was chosen from experimental measurement of the side of the fruit that would best fit the pit. The prongs are also small, and only pierce the fruit without causing damage.

3.6 GANTT CHART

Gantt Chart - Pitter.xlsx

4 ENGINEERING ANALYSIS

4.1 ENGINEERING ANALYSIS PROPOSAL

4.1.1 A form, signed by your section instructor

Discussed in recitation.

4.2 ENGINEERING ANALYSIS RESULTS

4.2.1 Motivation

The analysis of the prongs when they fail is the most important thing to study at this time because the prongs are central to our design and if they fail, the design will not work and is ruined. The prongs are attached in such a way with this prototype that they cannot be easily replaced. The prongs also must be able to withstand cyclic loading.

During our prototype production and assembly, we needed to mold our prongs from strips of fish tape which is thin tempered steel. This steel is flexible enough to bend during our extraction motion but rigid enough to sustain repetitive use. The prongs are critical to our design because they are what extract the pit which is the purpose of our prototype. They are also the only piece of our hardware that sustains what we define as critical cyclic loading.

The prong design is the crux of our project. If this material does not prove to sustain critical cyclic loading, then we need to use a different material.

4.2.2 Summary statement of analysis done

In this graphic below we see where the most load is being placed if the pressure is normal to the outer surface of the prongs. This does not happen but because there is the most stress at the corner of the prongs we have decided to anneal the prongs at that location to make them stronger to be able to sustain our critical cyclic loading.

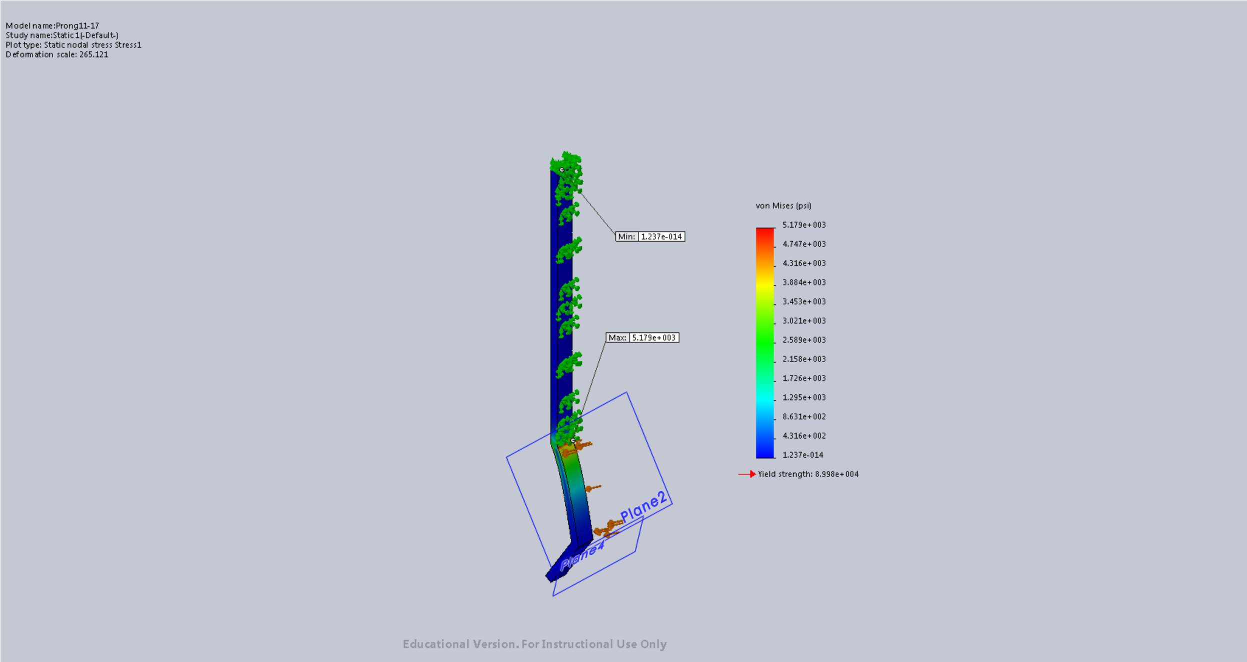


Figure 15 SolidWorks Static Simulation of the prongs

Prong11-17 with static study-Static 1.

4.2.3 Methodology

We could create a SolidWorks drawing of our prongs and use a SolidWorks simulation to show static loading. An ideal simulation of our prong loading. In this scenario, the top and side that would be against the wall of the center shaft is fixed. In our ideal simulation, a pressure force is placed along the whole surface normal to the surface of the prong.

During the assembly of our prototype, we decided to experiment on the design of the prongs based off how to attach our prongs to the inside of the center shaft. We found that filling the center with silicon provided spring between the prongs since silicon is not very rigid compared to another filling material such as concrete which would also be impractical. From this knowledge, we did not have to create a 90-degree angle at the top of the prong to secure them in the center shaft. We found that if the prongs were bent to a 90-degree angle the material would fracture and consequently break completely apart at the bend. From this information, we found that a 45-degree angle would best suit our purposes at the end of the prongs and a 30-degree angle outward from the inner shaft. Our manual testing and experimentation was done through trial and error therefore, no experimentation “rig” was required.

4.2.4 Results

From this simulation, we are able to see that the yield strength of the prongs is 8.998 PSI and the stress is concentrated at the angle outward from the inner shaft. We expected this since that is where the most bending happens during our critical cyclic loading. We do not expect our prongs to fail based off these results.

4.2.5 Significance

We decided to redesign the prongs to the 30 and 45-degree configuration and decided to secure the prongs in the inner shaft by filling the tube with silicon. We also modified our design prior to printing to enclose our mechanism and make the design rigid.
Through experimental and manual analysis, we could cut our prongs to fit inside the inner shaft, bend them to our specified angles and anneal the corners. We also found that the prong configuration we created during our manual experimentation was sufficient to take out an avocado pit so therefore our choice of annealed steel was correct. The material of the prongs was not changed.

Shown below are the design modification changes.

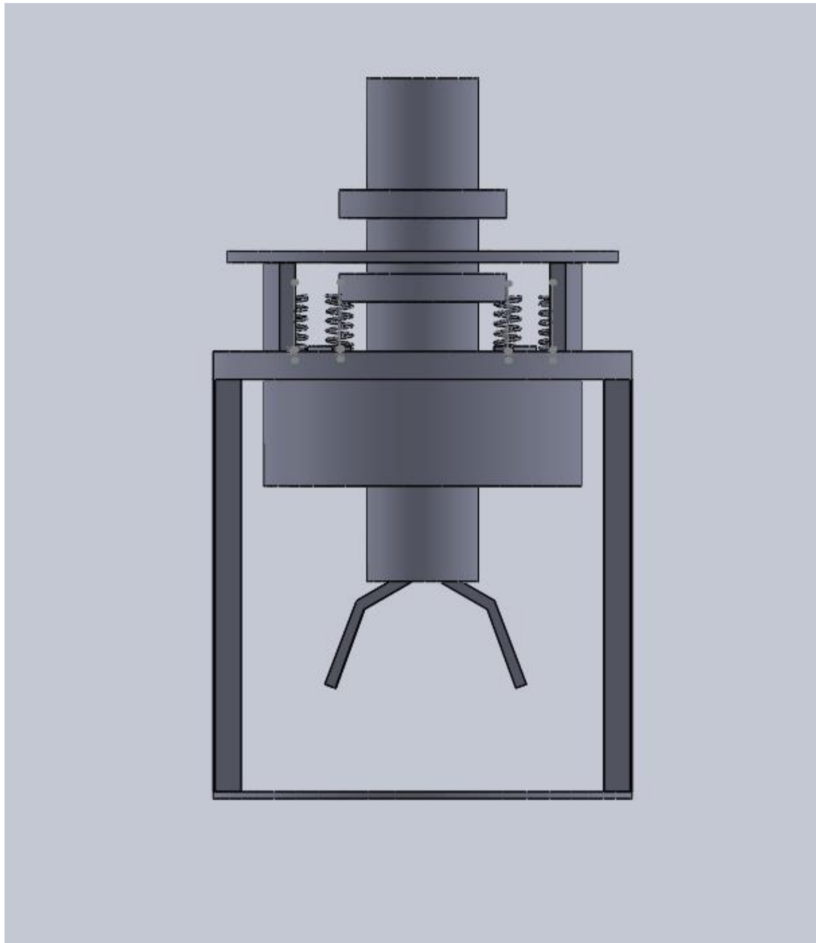


Figure 16 Before Prototype Assembled View

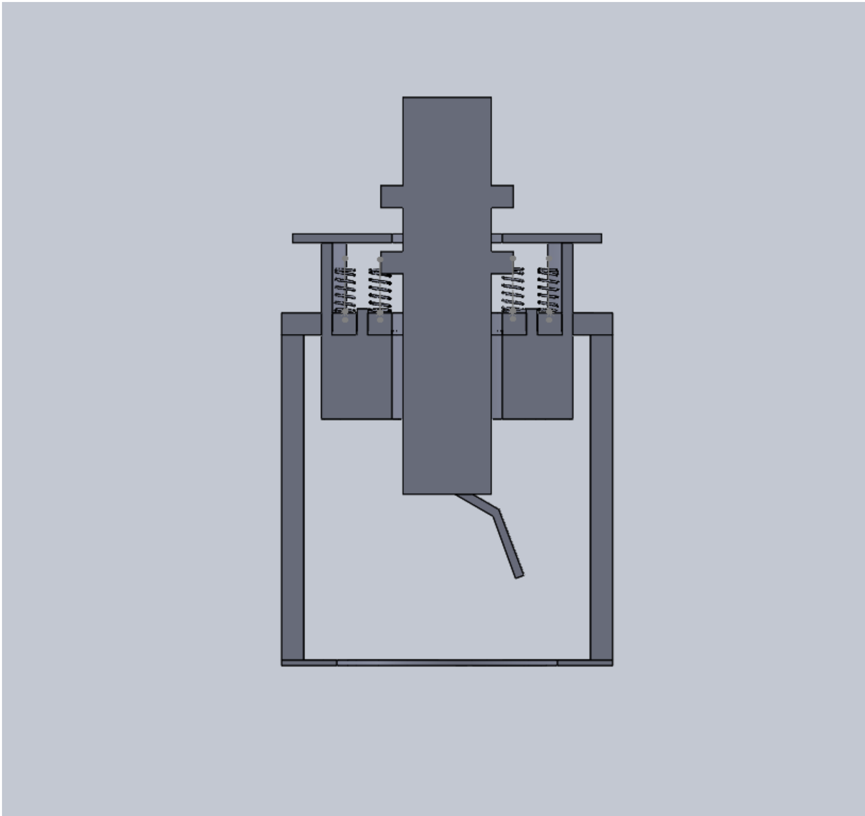


Figure 17 Before Prototype Section Cut View

Figure 18 After Prototype Assembled View

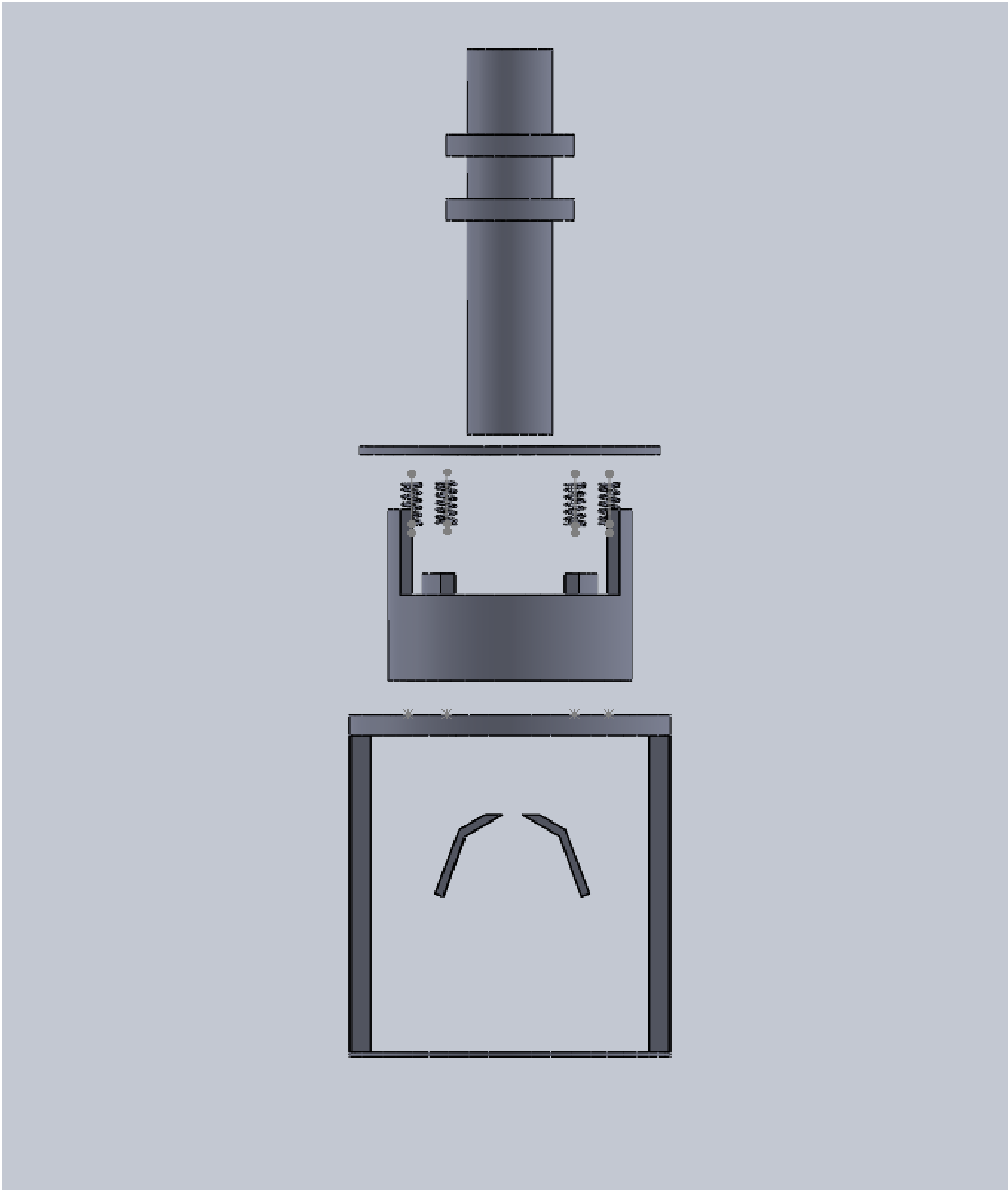


Figure 19 Before Exploded View of Assembled Prototype

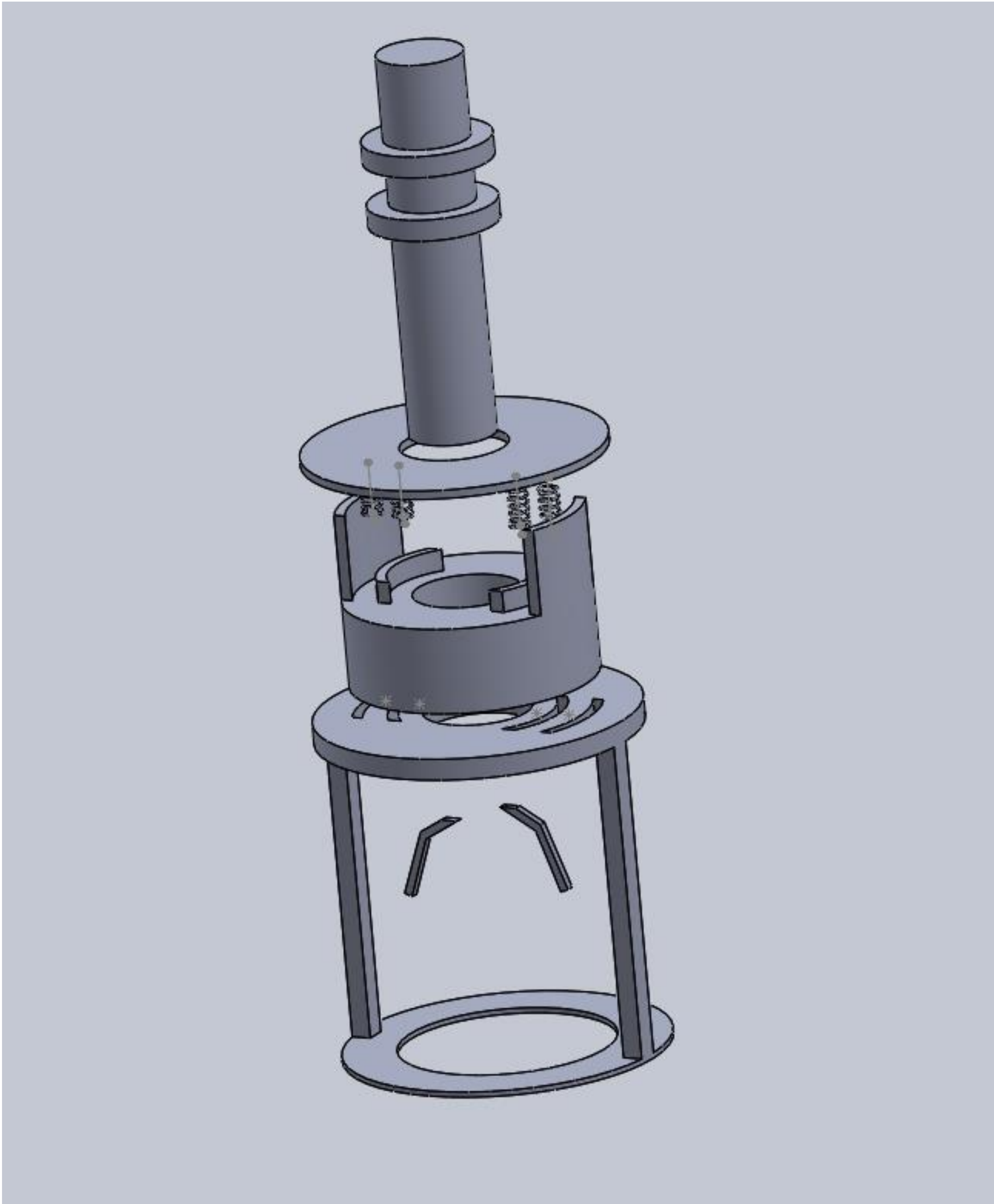


Figure 20 Before Exploded View of Assembled Prototype (Diametric)

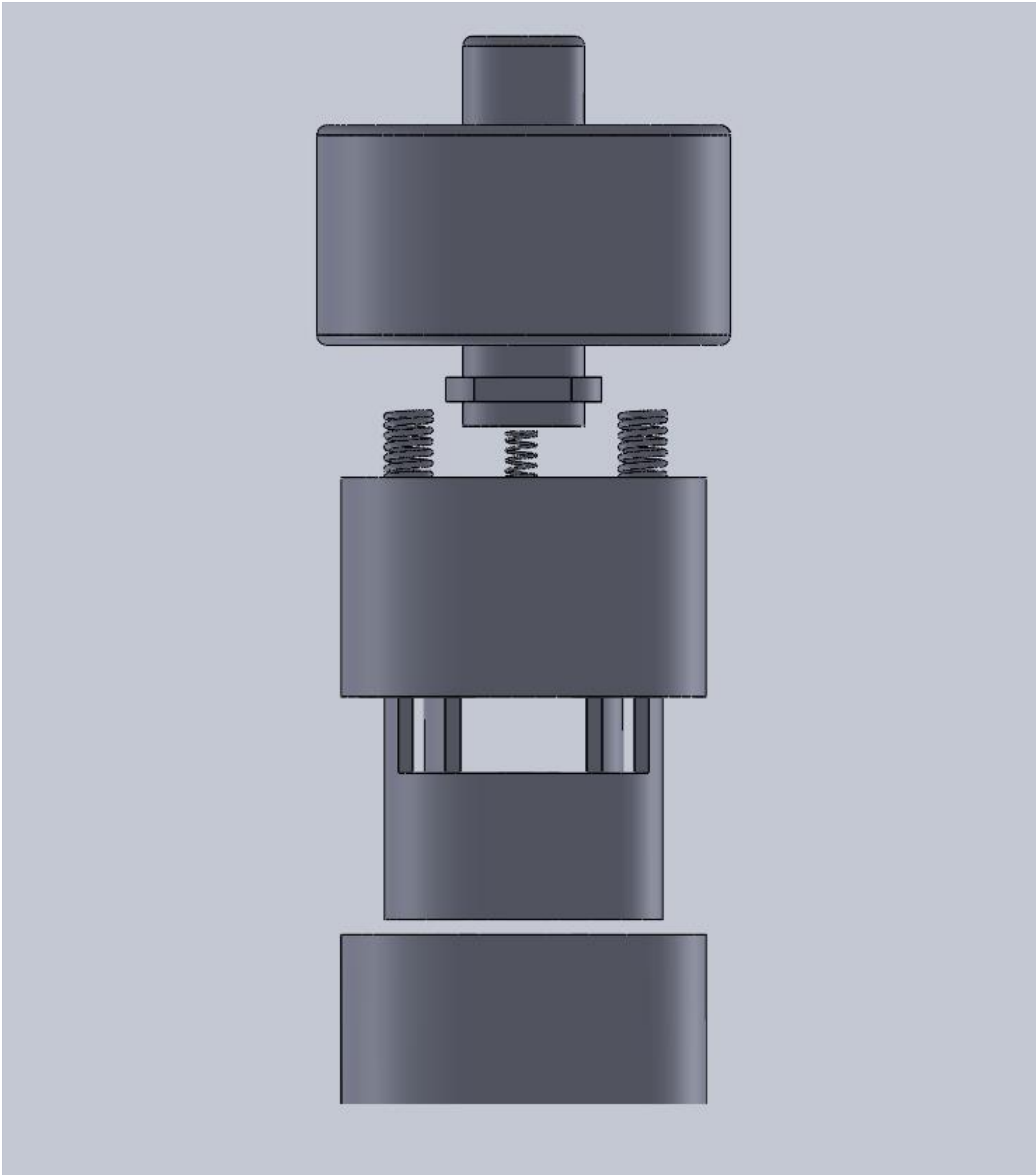


Figure 21 After Exploded View of Prototype

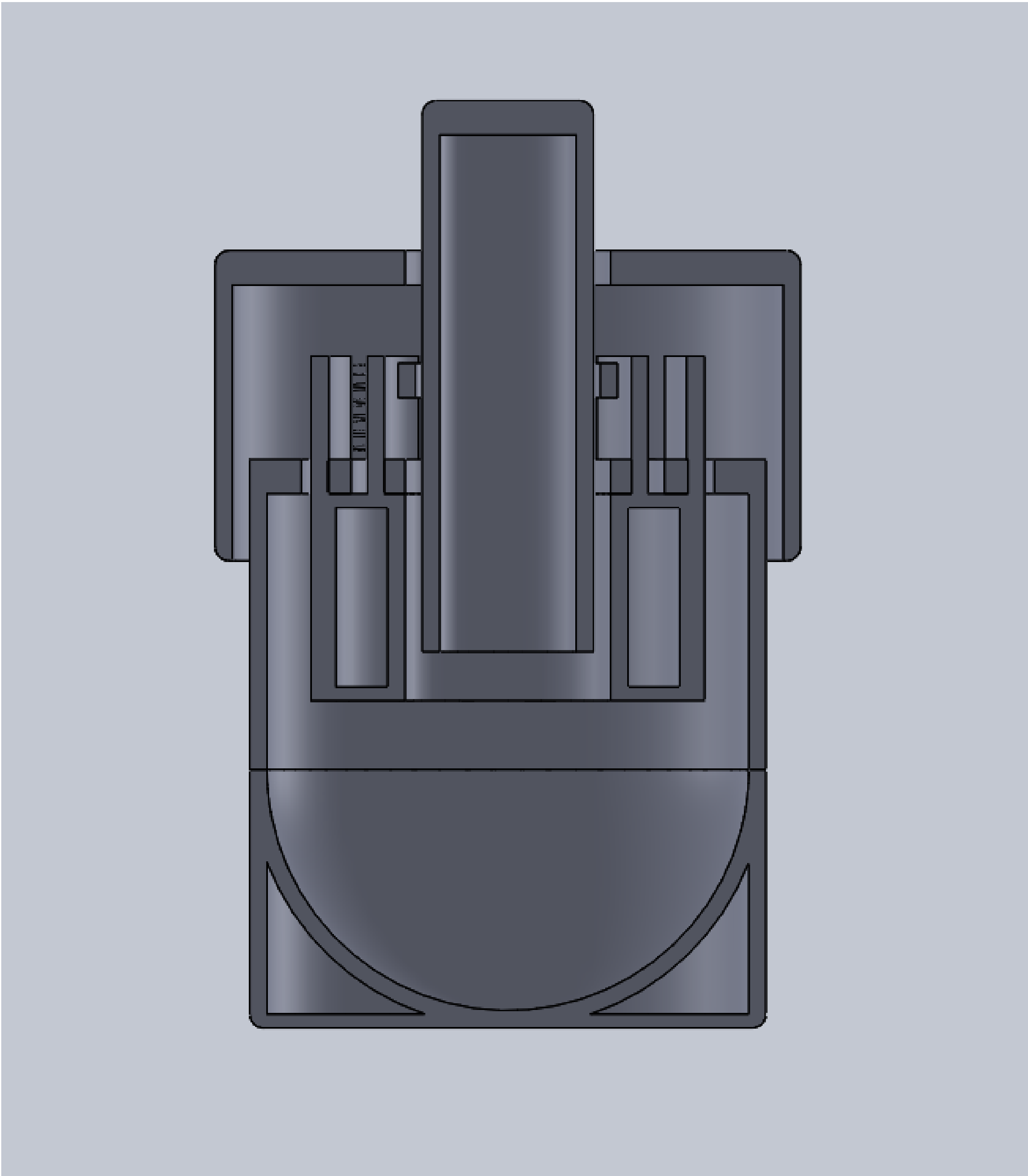


Figure 22 After Section Cut view of prototype

4.2.6 Summary of code and standards and their influence

For our materials, we have kept to silicon, PLA (3D printing material) and steel for the springs and prongs. These materials are within the codes and standards we chose dealing with food safe material for a kitchen gadget.

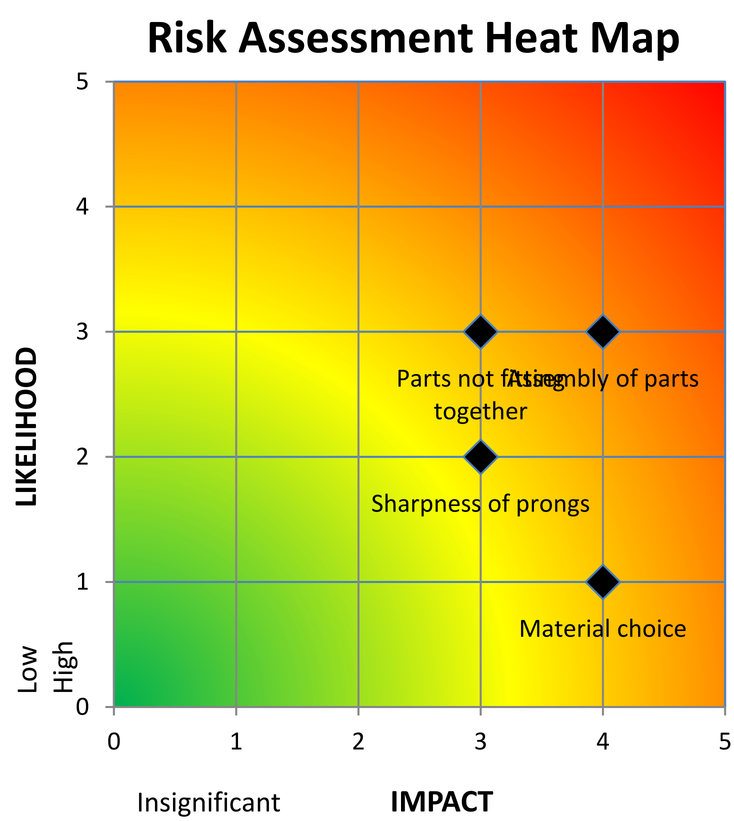
4.3 RISK ASSESSMENT

4.3.1 Risk Identification

RiskAssessmentTool
_withHeatMap.xlsm

4.3.2 Risk Impact or Consequence Assessment

The Risk Identification Tool allowed us to create this heat map to show the impact and consequences of our identified risks.



4.3.3 Risk Prioritization

The risks were prioritized based on the results of the heat map. We felt the impact was most import because even though the risk was possible, its occurrence would be detrimental to the use of the pitter.

The risks identified also have a cascading effect, if the highest risk is not successful the next risk won't wither. Therefore, we prioritized our risks in the follow manner from greatest risk to smallest.

1. **Assembly of Parts**- If the parts are not designed to assemble correctly the pitter can not work.
2. **Material Choice**- The material must be durable enough to withstand multiple tests and be food safe.
3. **Parts Not Fitting Together**- Tolerances must be accurate so that the mechanics of the pitter can function.
4. **Sharpness of Prongs**- If the prongs are sharp they can potentially harm the user. Though the pitter could still be used, it is not favorable to hurt the user.

5 WORKING PROTOTYPE

5.1 A PRELIMINARY DEMONSTRATION OF THE WORKING PROTOTYPE

Not Applicable

5.2 A FINAL DEMONSTRATION OF THE WORKING PROTOTYPE

https://www.youtube.com/watch?v=F1iEm8DGJSY

5.3 AT LEAST TWO DIGITAL PHOTOGRAPHS SHOWING THE PROTOTYPE

Figure 23 Prototype Model - Closed

Figure 24 Prototype Model - Open

5.4 A SHORT VIDEOCLIP THAT SHOWS THE FINAL PROTOTYPE PERFORMING

https://www.youtube.com/watch?v=F1iEm8DGJSY

5.5 AT LEAST 4 ADDITIONAL DIGITAL PHOTOGRAPHS AND THEIR EXPLANATIONS

Figure 25 A Picture of our prototype open showing how there is a hinge holding the pitter to the bowl where the fruit will be placed. This picture also shows the inner workings and how there are no sharp edges which makes our product easy and safe to use.

Figure 26 An avocado being placed in the bowl to show that our bowl is universal for even fruit that is in season. At the time this picture was taken, no peaches, plums or nectarines are in season.

Figure 27 This picture shows how our pitter mechanism is being placed around the avocado pit. The device closes on top of the fruit without damaging it and extracting the pit.

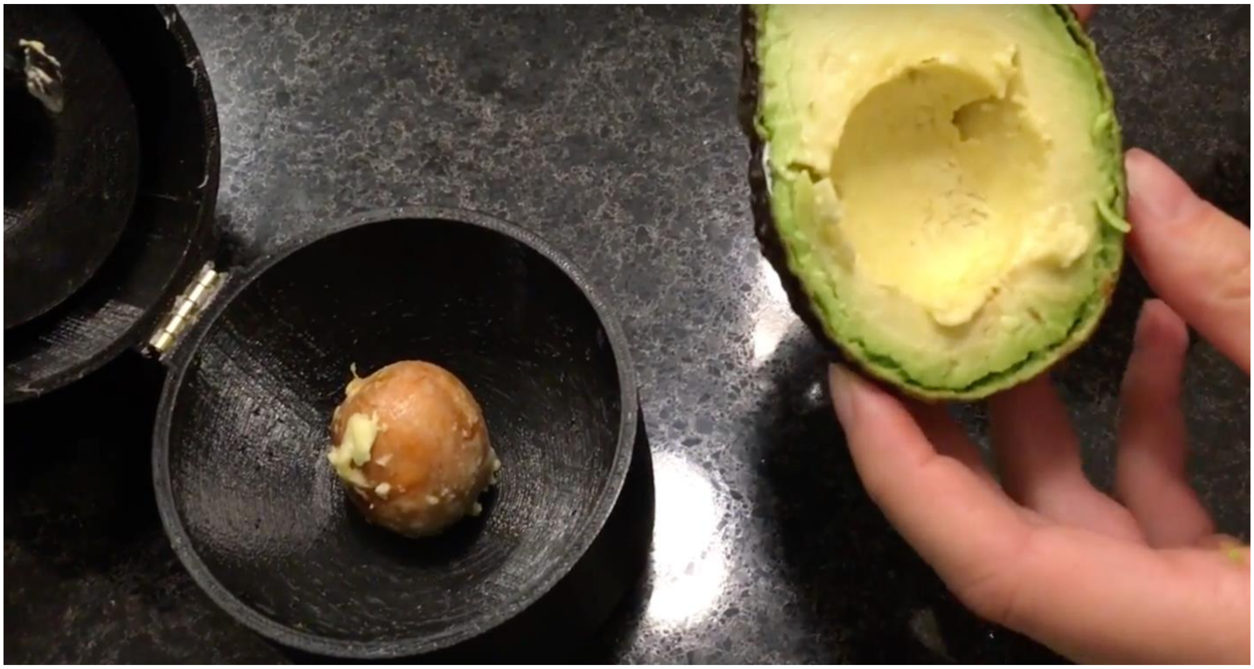


Figure 28 This picture shows an avocado that our pitter extracted the pit from. This image also shows how there was minimal damage to the fruit and minimal fruit left on the pit. This pitter design had been modified to accommodate fruit that was in season: hence the avocado.

6 DESIGN DOCUMENTATION

6.1 FINAL DRAWINGS AND DOCUMENTATION

6.1.1 Engineering drawings

See Appendix C for the CAD models.

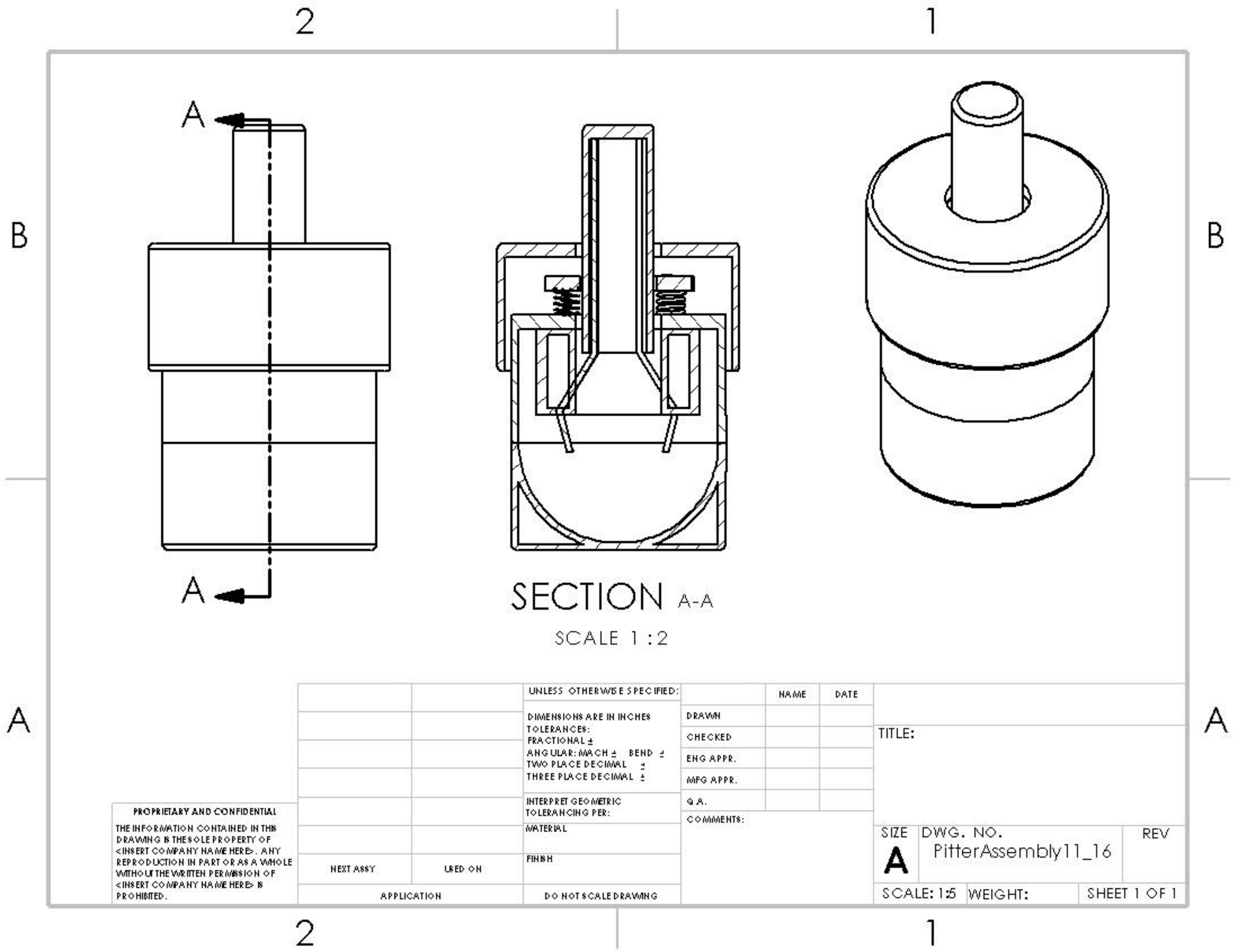


Figure 29 Assembled View of revised design

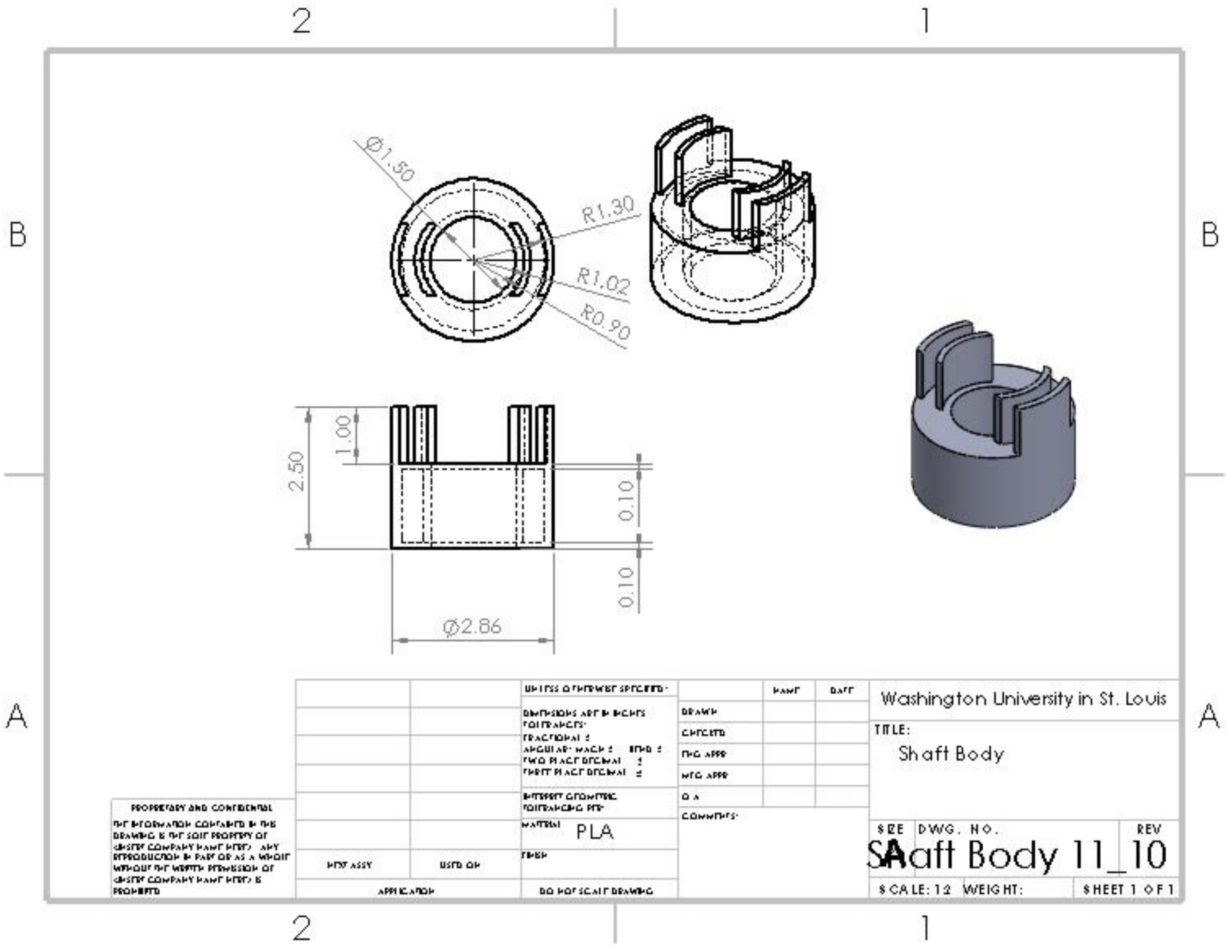


Figure 30 Shaft Body Revised Drawing

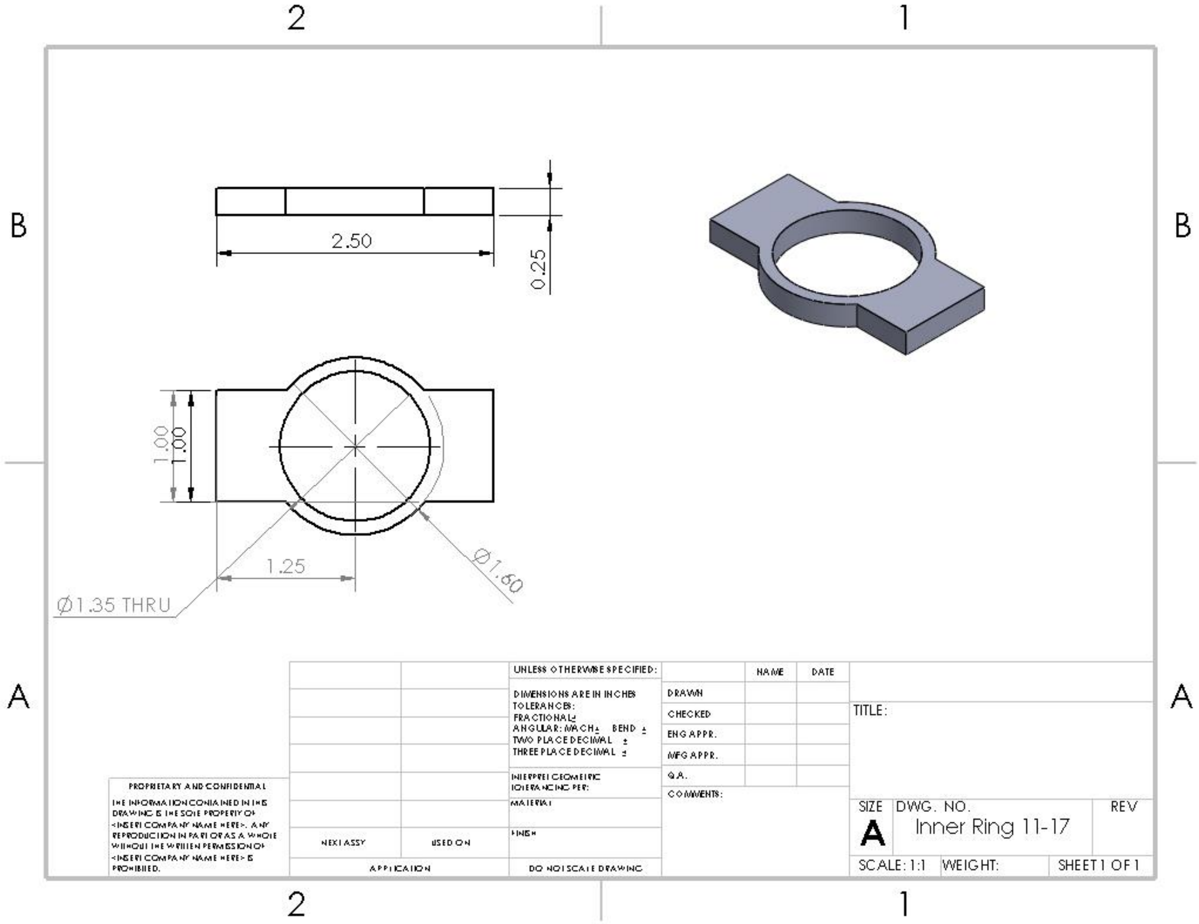


Figure 31 Inner ring Revised Drawing - This part was added to our design to provide stability to our mechanical motion

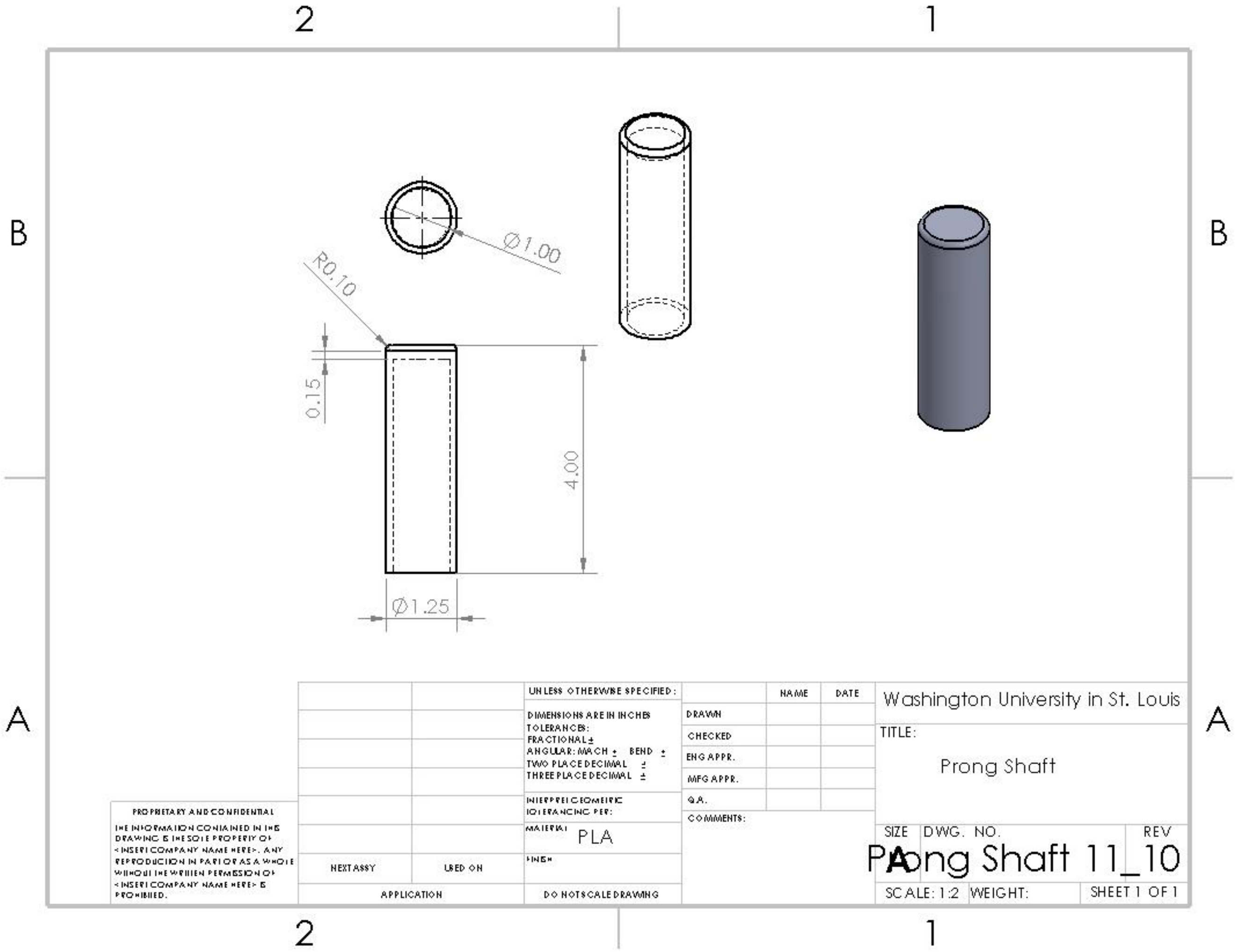


Figure 32 Prong Shaft Revised Model

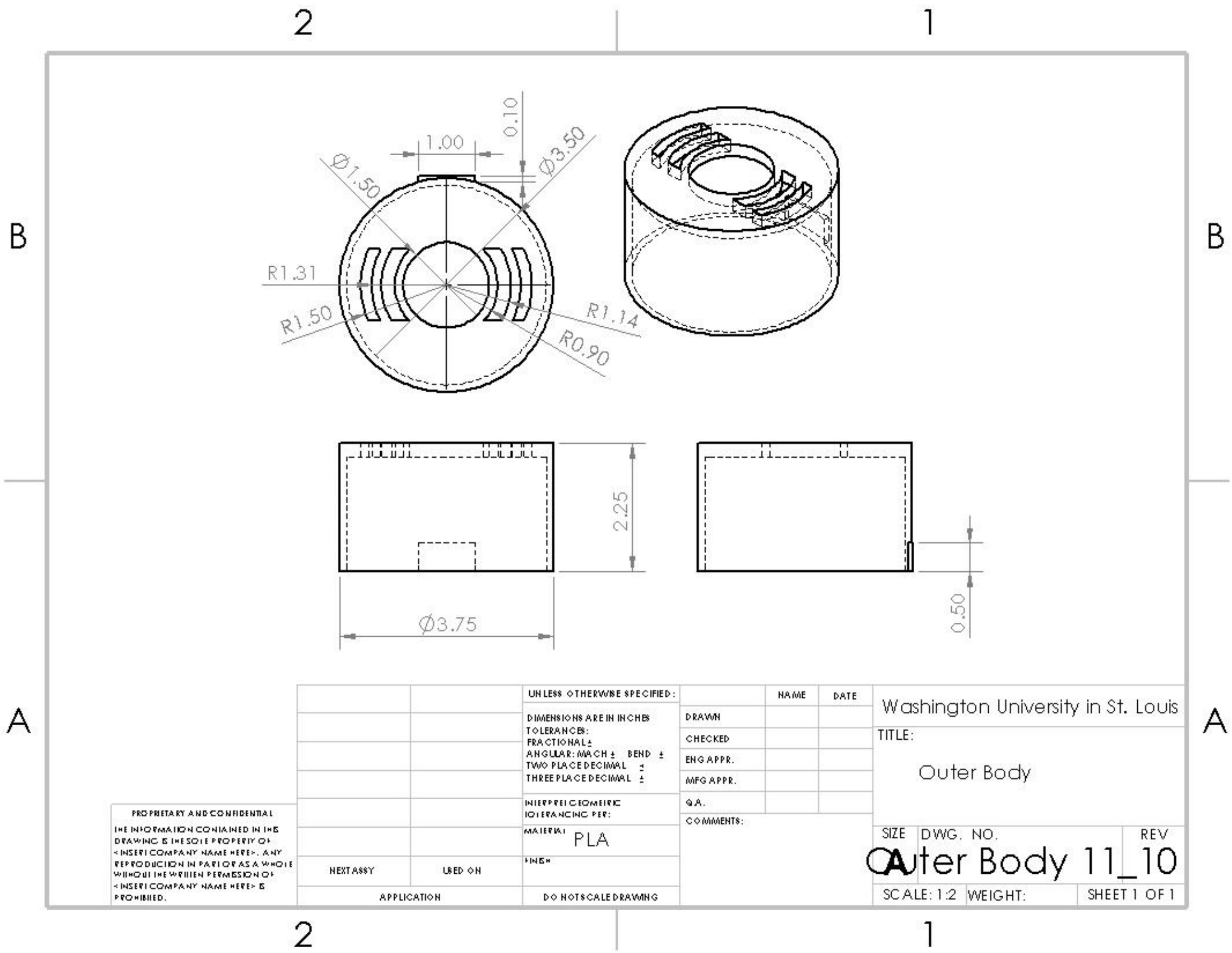


Figure 33 Outer Body Revised Drawing

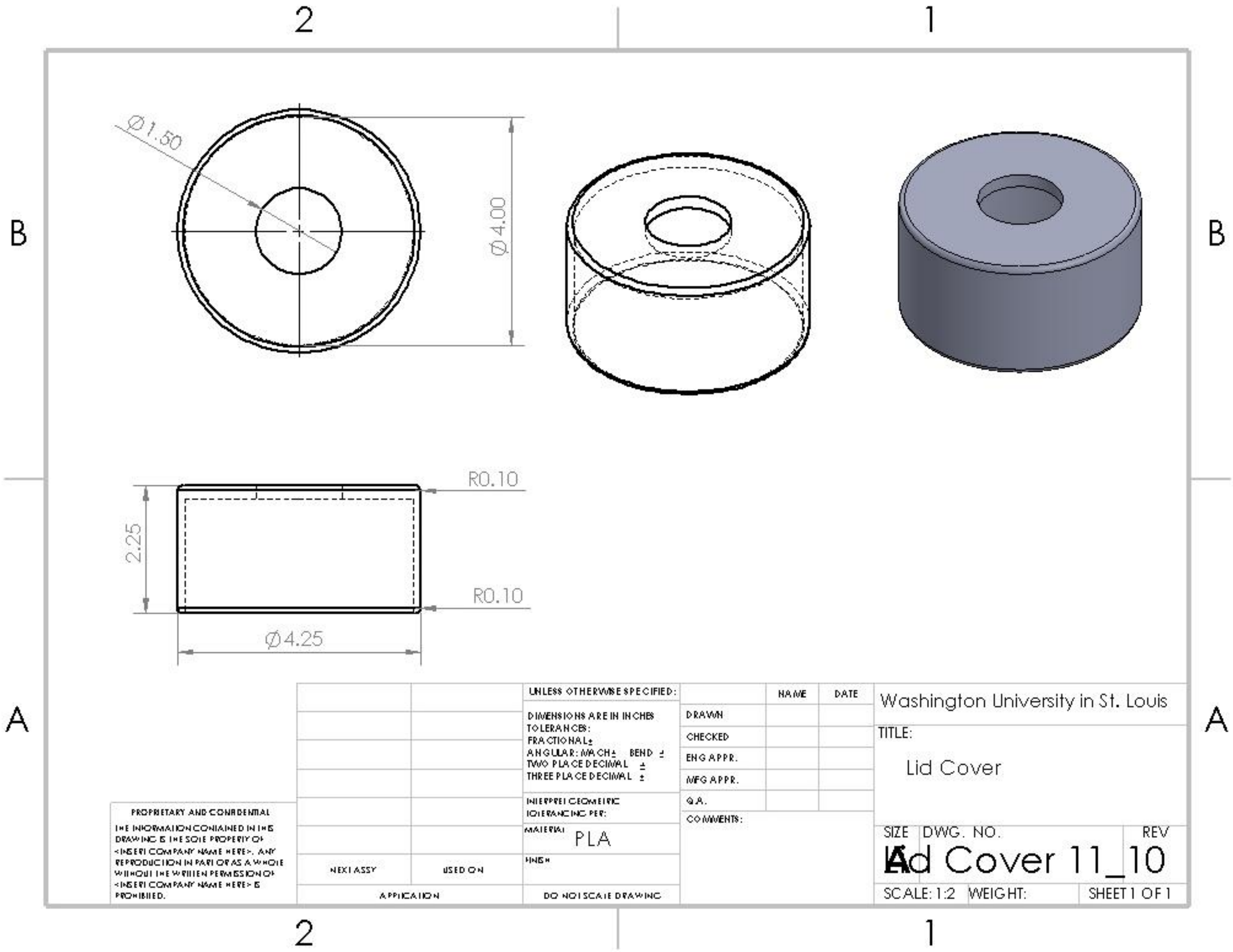


Figure 34 Lid Cover Revised Drawing

6.1.2 Sourcing instructions

6.2 FINAL PRESENTATION

6.2.1 A live presentation in front of the entire class and the instructors

Final
Presentation.pptx

6.2.2 A link to a video clip

https://www.youtube.com/watch?v=F1iEm8DGJSY

6.3 TEARDOWN

Teardown Assignment.pdf

7 DISCUSSION

7.1 USING THE FINAL PROTOTYPE PRODUCED TO OBTAIN VALUES FOR METRICS, EVALUATE THE QUANTIFIED NEEDS EQUATIONS FOR THE DESIGN. HOW WELL WERE THE NEEDS MET? DISCUSS THE RESULT.

We feel that our needs were met from our project prototype because our pitter successfully pitted a variety of fruit that was in season and was able to repeat pitting processes and sustain the cyclic loading. For all intents and purposes, we felt that our project was a success. If we could change one thing about our prototype it would be to be able to screw the top or outer casing on and off to make for easy cleaning. However, we were not able to reprint our pieces before the end of the semester to be able to complete the final phase of printing. However again, our prototype has demonstrated that it works within our standards and design metrics.

7.2 DISCUSS ANY SIGNIFICANT PARTS SOURCING ISSUES? DID IT MAKE SENSE TO SCROUNGE PARTS? DID ANY VENDOR HAVE AN UNREASONABLY LONG PART DELIVERY TIME? WHAT WOULD BE YOUR RECOMMENDATIONS FOR FUTURE PROJECTS?

We could find our parts at Home Depot which is very accessible because it is so close to campus. There was a bit of a struggle to get printing time because of the demand. We found that there was a significant spike in demand about a week before prototype demonstrations were to begin. We thought that a sign-up sheet would be helpful and prioritizing groups that have an earlier slot for prototype demonstrations. We were one of the first groups to go on our demonstration and seemed to get pushed to the bottom of the priority list when it came to printing.

7.3 DISCUSS THE OVERALL EXPERIENCE:

7.3.1 Was the project more of less difficult than you had expected?

Yes. We began the project very ambitious to make our project rigorous but because the entire engineering process was scaled into a semester, we decided to simplify our design and neglect using Arduino and make our project completely mechanical.

7.3.2 Does your final project result align with the project description?

Yes, we wanted to create a universal pitter to extract the pits of various fruits like peaches, nectarines and plums with minimal damage to the fruit. We manage to pit an abundance of avocados (the fruits that were in season) with minimal damage to the fruit as demonstrated in our prototype video clip and throughout the pictures in the above sections.

7.3.3 Did your team function well as a group?

We struggled with communication around the prototype demonstration, but it was resolved because we had a solid friendship prior to the project. We used Google Drive and text messaging to communicate and share work. Angelica Price arranged our folders in the Google Drive which made it helpful and easy to find things. Rachel Venn assembled the report, kept the files organized within the Google Drive and came up with a labeling method that included the title of the report and the date that it was last modified. This method was used to communicate the most recent file of the report and to not delete previous versions as backups.

7.3.4 Were your team member's skills complementary?

Yes, Angelica Price showed great skill with drawing our designs. Rachel helped modify the designs and create a SolidWorks Static simulation.

7.3.5 Did your team share the workload equally?

In the end, we feel that the work load was even.

7.3.6 Was any needed skill missing from the group?

If we had gone through with adding Arduino to automate the pitting process it would have been necessary to have someone with Arduino skills. However, this was not necessary.

7.3.7 Did you have to consult with your customer during the process, or did you work to the original design brief?

We did modify our design after multiple discussions and points of interest from recitation for modification design ideas. These proved to be very helpful and overall, helped us simplify our design.

7.3.8 Did the design brief (as provided by the customer) seem to change during the process?

Our design brief did not change throughout the process, our design changed to better fit the design brief and the customer.

7.3.9 Has the project enhanced your design skills?

This project has allowed us to gain engineering design process skills such as planning, scoping, designing and prototyping. We feel that this project was very applicable and allowed us to use our skills that we have learned at this point.

7.3.10 Would you now feel more comfortable accepting a design project assignment at a job?

We feel confident to be able to replicate the process in a larger context because our group was small enough that we could both participate in the entire process.

7.3.11 Are there projects that you would attempt now that you would not attempt before?

Yes, we feel that we can attempt any mechanical design process and can dissect the project. Especially minimizing material used on a project.

8 APPENDIX A - PARTS LIST

Parts that will be made using HIPS 3D Printer Filament:	
QUANTITY: 1	OUTER BODY
1	SHAFT BODY
1	CLAW BODY
1	CYLINDER RING
4	PRONGS

9 APPENDIX B - BILL OF MATERIALS

Part	Model Number	Source Model	Quantity	Unit Cost
Multi Pack of Springs	30699135547	Home Depot	1	$4.37
Gorilla Glue Proxy	1818179	Micro Center	1	$4.99
Multipurpose Gorilla Glue	52427500045	Home Depot	1	$6.47
Foam Tape	43374022537	Home Depot	2	$2.42
Depth Finder 25’ Wide Steel Fish Tape	92644560057	Home Depot	1	$12.24
Middle Hobby Hinge	30699197243	Home Depot	1	$1.98
Stretch and Seal tape	742366006295	Home Depot	2	6.98
			Total	$53.55

10 APPENDIX C - CAD MODELS

FruitHolder11_10.SLDPRT

Inner Ring 11-17.SLDPRT

Lid Cover 11_10.SLDPRT

modeling prupose spring- inner1986K7

modeling purpose Spring-Outer-1986K

Outer Body 11_10.SLDPRT

Prong Shaft 11_10.SLDPRT

Prong11-17.SLDPRT

Shaft Body 11_10.SLDPRT

11 DESIGN REVIEWS

Design Review Presentation #1 rev.

Design Review Presentation #2.ppt

12 ANNOTATED BIBLIOGRAPHY