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Saran Wrap Handling Device

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An innovation for everyday use and every household, the Saran wrap handling machine incorporates a unique rotating mechanism and entirely changes the way you wrap objects from a sandwich to a soup bowl.

MEMS 411 Design Report Title

Saran I

By Adams, Hou & Trinh

Department of Mechanical Engineering and Materials Science

School of Engineering and Applied Science

Washington University in Saint Louis

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1 Introduction

1.1 Project problem statement

Design and manufacture a wrap handling device that facilitates the wrapping process with existing cling wraps (such as Saran wrap) on the market. It should wrap fast and efficiently, and safe for all user ages. Ideally, a good variety of items should be able to fit with this device, including common sandwiches and soup bowls.

1.2 List of team members

Group Name: Saran I – Convenience for everyone

Team members: Andre Adams, Yi-Min Hou & Son Trinh

2 Background Information Study

2.1 A short design brief description that defines and describes the design problem

The goal of this design is to make a working device that greatly facilitates the wrapping experience. The fabrication process shall include wood crafting, metal cutting and other similar procedures practical for on campus facilities. The estimated manufacturing period is around 3 weeks and the estimated budget is at US$ 300 maximum.

2.2 Summary of relevant background information (such as similar existing devices or patents, patent numbers, URL's, et cetera)

Food Tray Wrapping Machine:

https://www.youtube.com/watch?v=o8mEYxRE-90

The CutCut Invention:

https://www.youtube.com/watch?v=9XTSyfzsBVs

Speedwrap Dispensers:

https://www.youtube.com/watch?v=zgvqHawpzR8

3 Concept Design and Specification

3.1 User needs, metrics, and quantified needs equations. This will include three main parts:

3.1.1 Record of the user needs interview

Saran Wrap Handling Device (SWHD) Customer: Dr. Jakiela, Dr. Malast Address: Washington University Date: Sept. 11th, 2015			
Question	Customer Statement	Interpreted Need	Importance
What is the ideal size?	The smaller, the better. Ideally flat. Should fit in a drawer.	SWHD is a little bigger than an average sandwich.	4
Should this device be portable or stationary?	Portable.	SWHD is lightweight and compact.	4
How tight should be item be wrapped?	The tighter, the better. But it should not break.	SWHD holds the item together without leaking/breaking.	5
What items will be placed on the device for wrapping?	Variety, including fruits, sandwiches, hotdogs, etc.	SWHD hosts a variety of shapes.	5
What is a tolerable noise level of this device?	It should be quieter than an electric can opener.	SWHD is quiet.	3
How efficient should this device be?	It should use no more wrap than hand wrapping and shall finish wrapping with one attempt.	Wraps in one attempt. Amount of wrap	4 3
How long is the ideal wrapping time?	Less than 10 seconds.	SWHD wraps within 10 seconds.	4
Do you prefer it to be powered by battery or plug-in?	No preference. Both good.	SWHD has battery or plug-in power.	4
How easy should this device be to be cleaned?	Easy to clean. Or have components that go dirty to be washed in dishwasher.	SWHD can be cleaned in a simple process.	5

What is a fair price of this device?	On average around $40 to $50.	SWHD costs below $50.	5
Is deformation acceptable?	Food item can have certain level of deformation. Less important factor.	SWHD makes low deformation to items.	2
How should the purchased wrap be loaded onto the device?	It is okay to manually load the purchased wrap onto this device.	Minimum manual action required.	3
Are there specific safety concerns/consideration?	It should prevent any cutting and electric shocks to the users.	SWHD will be safe for all ages to use.	5

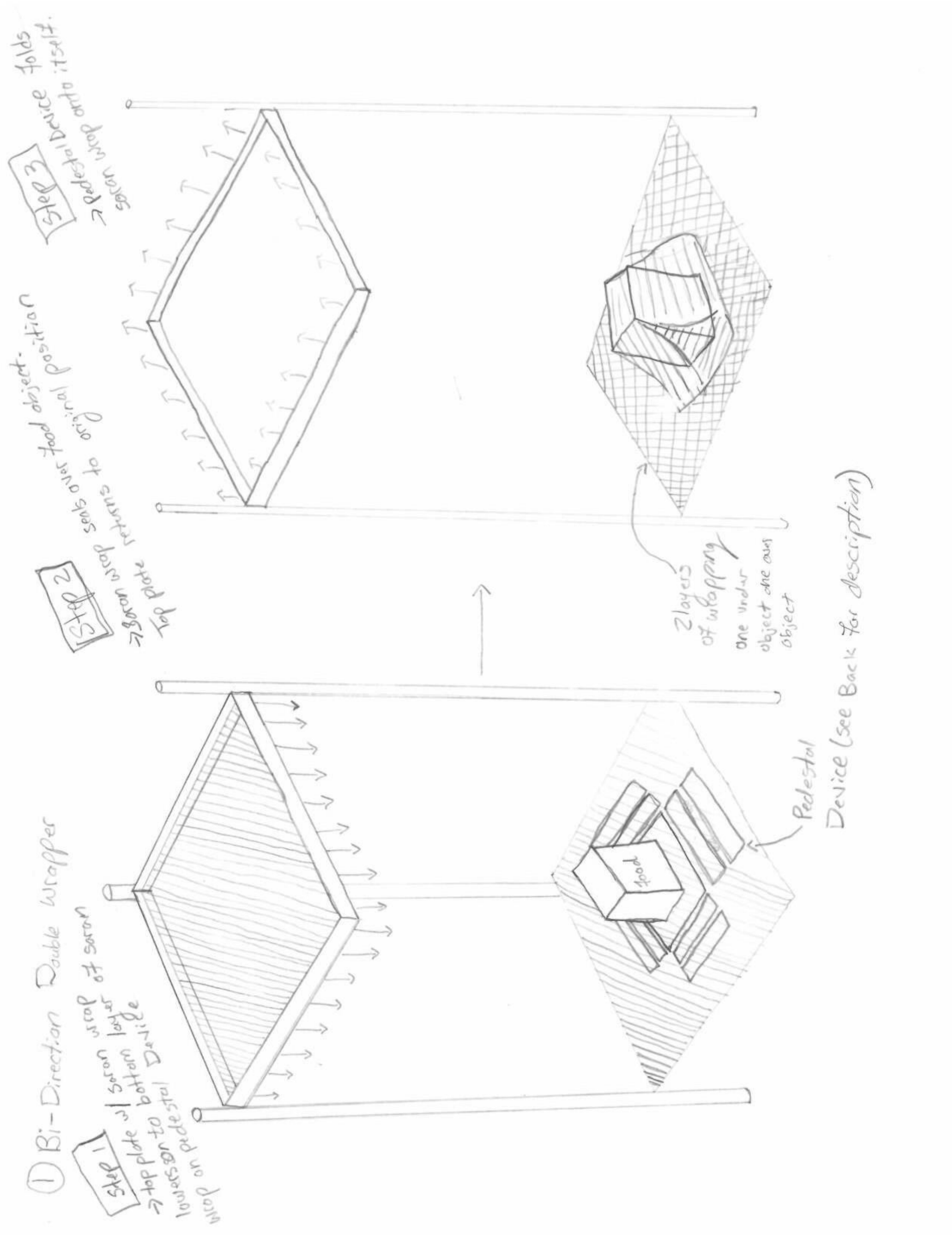
3.1.2 List of identified metrics

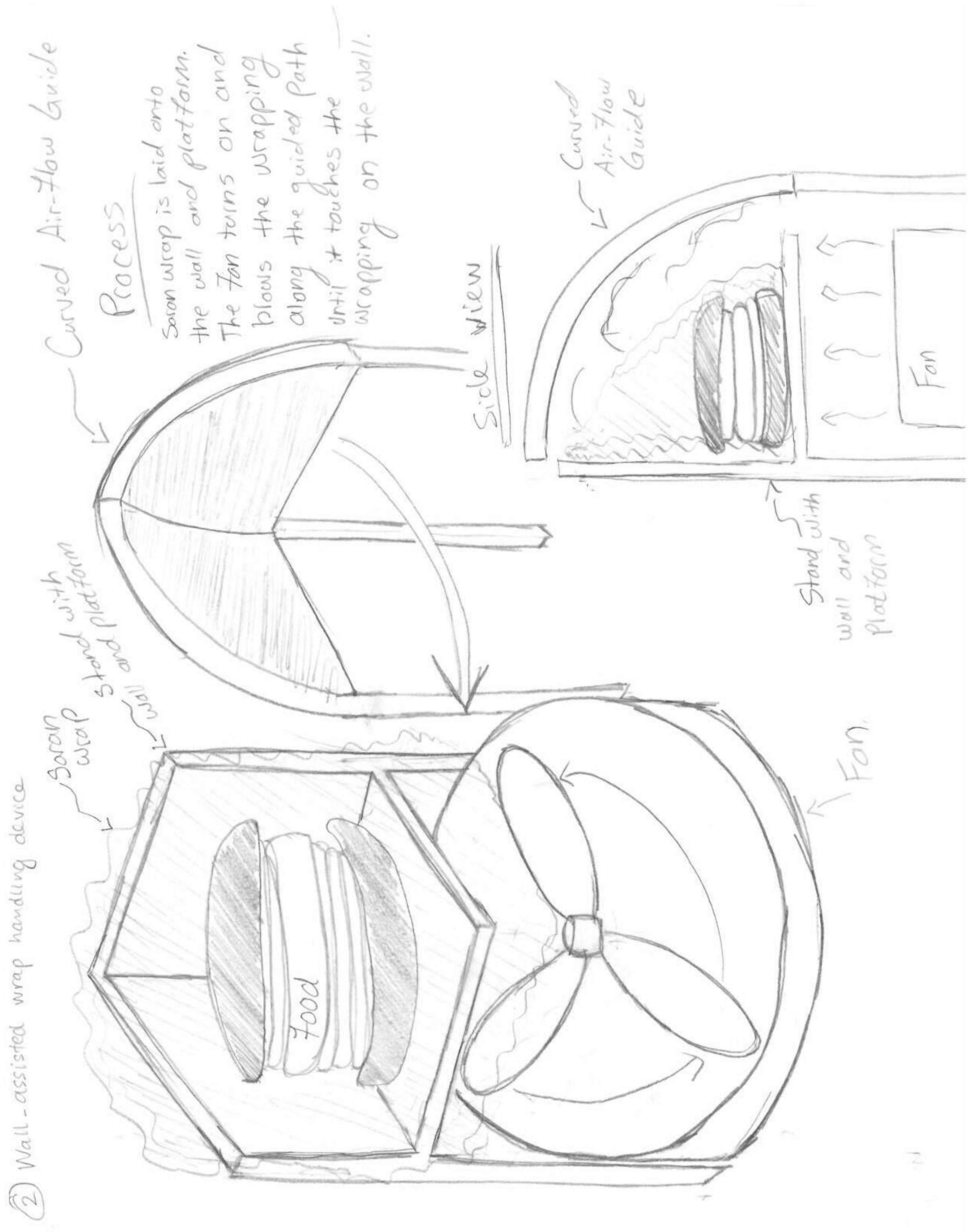
Need Number	Need	Importance
1	SWHD is a little bigger than an average sandwich.	4
2	SWHD is lightweight and compact.	4
3	SWHD holds the item together without leaking/breaking.	5
4	SWHD hosts a variety of shapes.	5
5	Quiet.	3
6	SWHD wraps in one attempt.	4
7	Amount of wrap.	3
8	SWHD wraps within 10 seconds.	4
9	SWHD has battery or plug-in power.	4
10	SWHD can be cleaned in a simple process.	5
11	SWHD costs below $50.	5
12	SWHD makes low deformation to items.	2
13	Minimum manual actions required.	3
14	Safe to use.	5

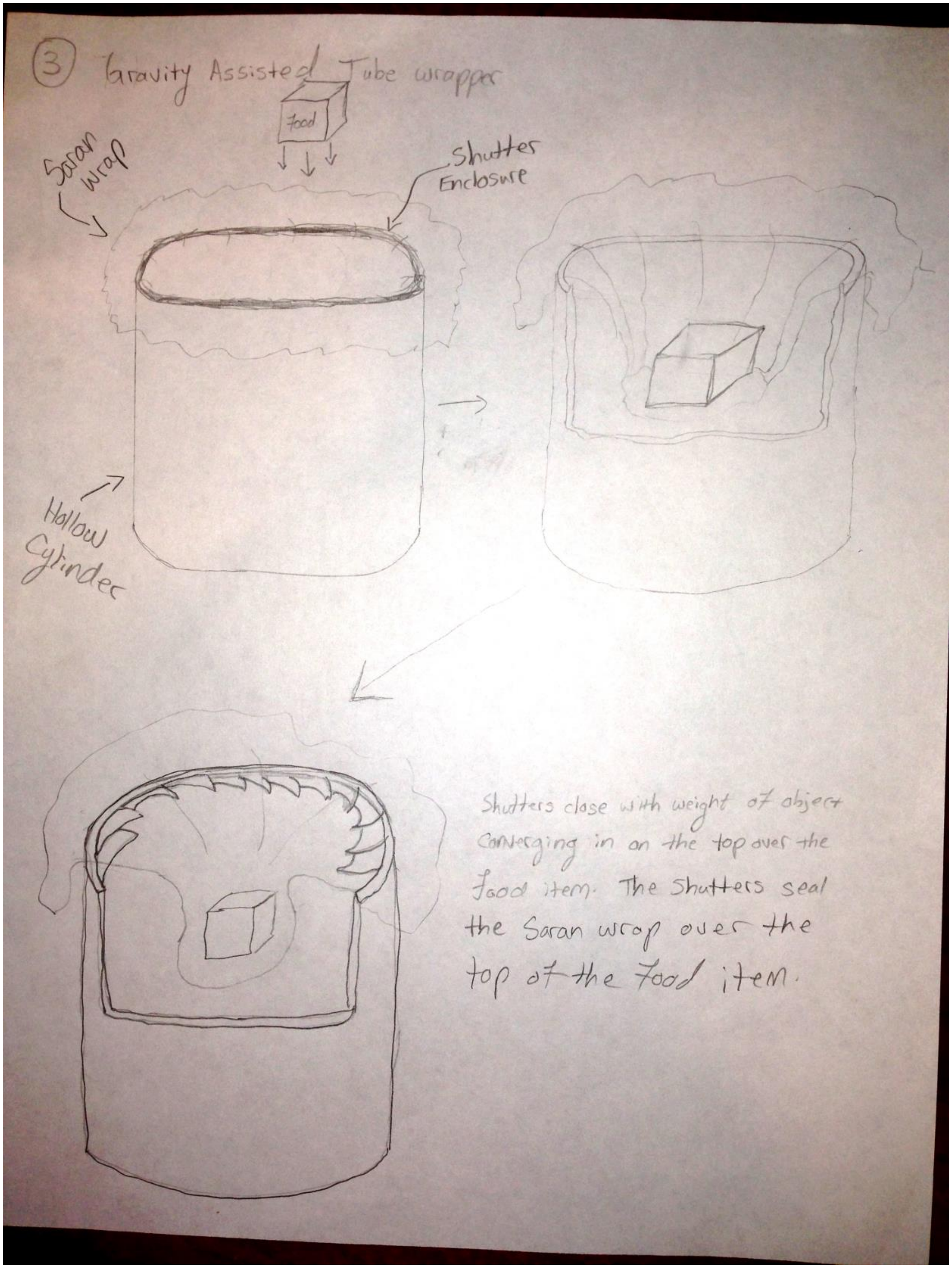
3.1.3 Table/list of quantified needs equations

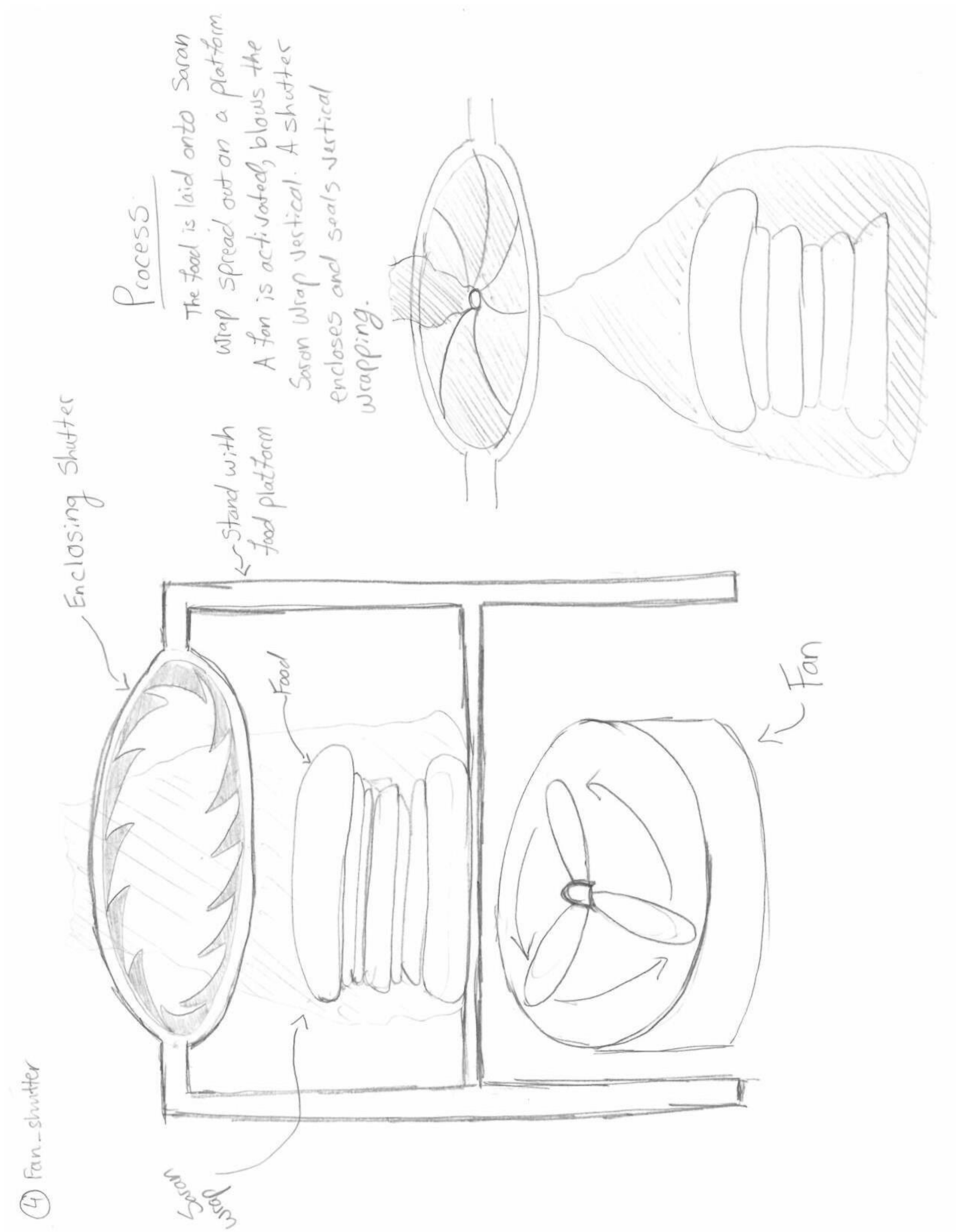
Design Metrics: Saran Wrap Handling Device					
Metric Number	Associated Needs	Metric	Units	Min Value	Max Value
1	1,2	Length	cm	20	50
2	1,2	Width	cm	20	50
3	10	Clean easiness	Integer	1	5
4	4	Number of compatible shapes	Integer	1	8
5	5	Noise level	dB	0	100
6	8	Wrapping time	Seconds	5	20
7	2	Weight	kg	2	5
8	14	Number of safety hazards	Integer	0	5
9	11	Price	USD ($)	1	60
10	6	Wrap single attempt	Binary	0	1
11	9	Power choice	Binary	0(Battery)	1(Plug in)
12	12	Level of deformation	Integer	0	5
13	13	No. of manual actions	Integer	2	5
14	3	Leakage/Breakage	Integer	0	5
15	7	Amount of Wrap	cm^2	225	500

3.2 Four (4) concept drawings




② Wall-assisted wrap handling device
Saran wrap
Stand with wall and platform
Curved Air-flow Guide
Process
Saran wrap is laid onto the wall and platform. The Fan turns on and blows the wrapping along the guided path until it touches the wrapping on the wall.
Side View
Curved Air-Flow Guide
Fan
Stand with wall and platform
Food
Fan.


③ Gravity Assisted Tube wrapper
Food
Saran wrap
Shutter Enclosure
Hollow Cylinder
Shutters close with weight of object converging in on the top over the food item. The Shutters seal the Saran wrap over the top of the food item.


4 Fan_shutter
Enclosing Shutter
Stand with food platform
Food
Fan
Saran wrap
Process
The food is laid onto Saran Wrap spread out on a platform. A fan is activated, blows the Saran Wrap vertical. A shutter encloses and seals vertical wrapping.

3.3 A concept selection process. This will have three parts:

3.3.1 Concept scoring (not screening)

		Metric																	
		Length	Width	Area	lean easine	f compatib	Noise level	rapping tin	Weight	r of safety	Price	ber of atte	ower choic	of deform	f manual a	eak/Break	ed Happin	Importance Weight (all entries should add up to 1)	Happiness
	Need	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
1	SWHD is a little bigger than an average sandwich.	0.5	0.5														0.666667	0.066	0.044
2	SWHD is lightweight and compact.	0.333	0.333						0.333								0.666	0.066	0.043956
3	SWHD holds the item together without leaking/breaking.															1	1	0.082	0.082
4	SWHD hosts a variety of shapes.					1											1	0.082	0.082
5	SWHD is quiet						1										0.4	0.049	0.0196
6	SWHD wraps in one attempt.											1					1	0.066	0.066
7	Amount of wrap.			1													0.4	0.049	0.0196
8	SWHD wraps within 10 seconds.							1									0.8	0.066	0.0528
9	SWHD has battery or plug-in power.												1				1	0.066	0.066
10	SWHD can be cleaned in a simple process.				1												1	0.082	0.082
11	SWHD costs below $50.										1						0.416667	0.082	0.034167
12	SWHD makes low deformation to items.													1			1	0.033	0.033
13	Minimum manual actions required.														1		1	0.049	0.049
14	SWHD is safe for all ages to use.									1							0.6	0.082	0.0492
	Units	cm	cm	cm^2	Integer	Integer	dB	Seconds	kg	Integer	USD ($)	Binary	Binary	Integer	Integer	Integer	**Total Happiness**		0.475956
	Best Value	20	20	0	5	8	0	5	2	0	1	1	1	0	2	0			
	Worst Value	50	50	100	1	1	100	20	5	5	60	0	0	5	5	5			
	Actual Value	30	30	60	5	8	60	8	3	2	35	1	1	0	2	0			
	Normalized Metric Happiness	0.667	0.667	0.400	1.000	1.000	0.400	0.800	0.667	0.600	0.417	1.000	1.000	1.000	1.000	1.000			

3.3.2 Preliminary analysis of each concept's physical feasibility

Concept 1: Gravity Tube Wrapper
Concept 1 has a tube geometry. By design, the item to be wrapped is placed into the device, falls to the bottom under gravity and gets wrapped automatically. While the mechanism is simple, the design and manufacturing of the specific parts can be challenging. In particular, in order for the item to be wrapped tightly and properly, with no leakage or breakage, the shutter must be accurately fabricated and positioned so it can enclose multiple shapes. Also, the tube must be carefully designed to accommodate shapes of various sizes yet not to leave too much extra room on the side for air etc.The material of this device should be lightweight, so both metal and plastic materials should be considered, must must comply with the basic cleaning requirements and food safety considerations. To make it safe for all age groups, the shutter mechanism must be carefully designed to prevent certain safety hazards for children and seniors. It should prevent the user from being cut if hand is accidentally placed inside the tube,

Concept 2: Flow-guided Wrapper
Unlike concept 1, concept 2 relies on a more complicated air flow mechanism. The fan at the bottom of the device will blow out air, which will travel through the platform, where the item is to be placed onto, by the openings along the enclosure surface. Then the flow of air will be directed along the curved surface and create force to tightly apply the wrap onto the item surface. Because of its complicated mechanism, three major physical difficulties are critical to the success of this design. First, the platform material must be carefully chosen, ideally with a partial perforated feature to facilitate the flow of air;. Secondly, the location and size of the openings should be calculated precisely so that it creates the ideal pressure and speed for the air that travels through. Thirdly and most importantly, the curvature and direction of the enclosure surface must be designed and fabricated properly and successfully so that the air will flow correctly and successfully guide the wrap to pack the item. Safety design should be applied to the cutting mechanism, where the Saran wrap gets cut off from the roll. Also the fan should be fully enclosed to prevent any possible intrusion by fingers.

Concept 3: Double Wrapper
The double wrapper takes the approach of double packing. The item to be wrapped will be placed on top of a wrap, and another wrap will come down from above to cover the top and side or the item. While the mechanism is relatively simple, the physical mechanism of this device will be simple because of its moving parts. In order for the upper wrap to come down and up (after the wrapping is done), a motor and leveling mechanism must be put in place. Ideally, the small motor will be used with a slow angular velocity to ensure the upper wrap travel downwards slowly and steadily. After the two wraps are applied, a four-sided folding arm mechanism will fold the side wraps towards the item so it will be wrapped ideally. Safety considerations should be applied towards the upper wrap frame, because user can get cut of electric shock. An electric insulator can be added to the device to make sure no such accidents.

Concept 4: Single Fan Shutter Wrapper
Concept 4 is similar to the Concept 1, except the bottom and sides of the item are wrapped under the air pressure created by the fan underneath. In this design, the lower part should create a strong air flow with correct direction to enclose the sides and the bottom of the item. Therefore, a fan with adequate flow strength should be procured and installed at such a location so that the air can direct the wrap apply to the surface of multiple-shaped items. To combine the air flow mechanism with the shutter design to close up the wrapping, the overall frame should be placed so that it doesn't collapse or have

parts fall into the fan at the bottom to create safety hazards. Like in design 1, the shutter must be carefully designed and fabricated so that it can successfully catch the wrapping materials placed under the air and get it meet at one point, preferably at the center. to prevent leakage or breakage. Since electric equipment and fan will be used, insulator and fan enclosures must be put in place to prevent safety hazards.

3.3.3 Final summary

WINNER: Concept 3 - Double Wrapper
Concept 3 is the winner because it has several significant advantages over the other designs. Compared with concept 1, it is better at making sure the item is wrapped tight and can accommodate more item shapes. While concept 1 has a simple mechanism with the item dropping to the bottom due to gravity, concept 3 takes an intuitive approach by applying wraps from above and below, which very much mimics the hand-wrapping process by humans. In addition, concept 3 is significantly easier to design and fabricate precisely than concept 2. Due to the complexity of air flow dynamics in reality, it is difficult to have the flow direction modeled to a great accuracy. As a result, the curved enclosure will be difficult to get designed perfectly in order achieve the ideal wrapping process. For a similar reason, concept 3 wins over concept 4 because the latter too utilizes the fan air flow to wrap the item. Besides, concept 4 has a shutter mechanism to close the finished wrap, which may not work as well as designed to the variety of shapes the items can be. Based on the physical analysis, which is backed by the happiness equations, concept 3 is the winner.

3.4 Design constraints (include at least one example of each of the following)

3.4.1 Functional

This device should be compatible with existing wraps on the market so the users don't need to purchase special wraps in order to use this device.

3.4.2 Safety

All sharp corners and edges should be smoothed or concealed.

3.4.3 Quality

This device should be reliable and perform consistently for the maximum convenience of the users.

3.4.4 Manufacturing

The manufacturing shall be finished with a combination of basic machining processes including lathe, band saw and milling.

3.4.5 Timing

The ideal wrapping time should be below ten seconds, shorter than the average time spent for a hand-wrapping process.

3.4.6 Economic

The cost of this device should be close to our competitors' products of US$ 10.

3.4.7 Ergonomic

Users should be able to rotate with minimum force and torque, so that a child or senior citizen can use this device with ease.

3.4.8 Ecological

This device should use environmentally friendly materials, so that there is minimum manufacturing pollution and zero food contaminations.

3.4.9 Aesthetic

The overall shape of this device should be of a simple and common geometry.

3.4.10 Life cycle

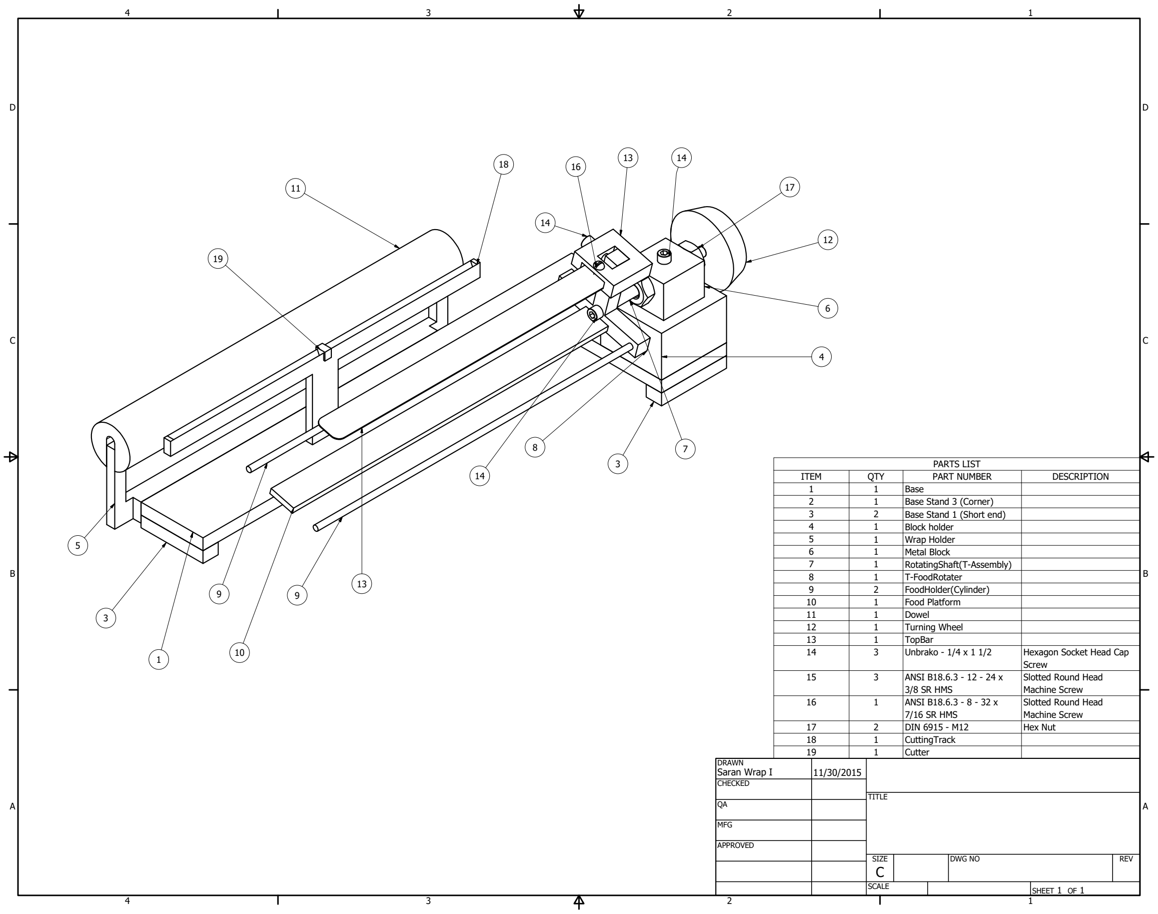
This device should be able to stay functional for at least five years and the ideal length is around ten years.

3.4.11 Legal

Our design shall avoid similar mechanisms of similar products such as “Food Tray Wrapping Machine with Stretch Film” to prevent any intellectual property infringements.

4 Embodiment and fabrication plan

4.1 Embodiment drawing



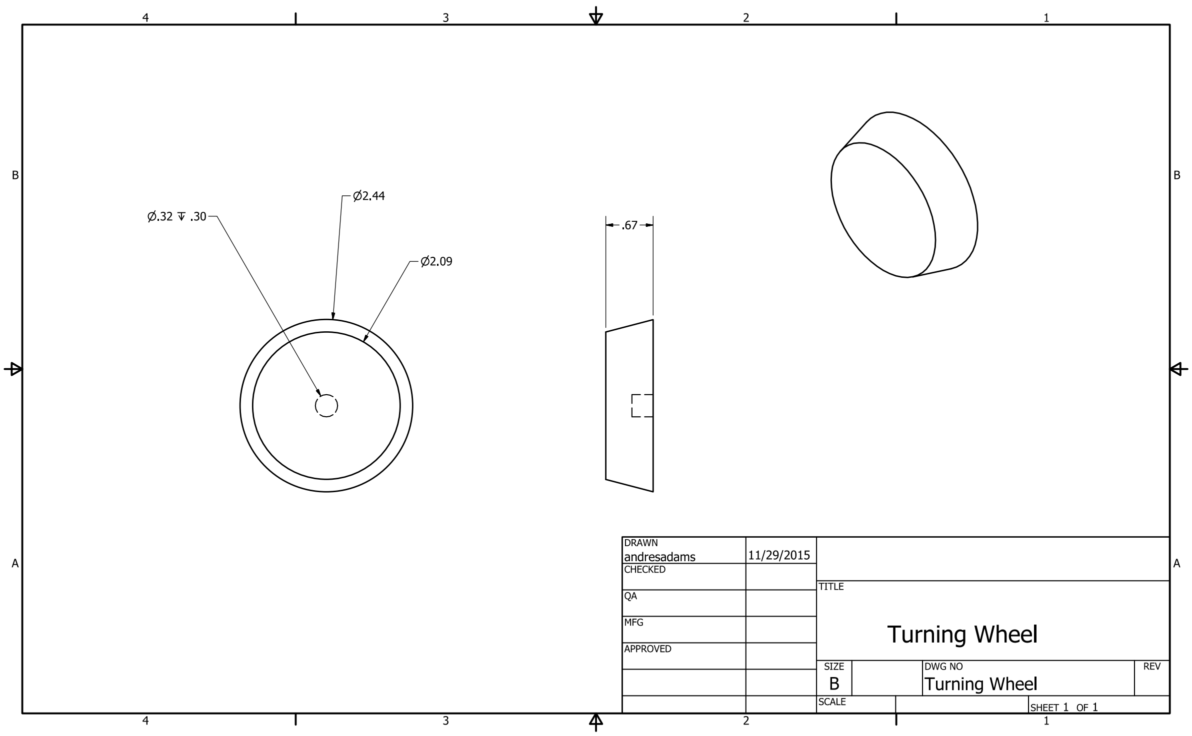
PARTS LIST			
ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	Base	
2	1	Base Stand 3 (Corner)	
3	2	Base Stand 1 (Short end)	
4	1	Block holder	
5	1	Wrap Holder	
6	1	Metal Block	
7	1	RotatingShaft(T-Assembly)	
8	1	T-FoodRotater	
9	2	FoodHolder(Cylinder)	
10	1	Food Platform	
11	1	Dowel	
12	1	Turning Wheel	
13	1	TopBar	
14	3	Unbrako - 1/4 x 1 1/2	Hexagon Socket Head Cap Screw
15	3	ANSI B18.6.3 - 12 - 24 x 3/8 SR HMS	Slotted Round Head Machine Screw
16	1	ANSI B18.6.3 - 8 - 32 x 7/16 SR HMS	Slotted Round Head Machine Screw
17	2	DIN 6915 - M12	Hex Nut
18	1	CuttingTrack	
19	1	Cutter	

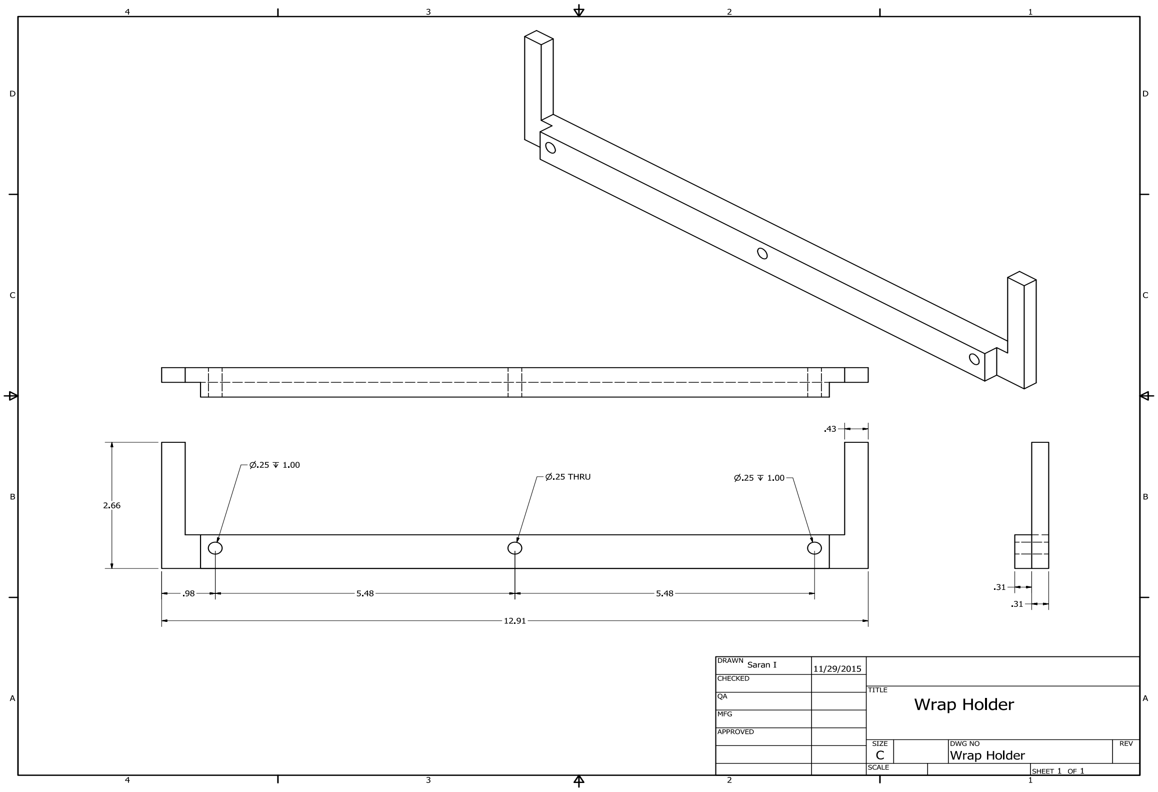
4.2 Parts List

Part Number	Part Name
1	Turning Wheel
2	Wrap Holder
3	Sliding Piece
4	T-shaped Rotator
5	Rotating Shaft
6	Metal Block
7	Food Platform (cylinder)
8	Platform
9	Flat Beam
10	Dowel
11	Cutting Track
12	Cutter

13	Block Holder
14	Base
15	Base Stand 1 (Short end)
16	Base Stand 2 (Long end)
17	Base Stand 3 (Corner)

4.3 Draft detail drawings for each manufactured part

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DRAWN Saran I 11/29/2015
CHECKED
QA
MFG
APPROVED
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SIZE C
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REV
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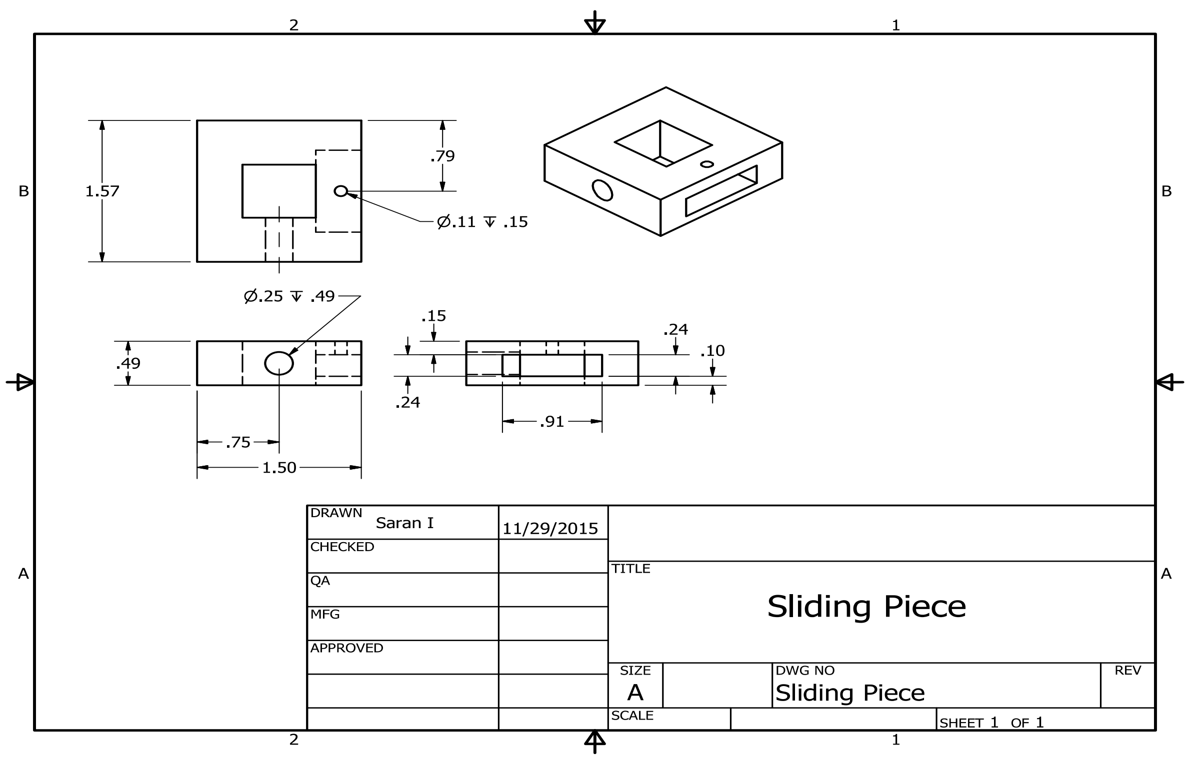
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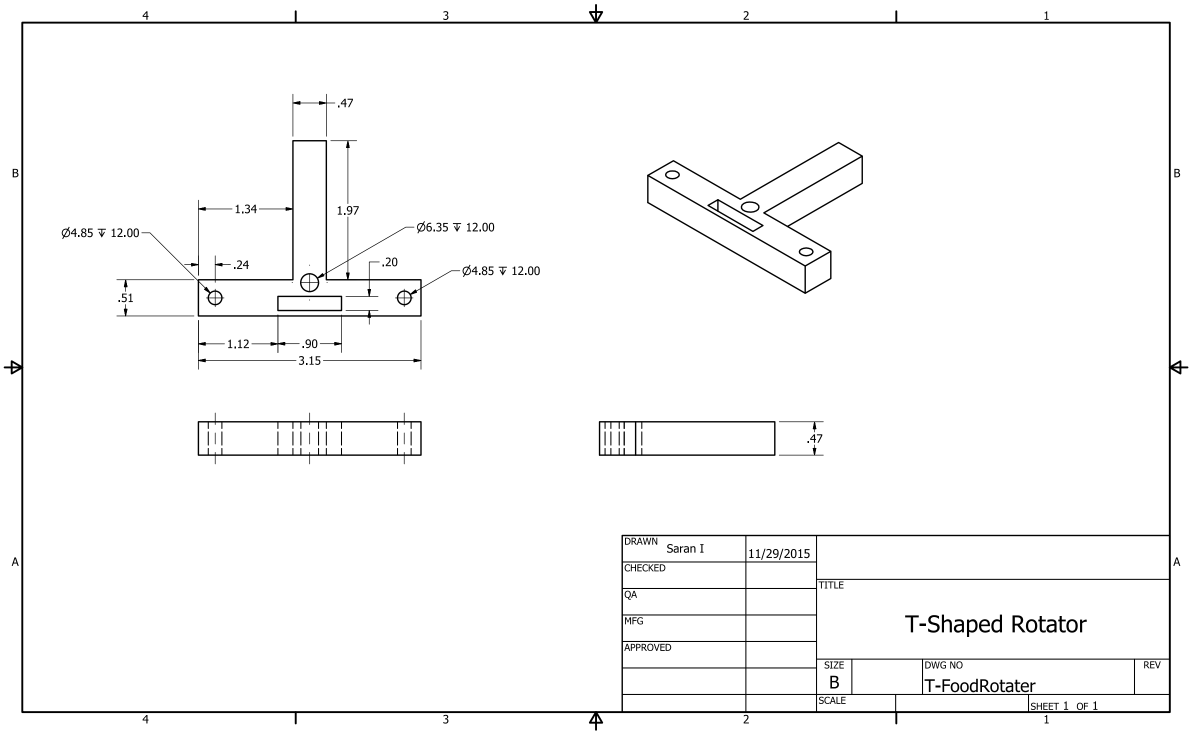
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11/29/2015
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QA
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TITLE
T-Shaped Rotator
SIZE
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T-FoodRotater
REV
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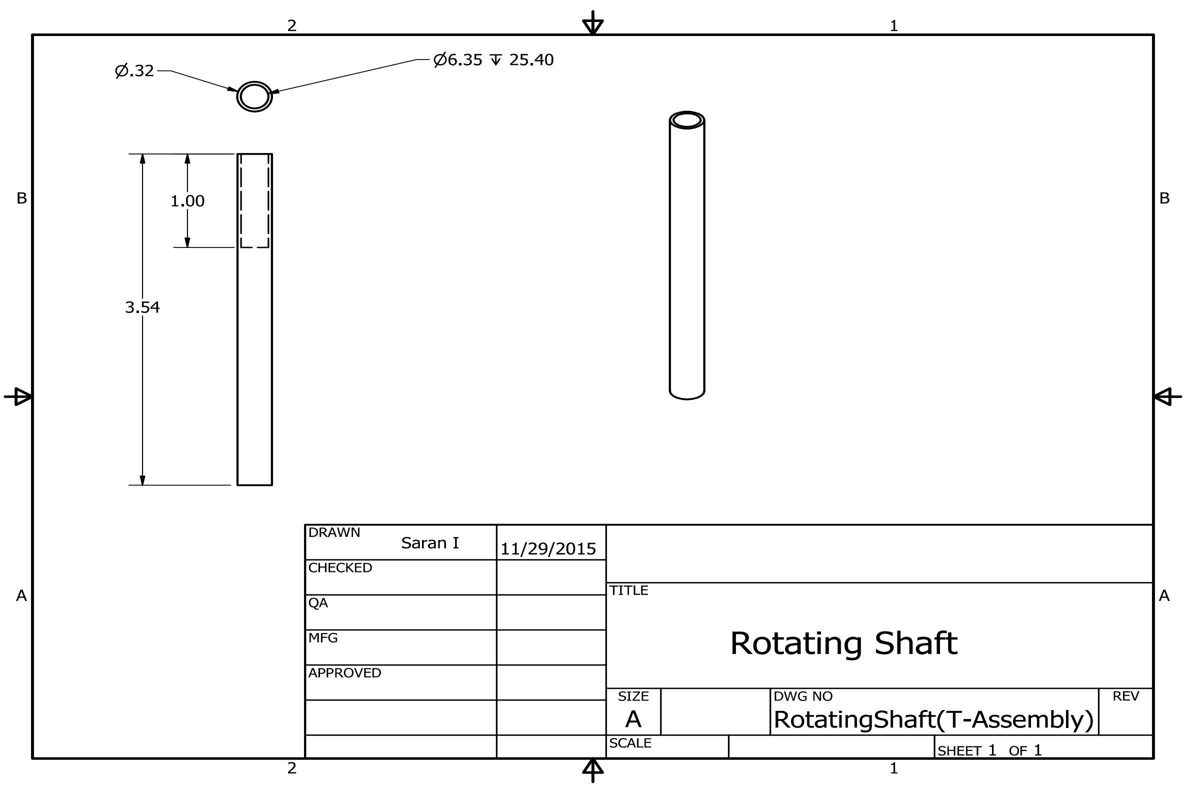
SHEET 1 OF 1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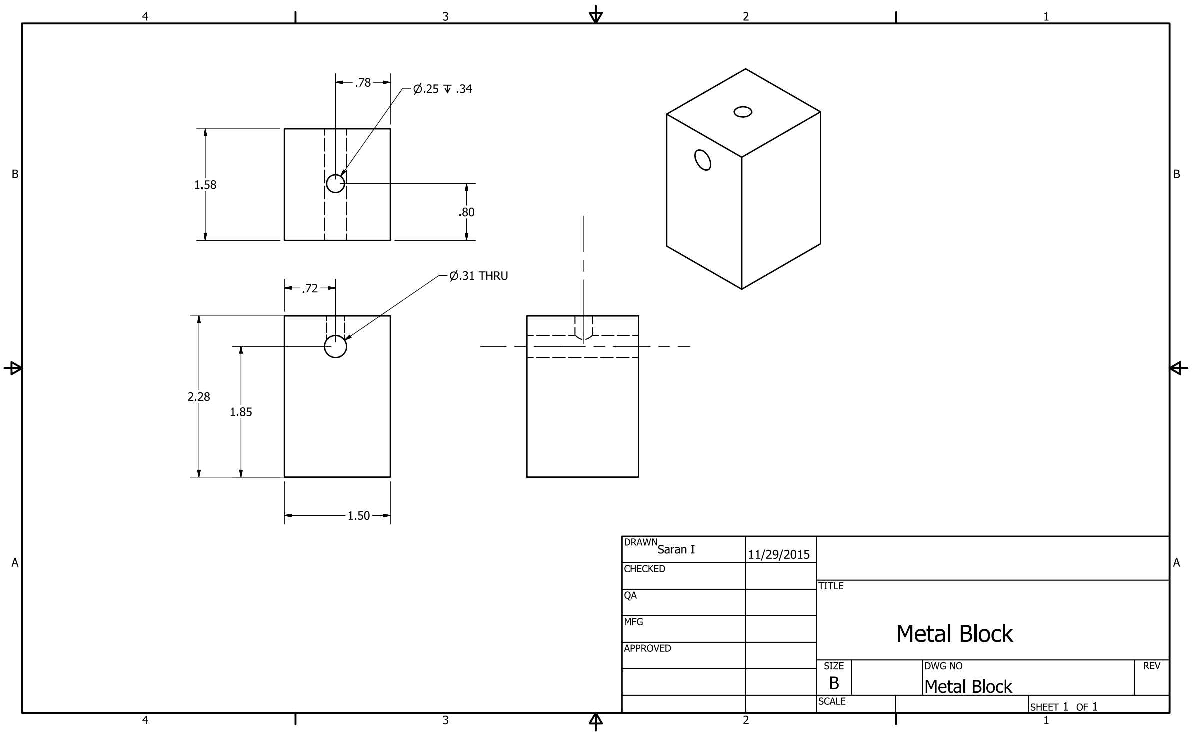
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Metal Block
SIZE
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Metal Block
REV
SCALE
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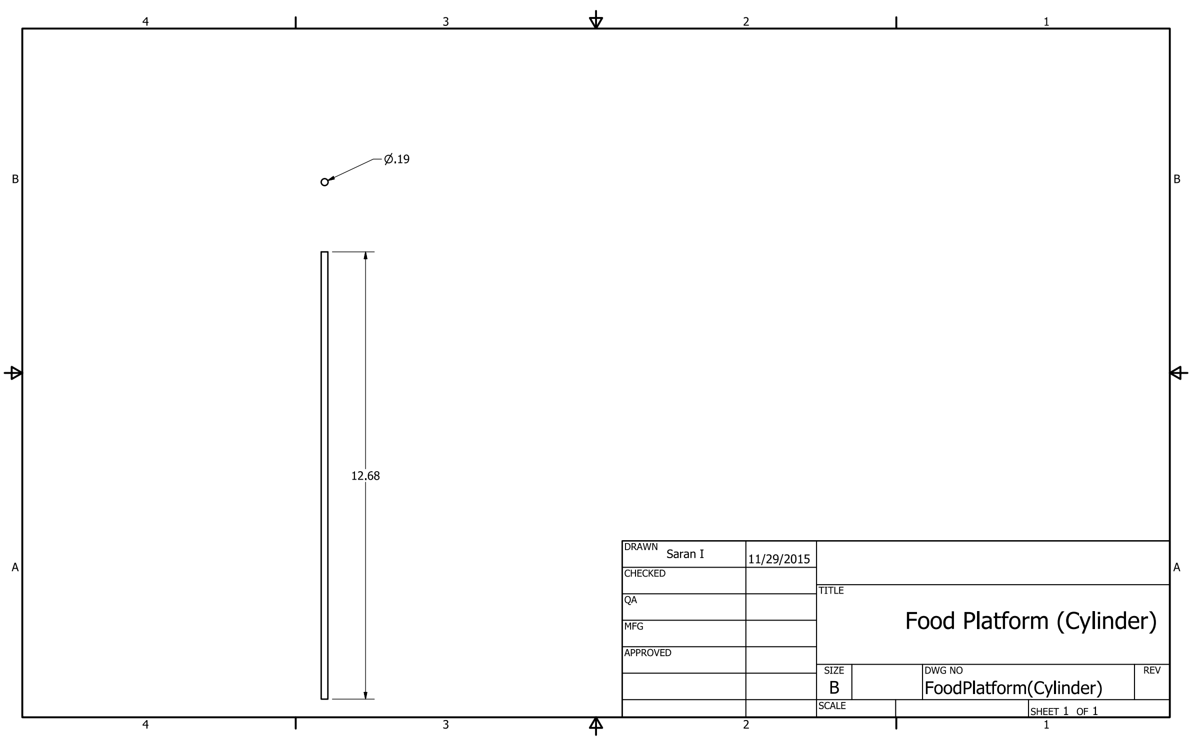
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Food Platform (Cylinder)
SIZE
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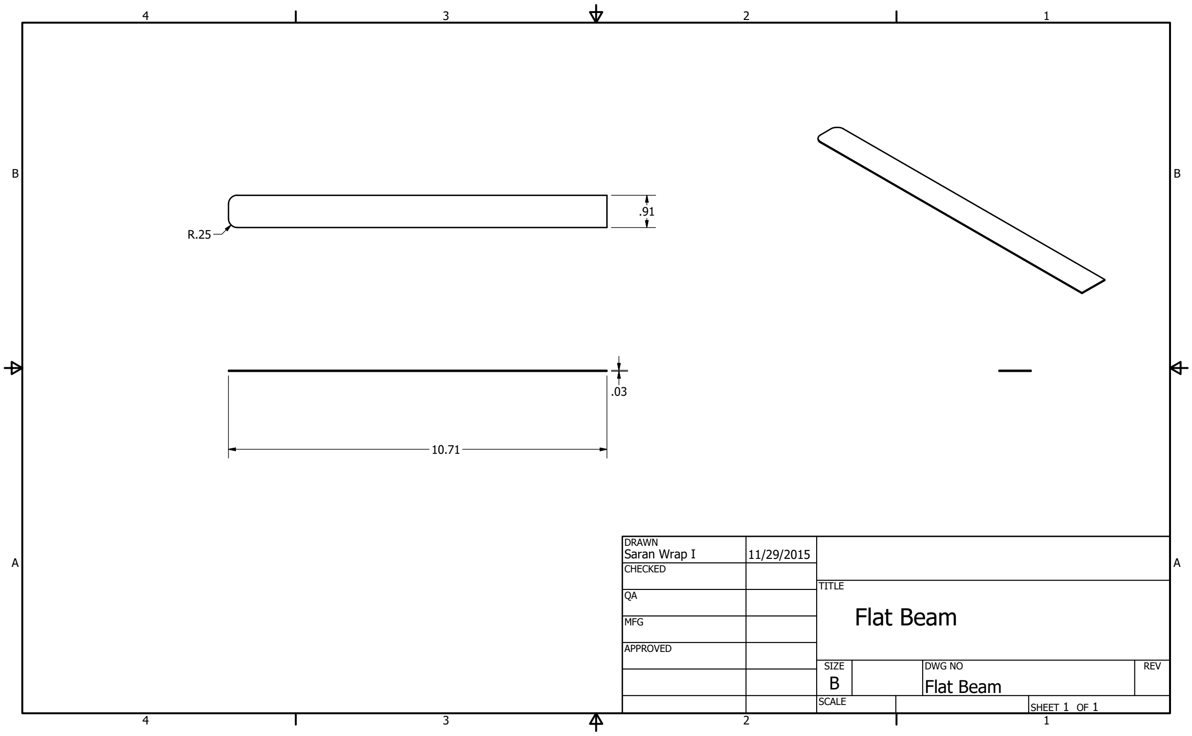
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Flat Beam
SIZE
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DWG NO
Flat Beam
REV
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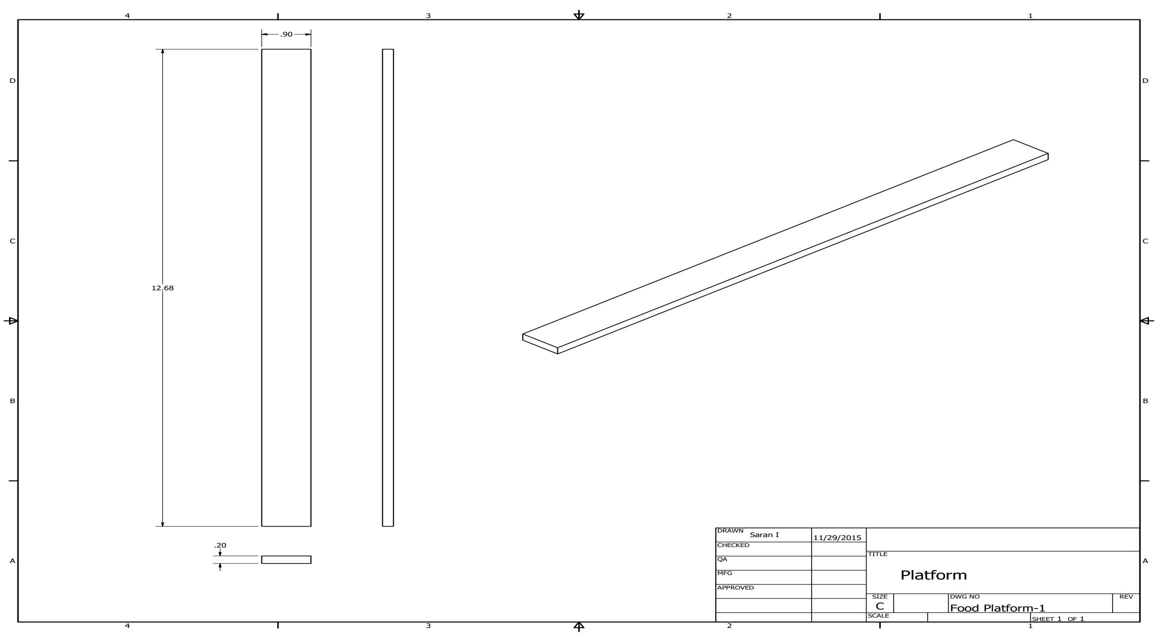
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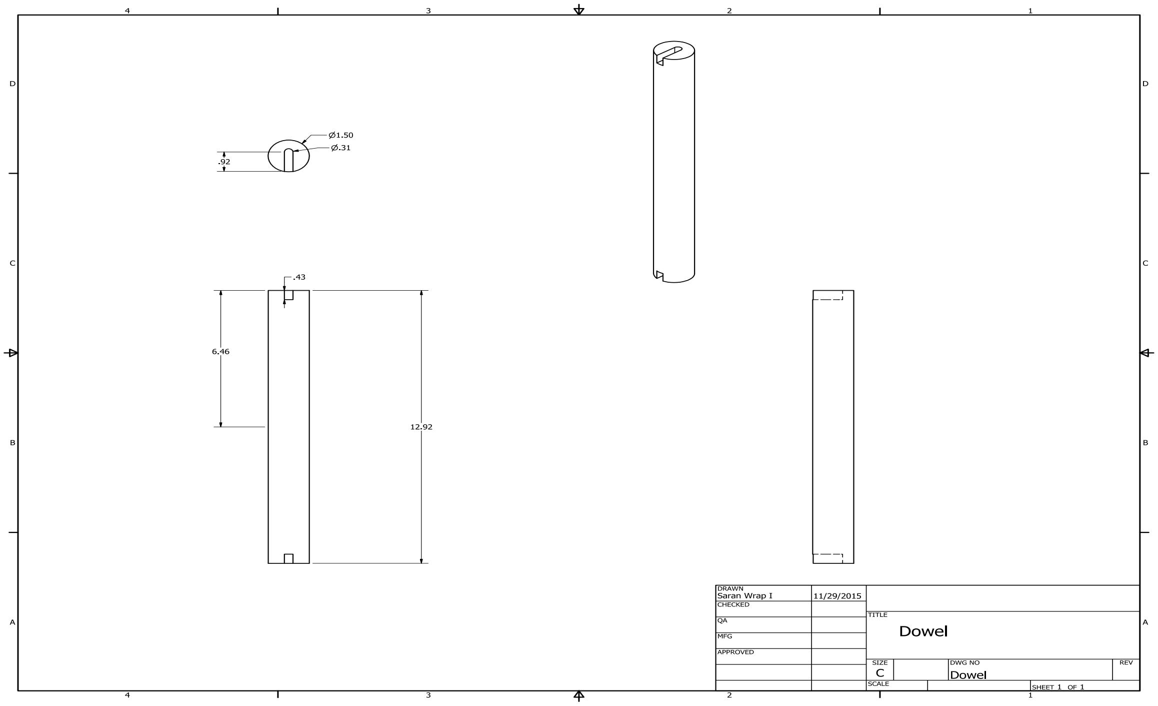
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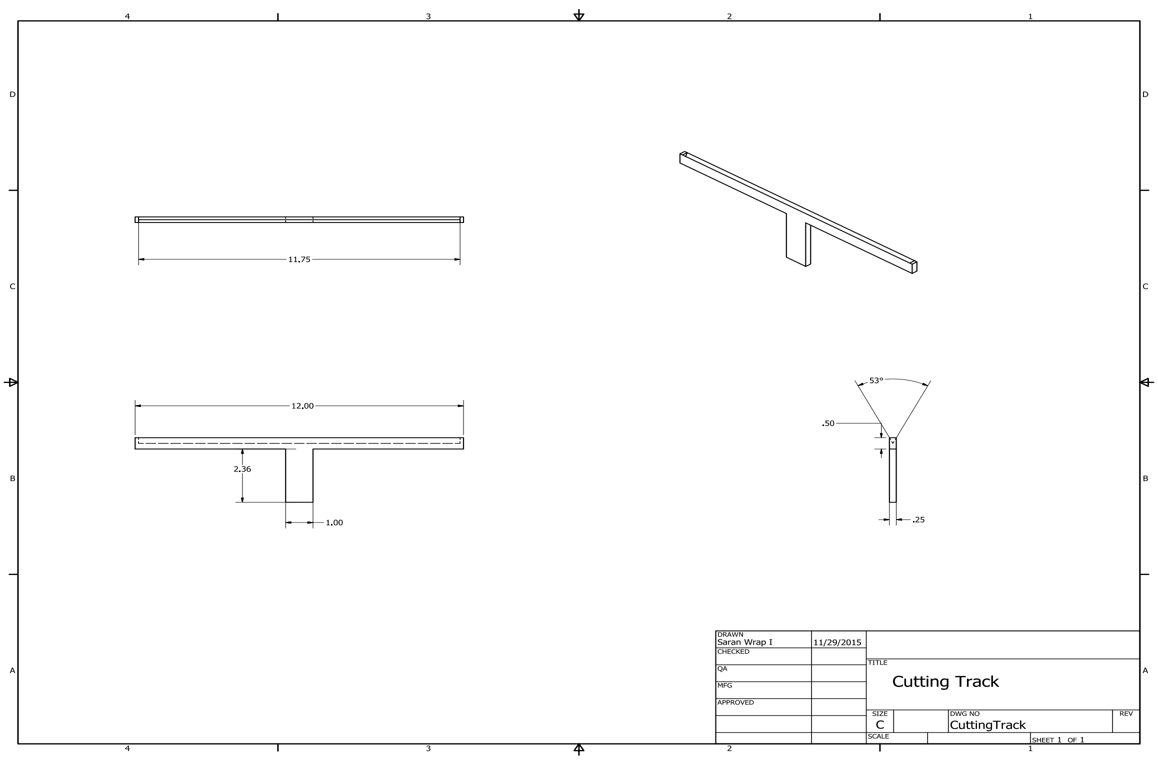
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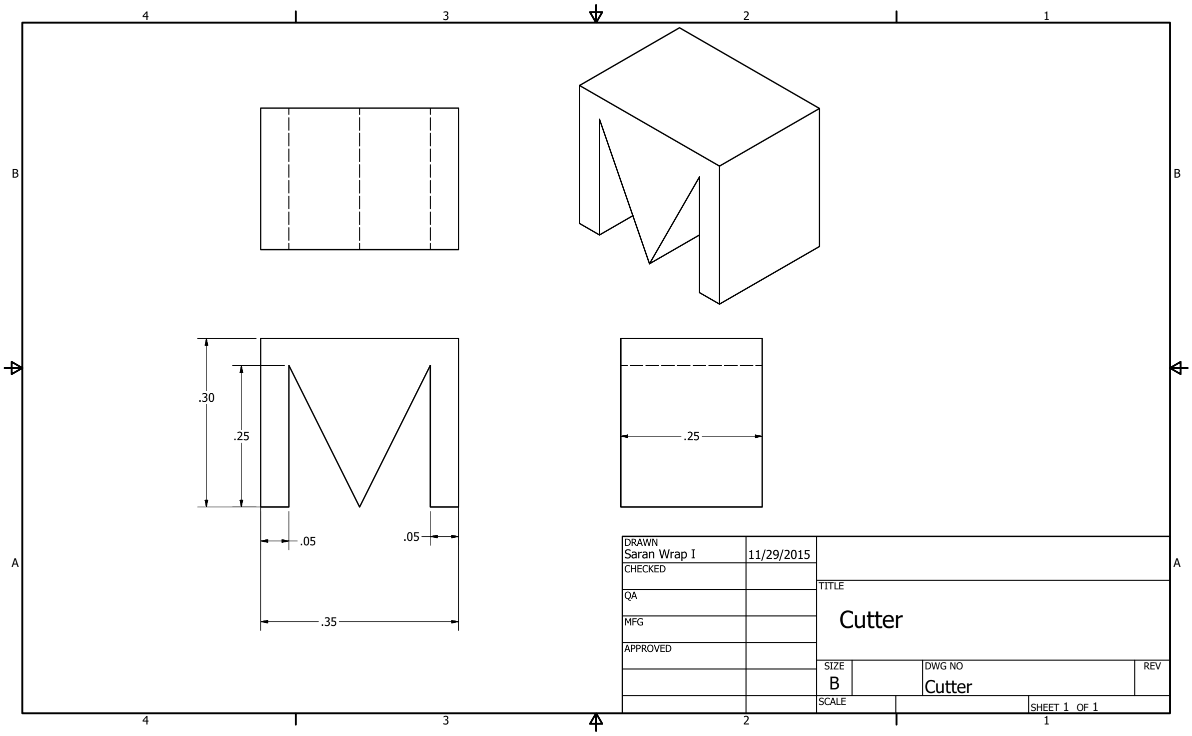
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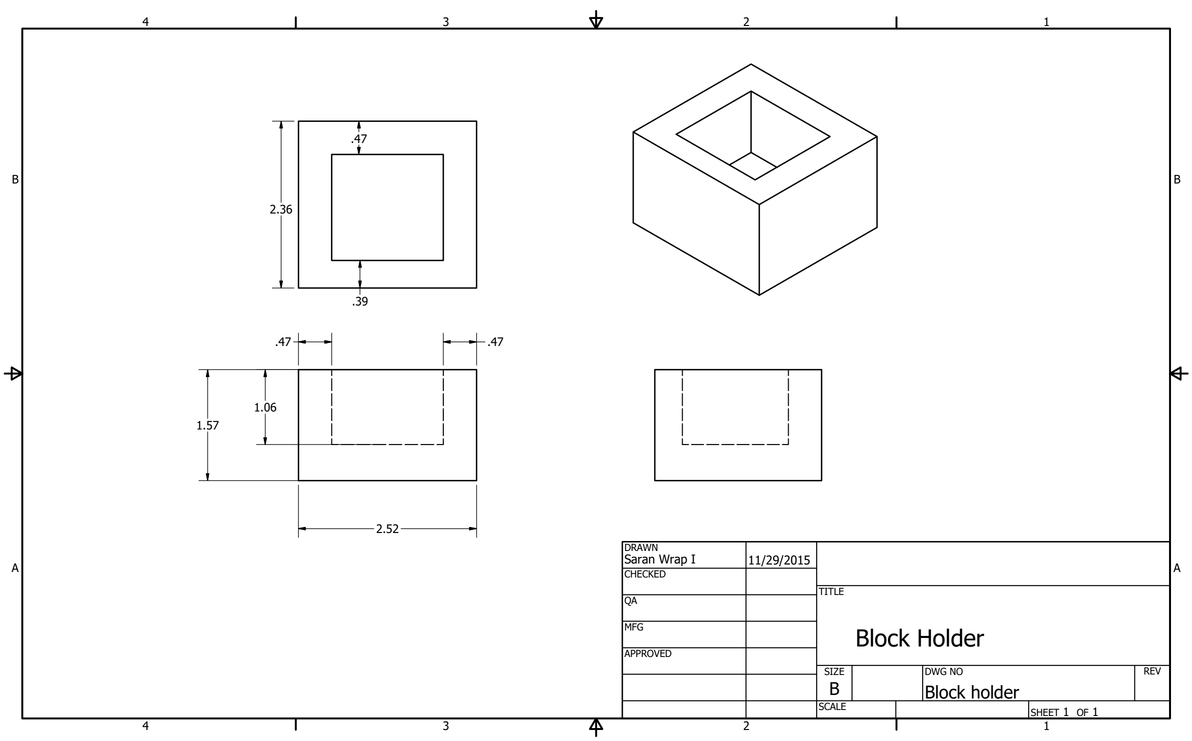
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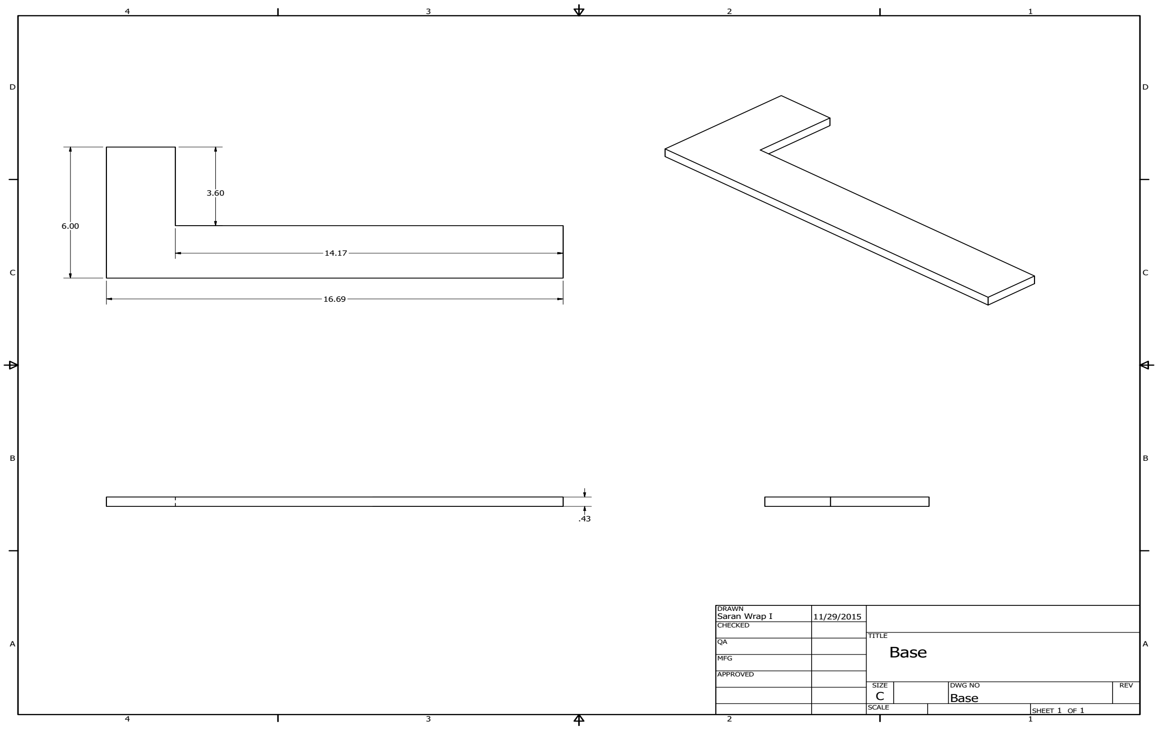
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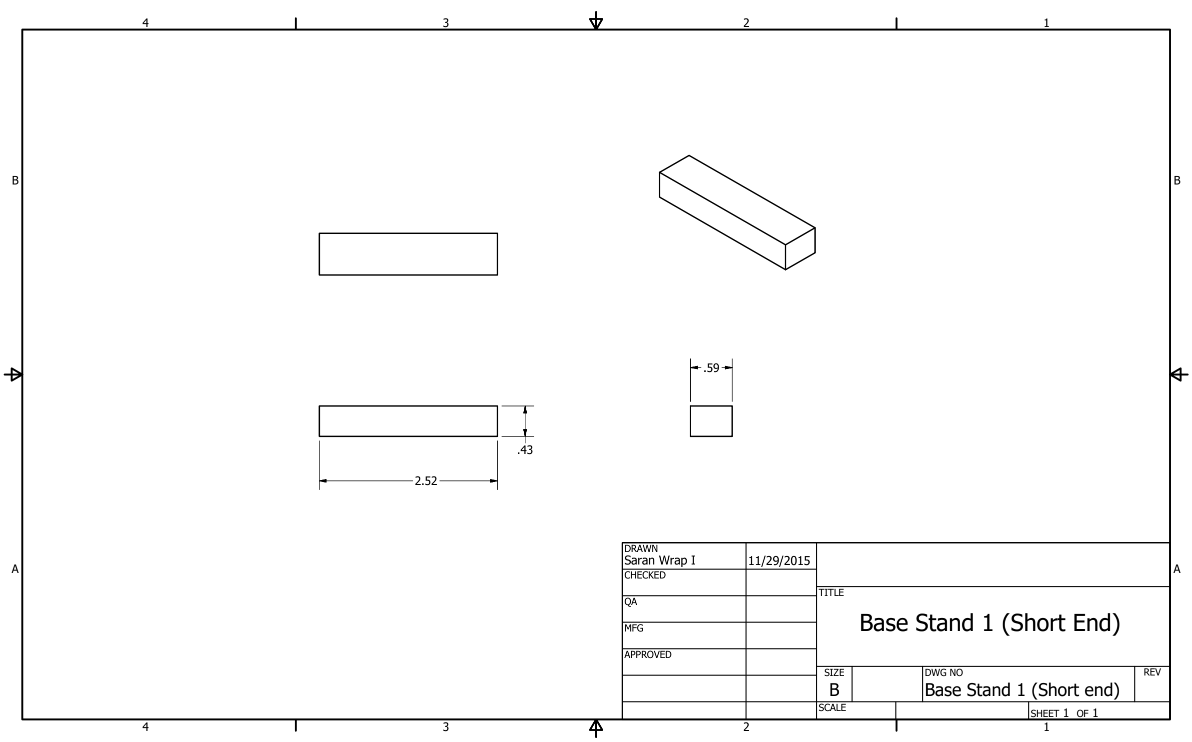
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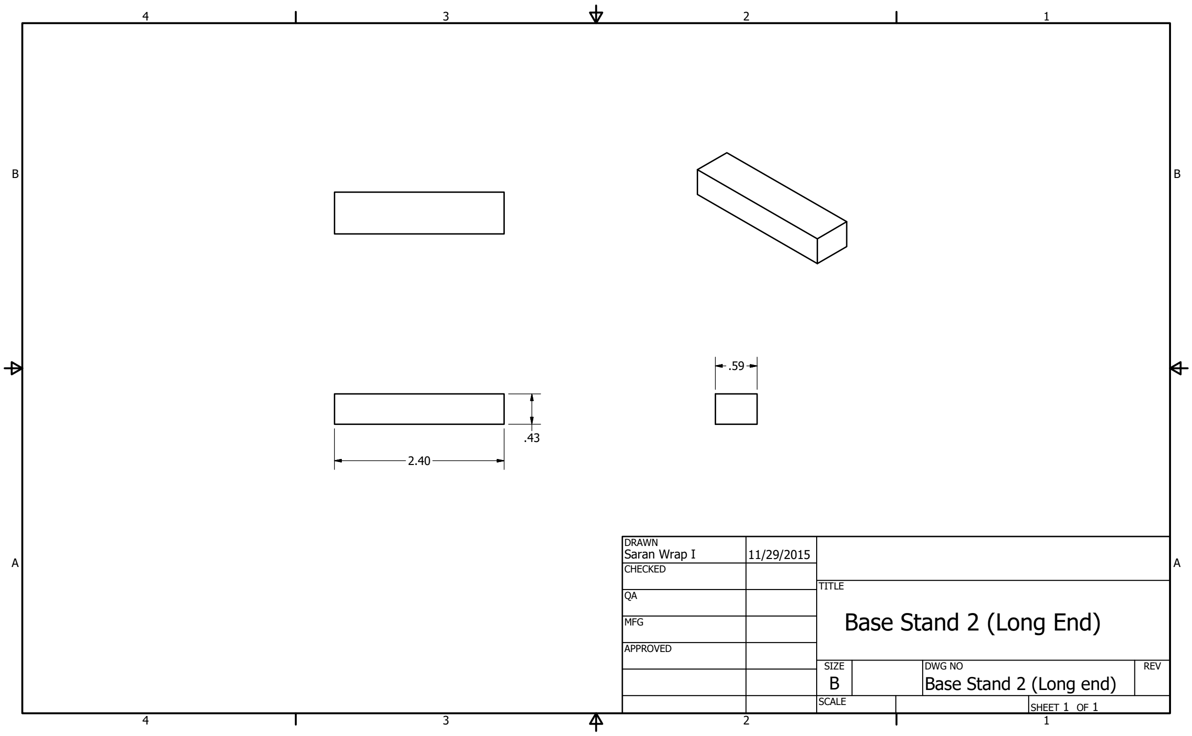
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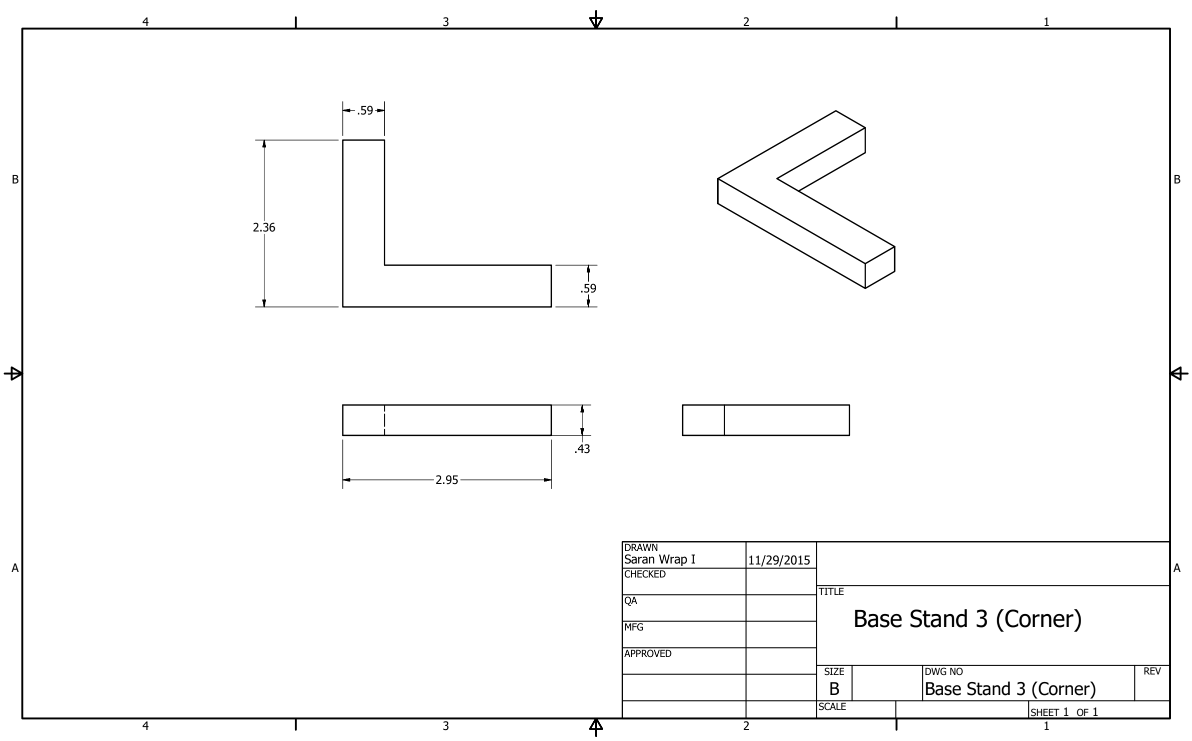
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SHEET 1 OF 1

4.4 Description of the design rationale for the choice/size/shape of each part

1. Base Stand Series (1,2,3)

   Base Stands 1, 2, and 3: These pieces are simple rectangles that sit on the bottom of the entire structure. Their purpose is simply to add height to the structure, as well as increase the pressure (through a decrease in surface area) so that the system is less likely to slip on whatever surface it rests on. They are each made of wood. The wood used is not important, however, in this particular case, plywood was the cheapest and easiest option. One can get plywood (4'x8'x7/16') for about 20 dollars. It would suffice for the entire needs plus more for all the wood used in this project.

2. Base

   The base is an L-shape made out of wood. The base got its shape because we needed a perpendicular to where the wrap was held. There are two important geometric dimensions. One, the short leg of the "L" shape needs to extend far enough from the wrap and its connecting surfaces so as to let the T-Shaped Rotator, rotate freely. Second, the length of the long leg of the "L" should extend long enough to effectively hold the wrap and its respective holder.

3. Block Holder

   The block holder has one purpose: to hold, fairly rigidly, the Metal Block which holds the T-Shaped Rotator. We made our block holder out of wood, because wood holds the metal block firmly, but also allows the user to slip the metal block in more easily as the wood can contour the metal block through particular deformation. One may make the piece out of metal as well, however, metal is less yielding which makes it harder for the user to slip the metal block in unless larger clearance is given. We chose wood in the end, which require us to increase the size of the walls that hold the metal block in. The block needs a bottom thick enough so that it may be screwed into the base securely.

4. Block

   The Block is an aluminum block that holds all the rotating pieces together. Aluminum is necessary as all the rotating pieces exert forces on the block that are approximately the largest forces the system experiences. Wood may suffice but over time it will most likely cause deformation. We found an block the size we wanted and constructed the system according to that size. If this is not available, making a block large enough to be stable (when given external supports) is the only requirement. A very thin light block may be hard to stabilize all the moving components on it. The block has a large hole through it to hold a shaft that allows for all the rotating parts and an additional threaded hole that is directly perpendicular to it, so that one may screw through and provide friction so that the system does not rotate when it is not desired.

5. Threaded Shaft and Turning Wheel

   The shaft holsters the T-Shaped Rotator and fits in the hole on the block. It must be able to rotate within the hole of the block. The shaft is threaded on its exterior surface so that two nuts can be placed on either side of the block preventing the shaft and its assembly from translating forward. The shaft is made of aluminum. We found the piece, however, it can be constructed from aluminum rod stock and threaded to get the same product. The shaft holds the T-Shaped Rotator together with the food assembly and allows them to rotate thus wrapping the food.

   The turning wheel attaches to the end of the shaft. Its purpose is quite simply to allow the user to turn the shaft using an apparatus that is more easily manipulated than the shaft itself. We chose a rubber wheel as rubber has plenty of friction and is easy for the user to grab. The wheel shape was chosen as it maximizes surface area and thus grip ability. We found the piece in the machine shop which made its implementation easy since we just needed to screw into it. If one wishes to use the same assembly, one need only to find a rubber piece, fit it tight to a circular metal piece, and thread the metal piece. The threading must end into a wall so that the piece can be tightened appropriately.

6. T-Shaped Rotator

   The T-Shaped Rotator is made of aluminum. This aluminum was taken from the stock available in the Washington University machine shop. If stock is not available, one may purchase aluminum stock from McMaster Carr and use a mill to get the desired shape. We wanted this piece to be small, but still have many holes through it, as well as the largest forces felt in the entire system (granted they are still not that great); so we decided to choose aluminum incase the wood could not handle the stress concentrations created by the numerous holes carved into it. The shape got its "T" shape because we need a large flat bottom (corresponding to the top bar of the T) and a skinny "track" in the middle. The large base provides the width necessary for the various holders that hold the food item. This width does not need to be as wide as say a sandwich, but it should be wide enough so that when one puts a sandwich on, it does not risk falling off. The skinny track merely has the function of allowing a piece to slide up and down on it. This piece called the Sliding Piece slides up and down this track.

7. Sliding Piece

   The sliding piece is a hollow square the slides up and down on the skinny part of the T-Shaped Rotator. The purpose of this piece is to be adjustable and "tighten" down on the food and hold it in place as the user rotates the food and wraps it. It is made of aluminum for stability and has a threaded hole so that it may be tightened in place. The hole can be made with a successive series of different end mills, however, the size does not need to exactly match the size of the track it slides on as the screw can tighten it to any position.

8. Flat Beam

   The top bar is a piece of steel meshing like structure that we found in the machine shop. Its mesh structure is not necessary but we wanted something very rigid like steel but without much weight. All the holes lessened the weight of the entire piece. This piece is inserted into the sliding piece and is used to hold down the food as the system gets rotated.

9. Food Platform Series (Cylinder and Rectangle)

   The food platform series contains 3 pieces: 2 cylindrical and 1 rectangle extrusion coming out of the T-Shaped Rotator. Each of these pieces has one purpose, namely, to hold the food. The rectangular piece was made from stock from the machine shop, however, stock may be ordered from McMaster Carr if none is available. The cylindrical rods are made from a sort of PVC plastic, however, they exact composition is not critical, they can be made out of a more rigid material. Ultimately, each piece was chosen for its relatively light weight, yet higher stiffness. These pieces must not deflect under their own weight, and be able to hold the weight of a sandwich without any large deflections. The only geometric constraints are that they fit into the holes in the T-Shaped Rotator, and that they be long enough to reach the middle of the wrap plus approximately half the length of a sandwich. This allows the user to place a sandwich in the middle of the width of the wrap and have enough wrap on both sides to effectively wrap both sides of the sandwich.

10. Dowel

    The dowel is a simple piece, we purchased from Home Depot for about 5 dollars. The exact size is not important, so long as the diameter is less than the diameter of the wrap (approximately 1.5’’). One can then cut the dowel, with a band saw or something (it does not need to be very flat) to a length that fits the hold. Our length was approximately 11.75 for the wrap, so the dowel was approximately 12.1 inches with cut ins for the holder.

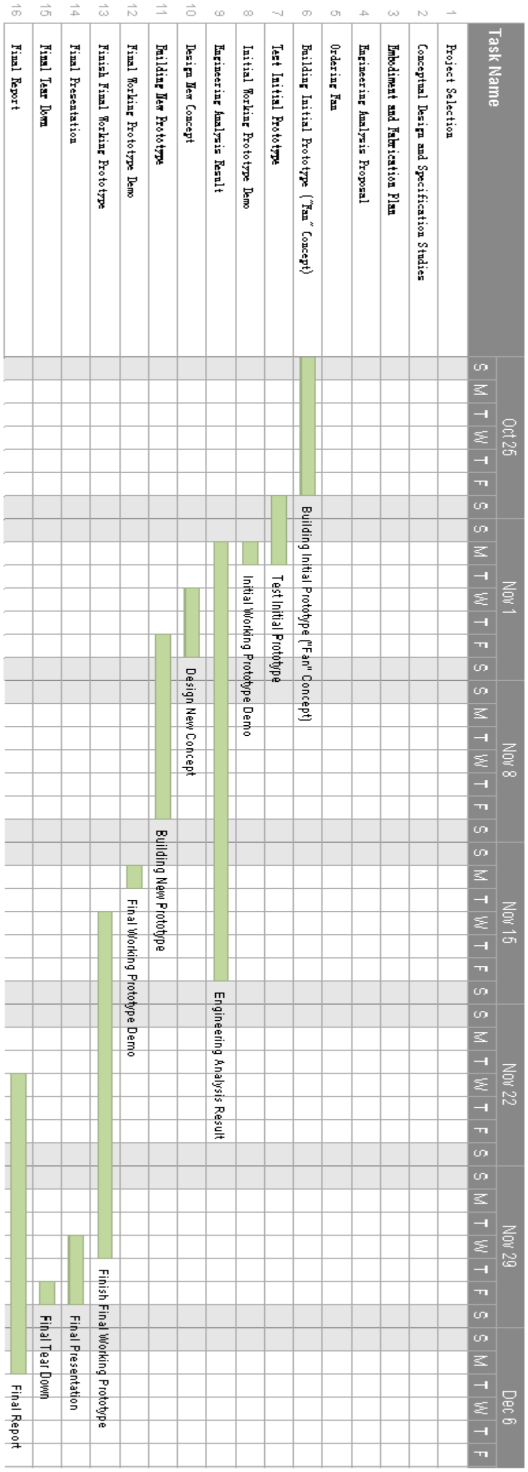
11. Wrap Holder

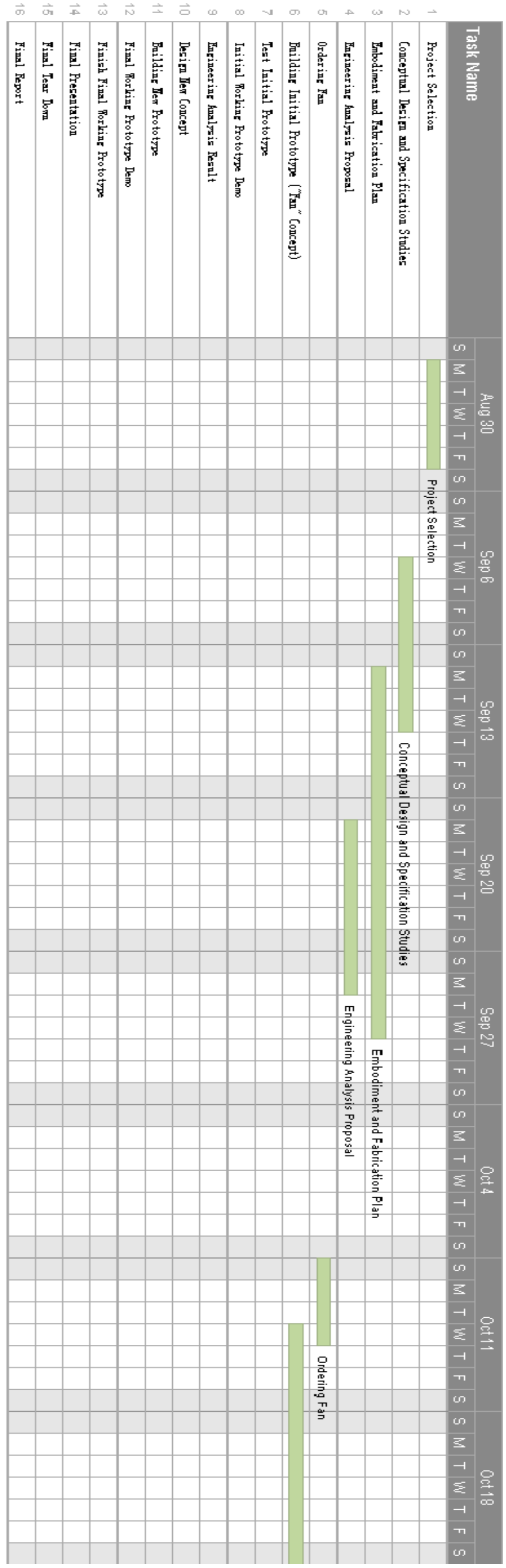
    This “C” shaped piece simply holds the wrap. It is screwed in the base for stability (the previous piece was glued in, and broke) and is long enough to hold the ends of the dowel. It is made of wood as the system will not experience much force.

12. Cutter and Cutter Track

    We purchased a standard cutter implement on a saran wrap assembly from Walmart. It is about the same price as buying a new roll of wrap. We merely ripped it out of the packaging and mounted it on a wood platform. It is raised in this way so that the wrapping can be tauter on the surface.

4.5 Gantt chart





5 Engineering analysis

5.1 Engineering analysis proposal

5.1.1 A form, signed by your section instructor (insert your form here)

ANALYSIS TASKS AGREEMENT

PROJECT: Saran Wrap Handling Device
NAMES: Andre Adams, Yi-Min Hou, Son Trinh
INSTRUCTOR: Jakiela, Malast

The following engineering analysis tasks will be performed:

Task #	Task Name	Implementation	Timing	Assignment
1	Air Flow Direction	Utilize fans of various geometric designs and compare the direction of their air flows and corresponding response by the Saran Wrap	Before Prototype	Adams Hou
2	Air Flow Strength	Place a fan stationary and move the wrapping item, or vice versa, and test what distance away from the fan provides the best combination of high air strength and low air suction.	Before Prototype	Adams Trinh
3	Clamp Surface Friction	Try different surface materials on the clamp and compare which one(s) are best at guiding the wrap material without slipping, thus smoothly enclose the top surface.	After Prototype	Trinh
4	Cutter	Compare the existing cutting mechanisms for Saran wraps and select the one that has the easiest and cleanest cut. Safety is also considered, such as exposed sharp edges.	After Prototype	Hou

Instructor Signature: Mary Malast

Date: 12/7/15

5.2 Engineering analysis results

5.2.1 Motivation. Describe why/how the before analysis is the most important thing to study at this time. How does it facilitate carrying the project forward?

In order to make this wrapping machine a good tool, it is key to have it work with a variety of food items. And that requires the food wrapping platform to have an arrangement and load capacity that can accommodate most common food items. After determining the dimensions and weights of these items, it is easy for us to determine how many parallel supports is needed and what kind of light metal materials can be used for fabrication.

5.2.2 Summary statement of analysis done. Summarize, with some type of readable graphic, the engineering analysis done and the relevant engineering equations

5.2.3 Methodology. How, exactly, did you get the analysis done? Was any experimentation required? Did you have to build any type of test rig? Was computation used?

5.2.4 Results. What are the results of your analysis study? Do the results make sense?

5.2.5 Significance. How will the results influence the final prototype? What dimensions and material choices will be affected? This should be shown with some type of revised embodiment drawing. Ideally, you would show a "before/after" analysis pair of embodiment drawings.

5.2.6 Summary of code and standards and their influence. Similarly, summarize the relevant codes and standards identified and how they influence revision of the design.

5.3 Risk Assessment (Systems Engineering program is your project. You are the project manager)

5.3.1 Risk Identification

The potential risks are outlined below. Each will be presented and described.

1) The item may fall on the ground and be damaged. Since it is made out of wood, a fall off a shelf presents the potential for the metal blocks to cause damage to the wooden base.
2) The wood may warp with continuous exposure to liquid.
3) Harsh use of the shaft (use beyond simple rotation, i.e. jiggling it frantically) may results in the damage of the rotating shaft impeding rotation.
4) Over exertion of the dowel onto the wrap holder can result in a break in the wrap holder. It is sturdy but slamming the dowel down may damage it.

5) Scraping the product on the surface may damage the no slip foam pads on the bottom. This will result in slipping of the system when in use.

5.3.2 Risk Analysis (This is based on your project engineering analysis. Tools include simulation, happiness equations, calculation by hand or with SolidWorks, MATLAB, etc.). Discuss risk as it pertains to your performance specification, cost, and schedule.

Tools used

1) Simulation: all simulation needs used Inventor 2015 CAD software. Inventor allowed for the successful mode construction of the system, allowing for all rotating parts and functions to be completed in a simulation.
2) User Needs: Happiness equations were used to access the requirements of the project as defined by a series of interviews with potential customers.

Risks defined in 5.4.1 will be accessed here in terms of the effect on the overall function if the risk were actualized.

1) If the item were to fall from a considerable height, it may be damaged. Damages of course range depending on the height at which it drops. At a weight of approximately 7 lbs, the system should be able to support a fall of an average counter height of 4 feet with minor cracks in the wood. Above that height risks potential fractures resulting in the separation of the wrap holder and wrap system from the metal rotating system. A fix would be easy with a simple application of glue with some structural problems.
2) Cleaning of the system with a lot of water may result in the warping of the wood. This risk though possible will not result in the failure of the system. The warped wood will slightly displace the direction the wrap is pulled out, however, wrap is flexible and can be redirected without adjustment to the system. The extent of warping of the system is not clear. However, assuming a total strain 20% in the top down plane will not substantially effect the system. However, a 20% strain so that the wood adjusts in height will reduce the stability of the system, potentially forcing it to rotate when using the product. Granted the weight of the metal block is substantial and the likelihood of a strain so large is unlikely.
3) Damage to the shaft is unlikely as it is made of aluminum. However, an above average individual may possibly deform the shaft, if he or she exerted excessive force as if they were pushing down on the system with their body weight. Unless intended, the force required to damage the shaft will most likely never happen incidentally.
4) If one slams the dowel onto the holder, one of the arms may break. However, due to the ease at which the dowel fits onto the holder, one does not need excessive force to fit it on. Thus damage will much more likely occur incidentally.
5) Foam can be damaged if one drags the system across either a rough surface or pushes down heavily and drags it. Most of these circumstances will either occur due to malicious intent of the user, or incidentally. Repeated causes of damage increase the likelihood of failure.

5.3.3 Risk Prioritization (Write a short description of how your team prioritized risk for your project. Include any tables or diagrams that support your prioritization).

In order to access risk, we chose the most likely scenarios that occur incidentally. The likely accidents will occur if the system falls off of the counter as it can get caught on clothing if someone walks close by it. However, it should withstand multiple falls within reasonable counter heights. A fall from a shelf height above the average height of a male will result in more damage however, only multiple falls of similar height will result in system failure. Judging the likelihood of this and all scenarios was difficult. So we tried an experiment by keeping the apparatus in our household and using it every now and then (approximately twice a week). Of those times we recorded zero occurrences of risks 3-5. However, the item fell off the table which it rested a total of 2 times over a month and a half. Our table is usually crowded so the item often ended up near the ends of it and caught on our jackets as we walked by. We cleaned it after use with a wetted paper towel and could notice any warping, granted a wetted paper towel provides minimal moisture.

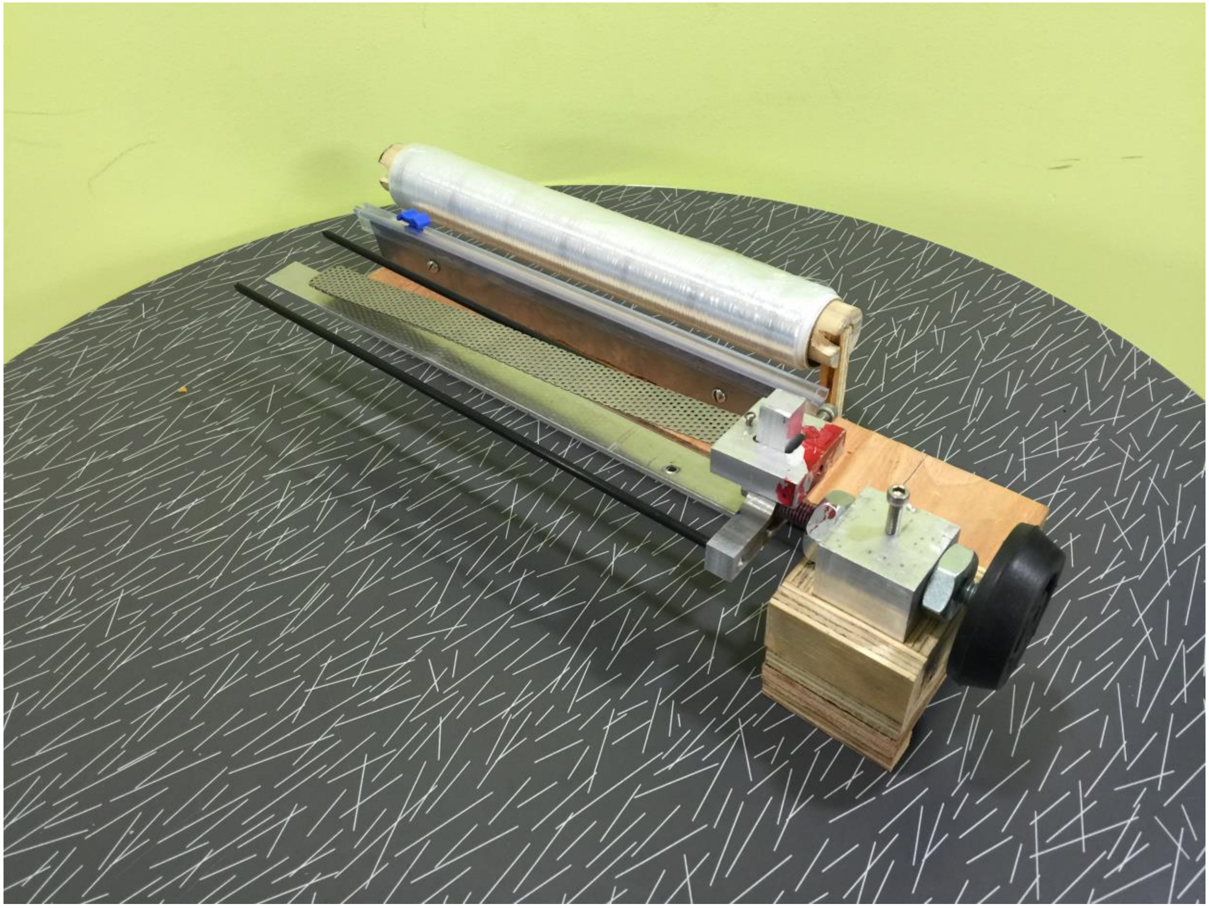
5.3.3.1 Risk Prioritization in the Systems Engineering Program

Priority then lies primarily in the risk associated with the system falling off of a surface. In order to deal with this risk, extra time is needed to ensure that surfaces be smoothed. Rough surfaces increase the potential of the system gripping clothing and being dragged off the table. One time the rotating shaft caught a pocket of a passerby. In order to avoid this, an effort should be made to reduce the shaft length as much as possible. Increased shaft length increases the chance that the shaft grip a passerby or a user's clothing. In general, the smoother the system, the less likely it is that the system fall.

In order to deal with warping risk, a reassessment of the wooden base material used is a priority. Instead of wood, a non-warping system will completely eliminate this risk (such as aluminum). Though it is noted that additional weight considerations will be needed if the base is altered to an aluminum one for safety of the user.

6 Working prototype

6.1 At least two digital photographs showing the prototype



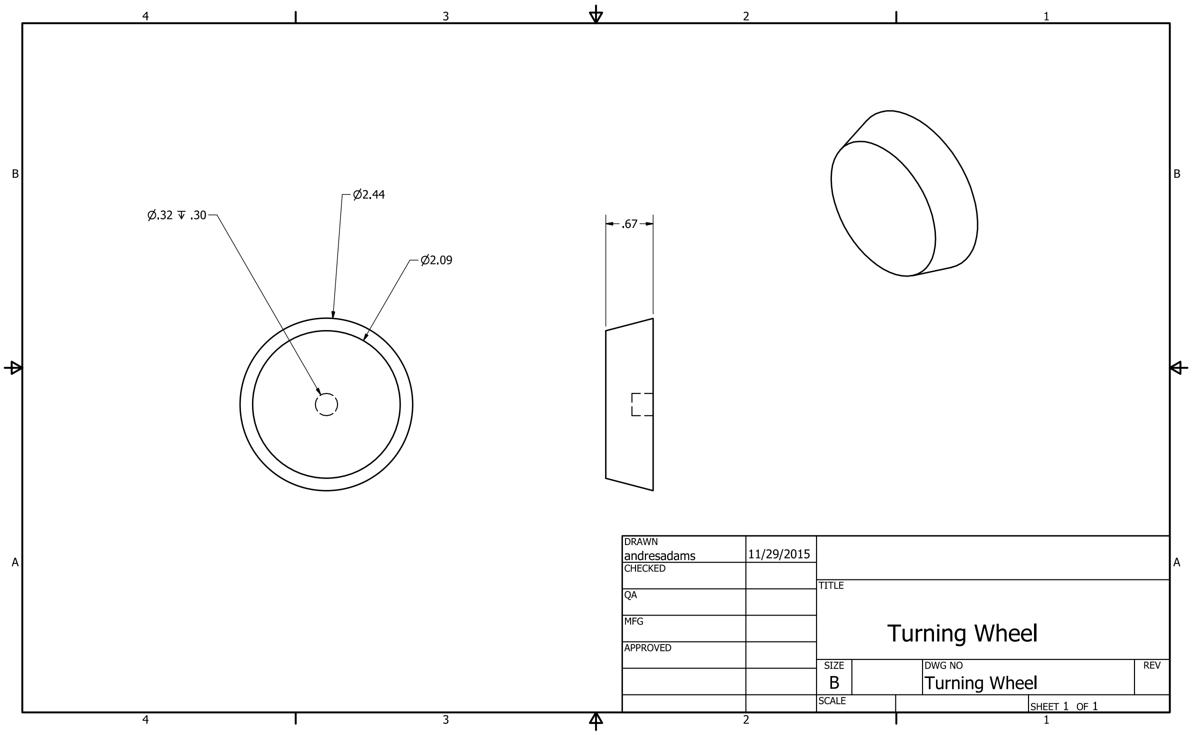
6.2 A short video clip that shows the final prototype performing

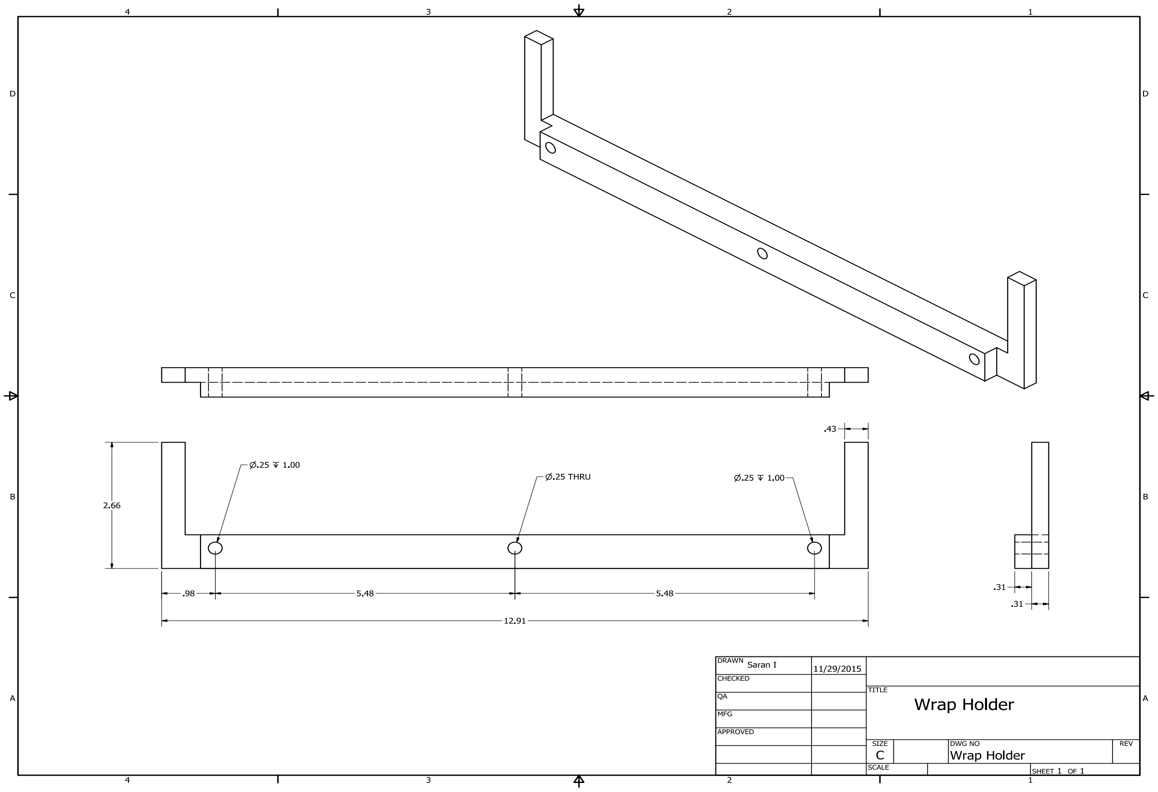
https://www.youtube.com/watch?v=g76nPctq6vw

7 Design documentation

7.1 Final Drawings and Documentation

7.1.1 A set of engineering drawings that includes all CAD model files and all drawings derived from CAD models. *Include units on all CAD drawings.* See Appendix C for the CAD models.

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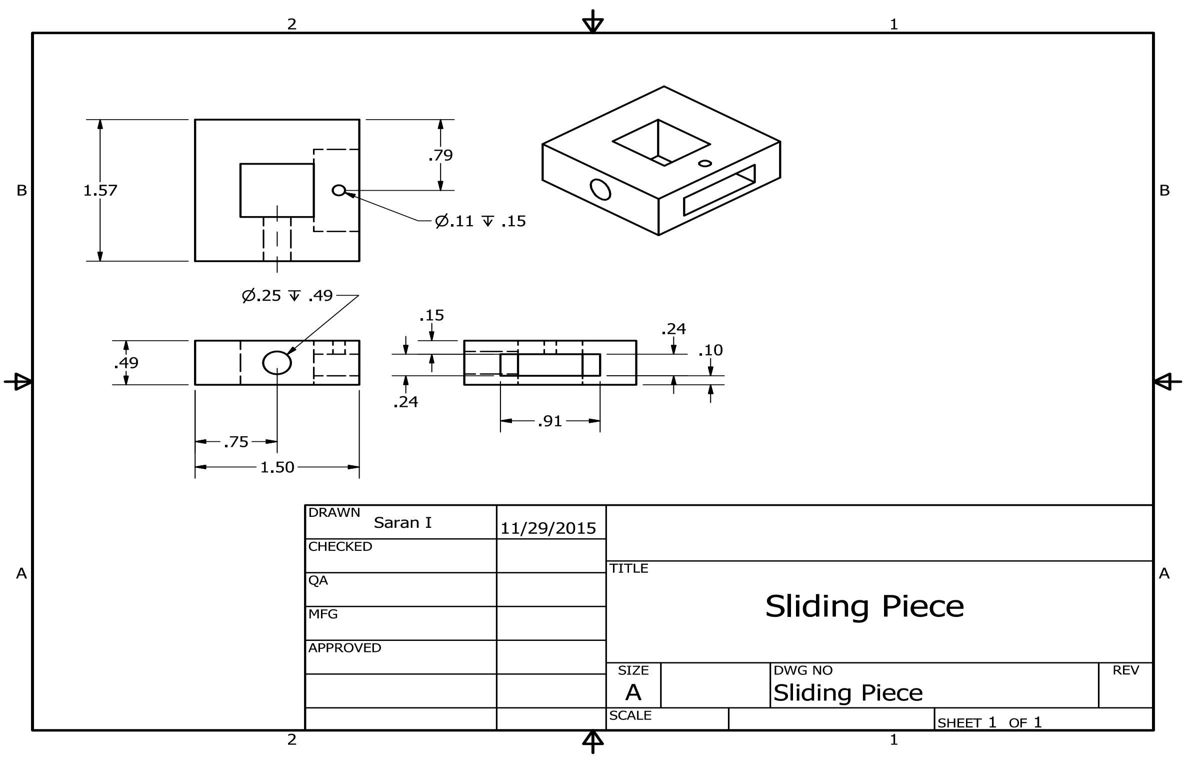
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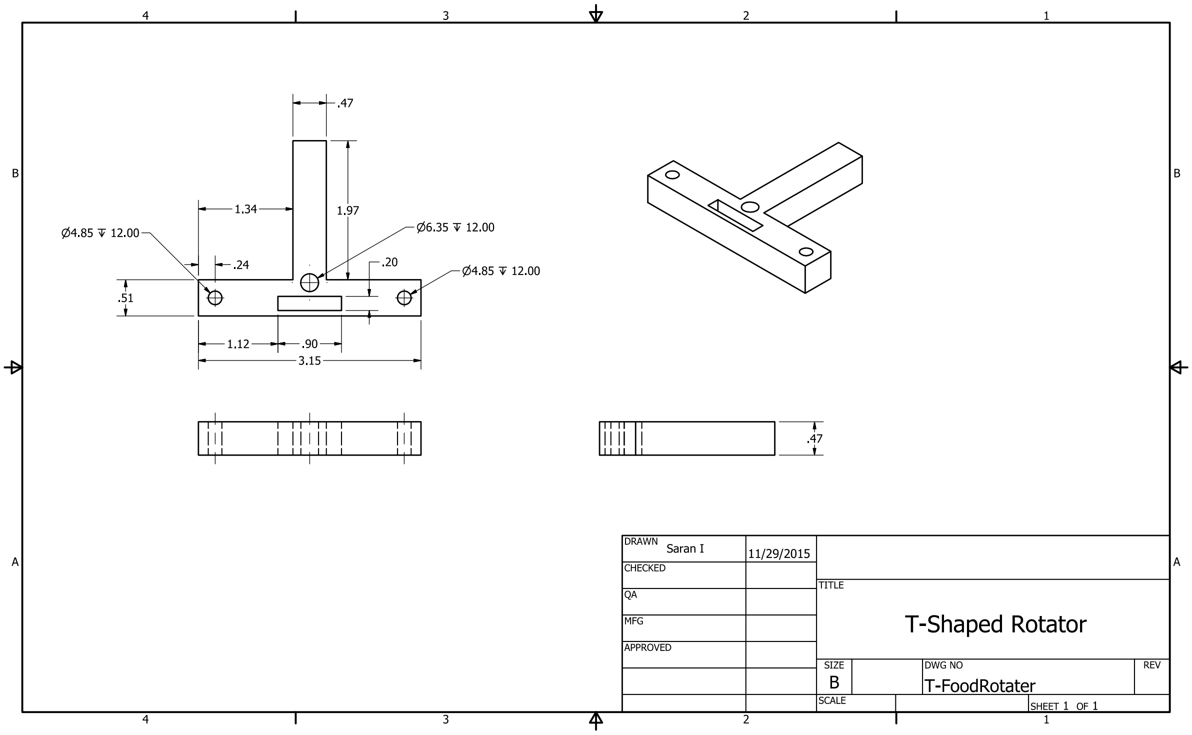
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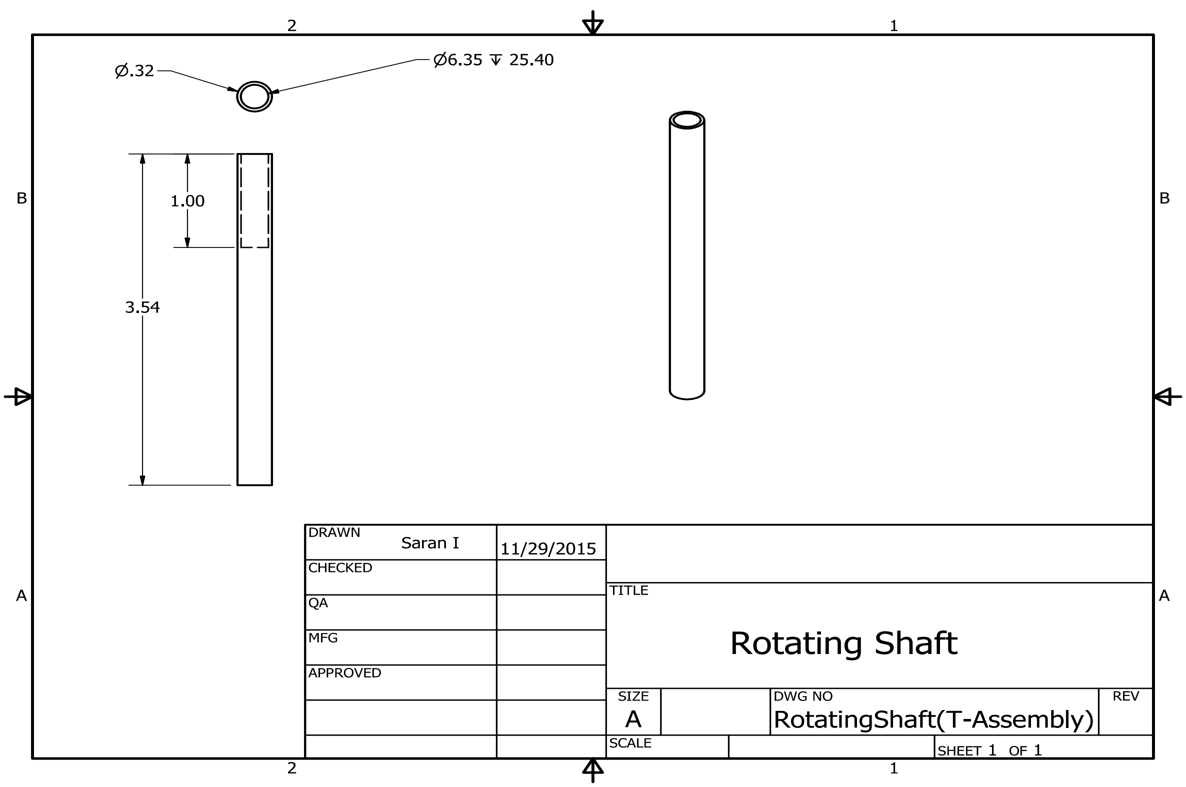
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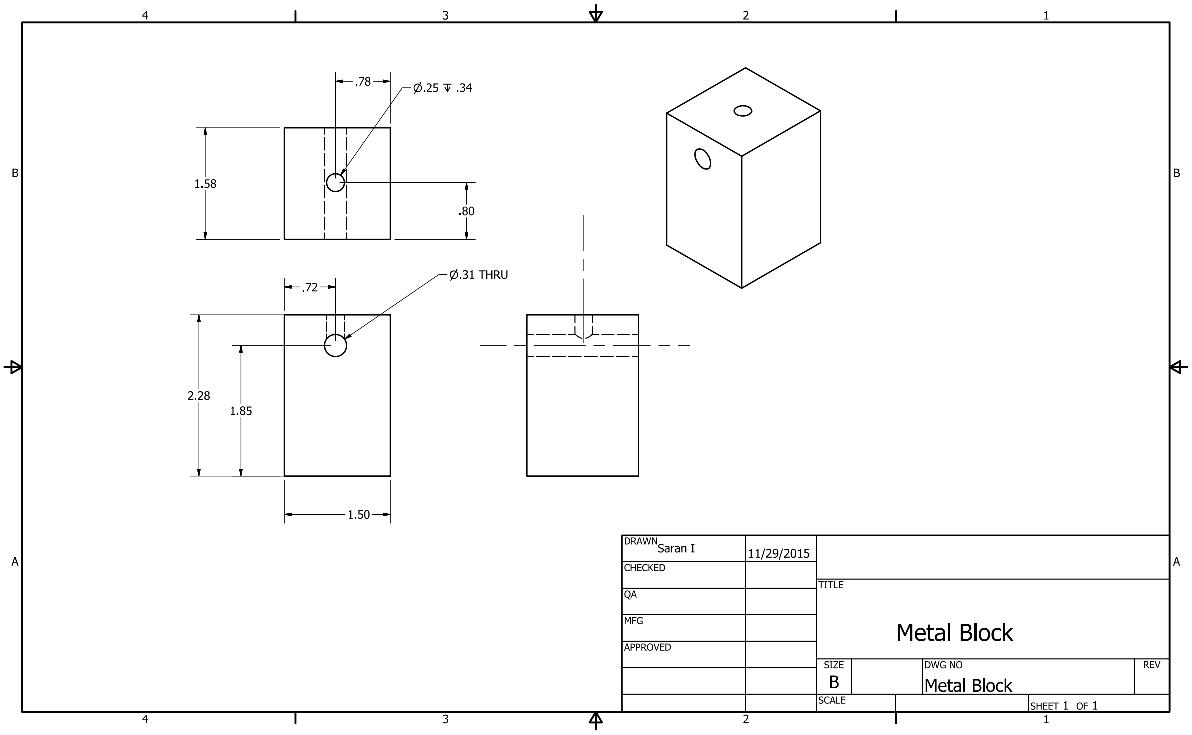
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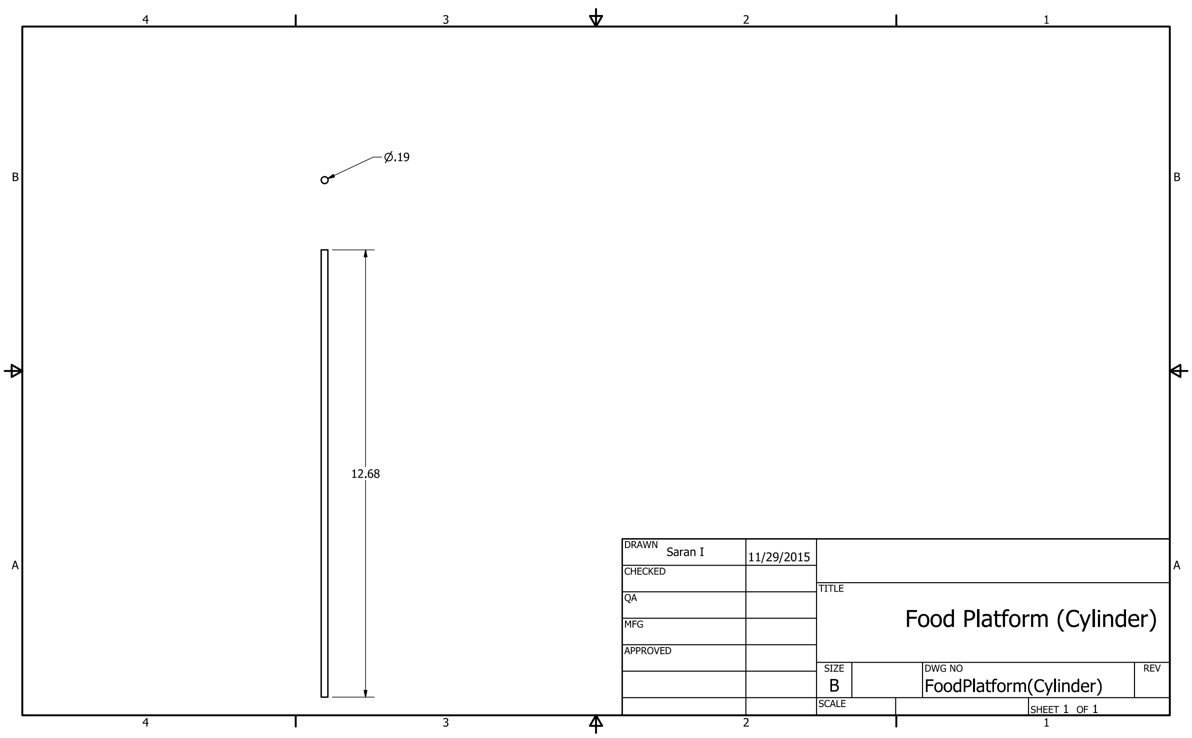
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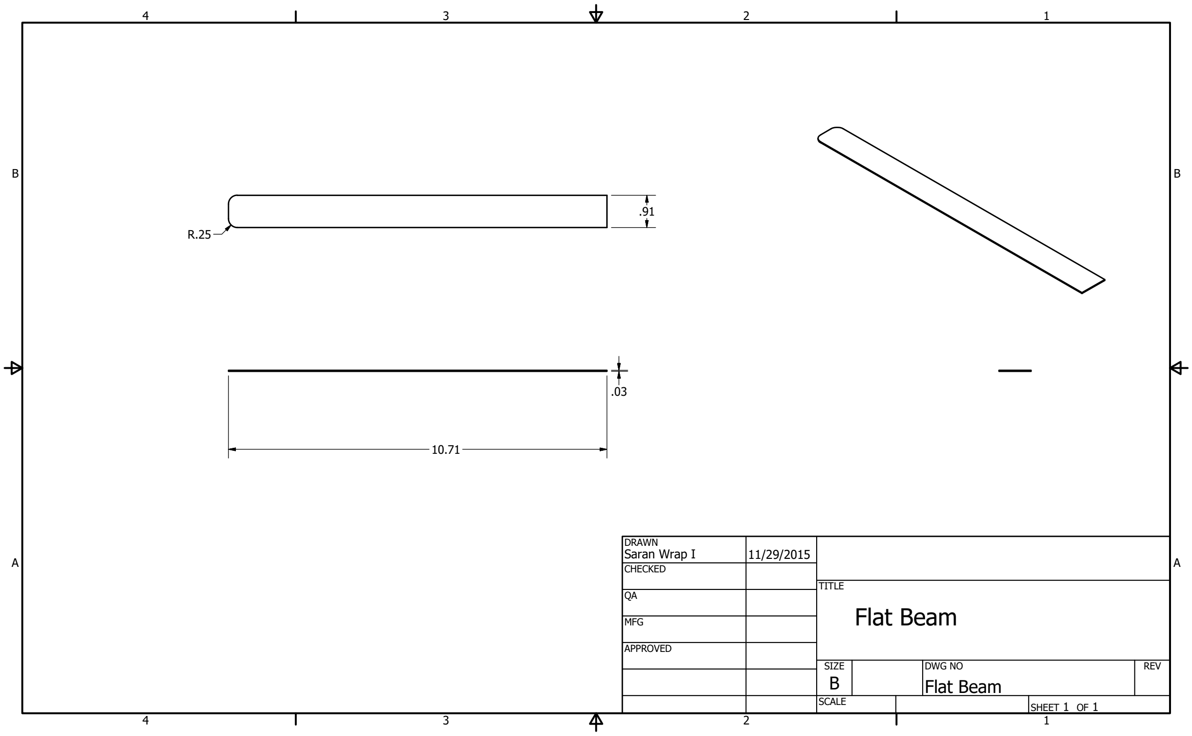
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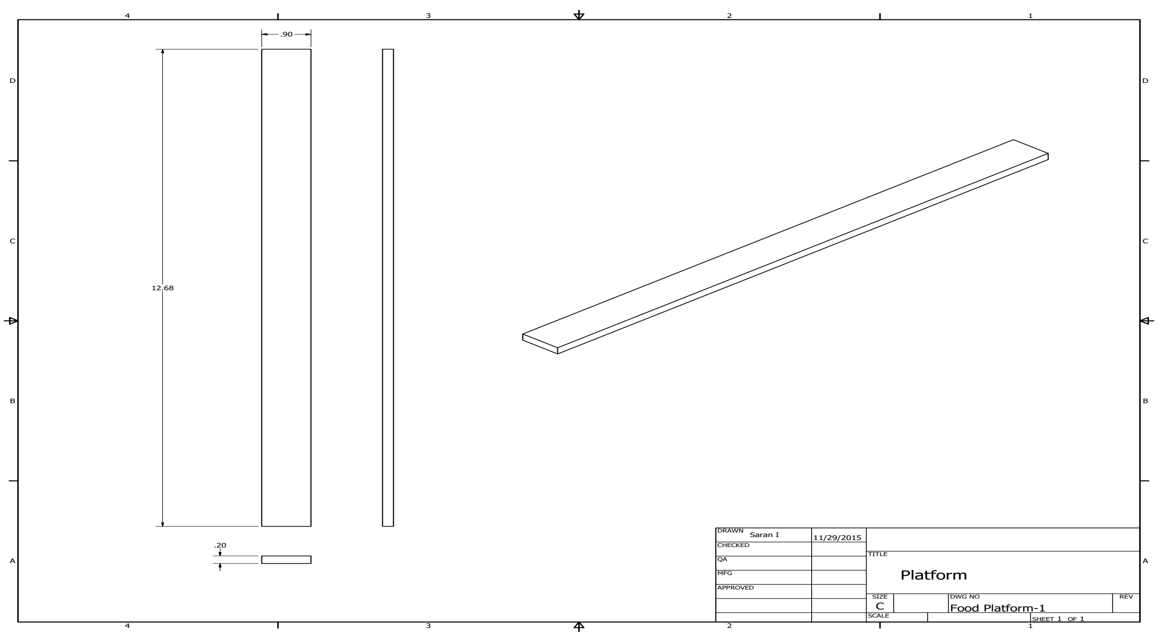
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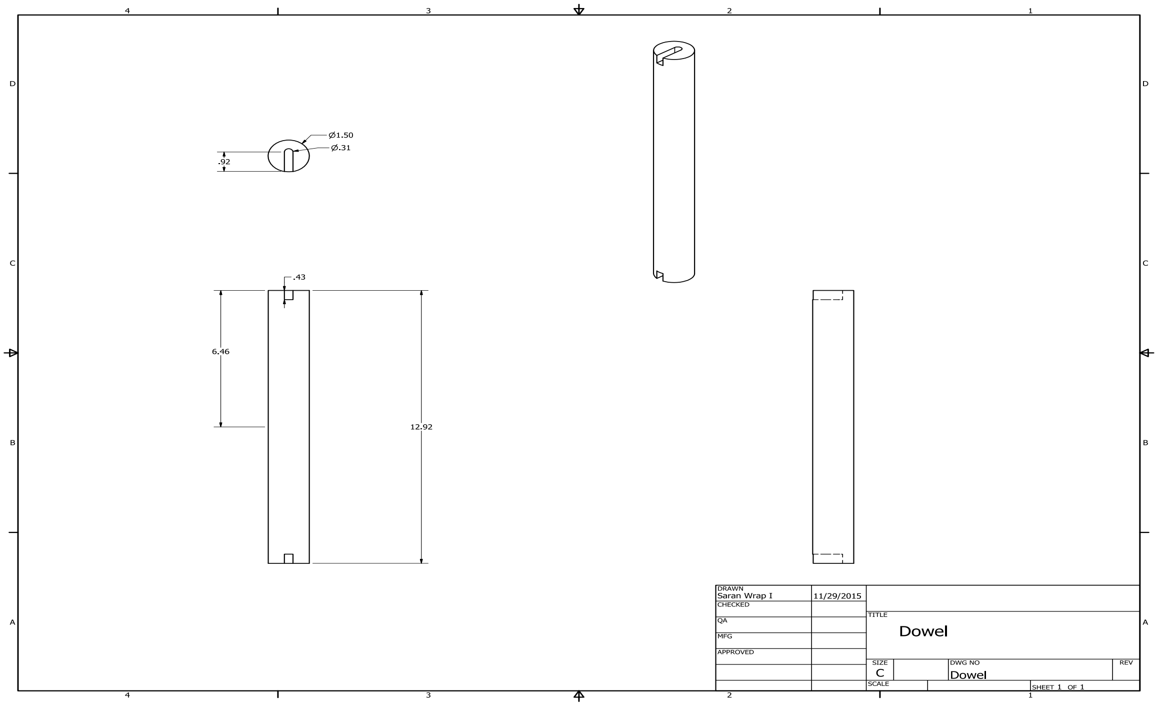
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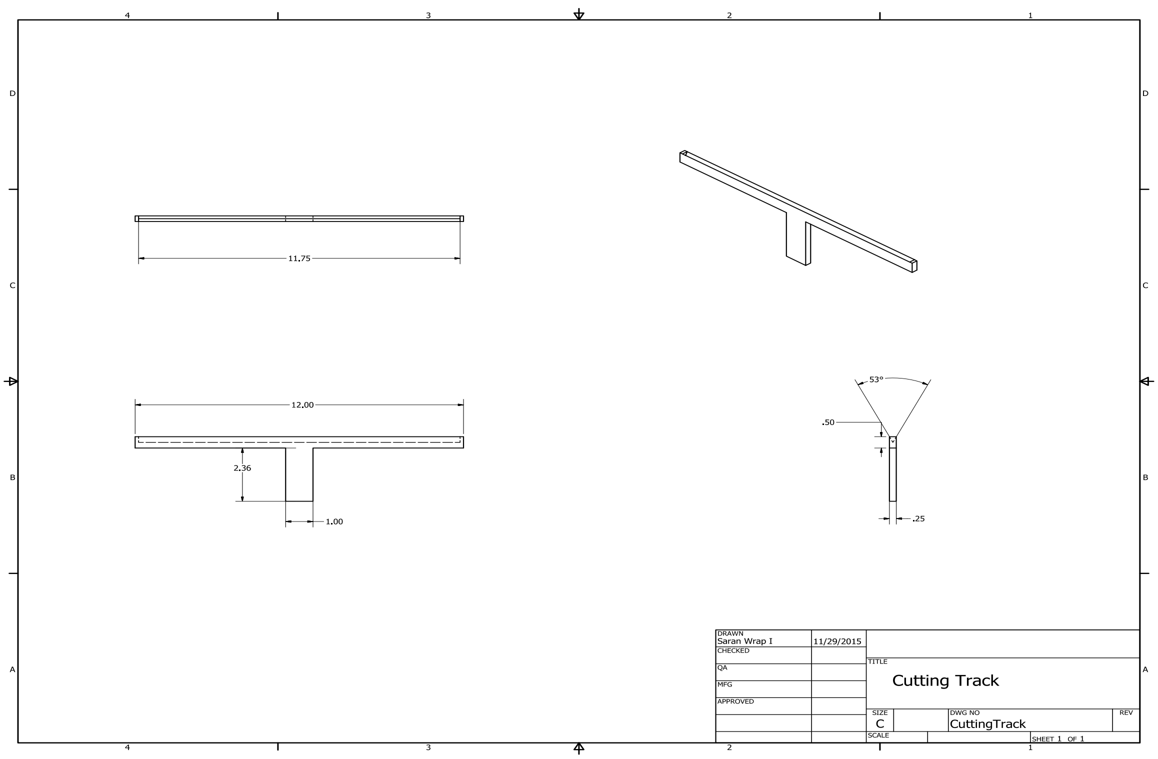
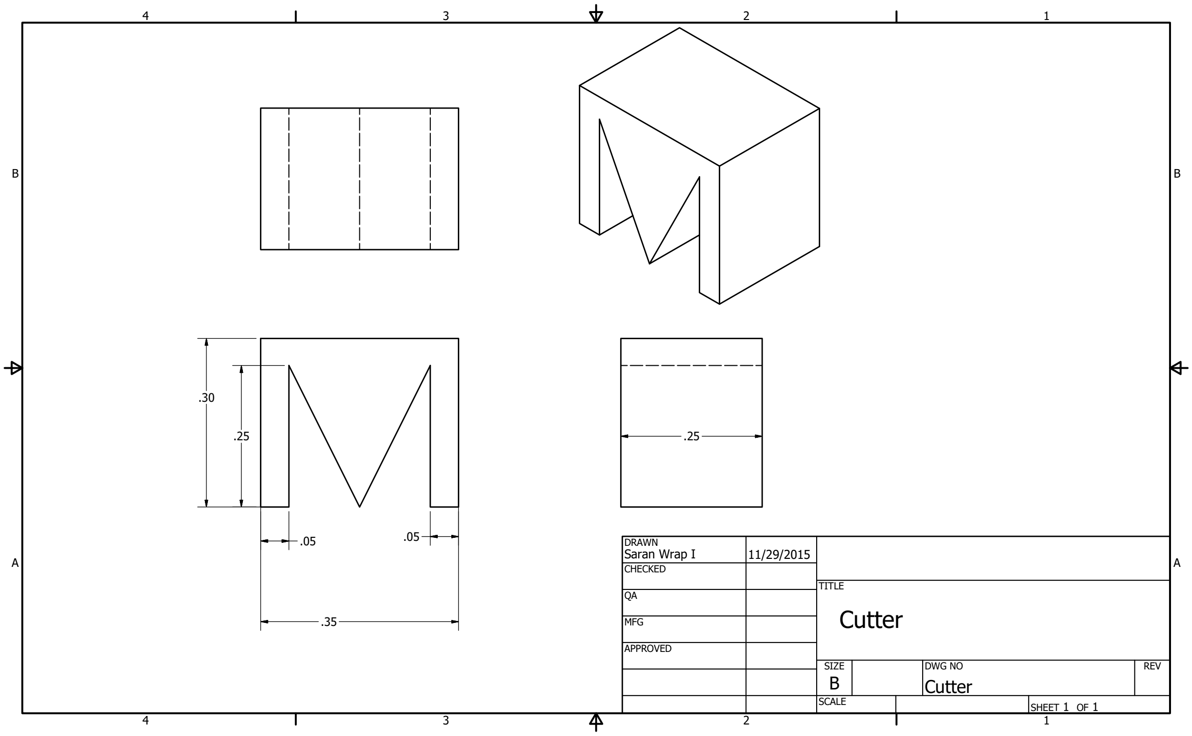
SHEET 1 OF 1


11.75
12.00
2.36
1.00
53°
.50
.25
DRAWN
Saran Wrap I
11/29/2015
CHECKED
QA
MFG
APPROVED
TITLE
Cutting Track
SIZE
C
DWG NO
CuttingTrack
REV
SCALE
SHEET 1 OF 1



.30
.25
.05
.05
.35
.25
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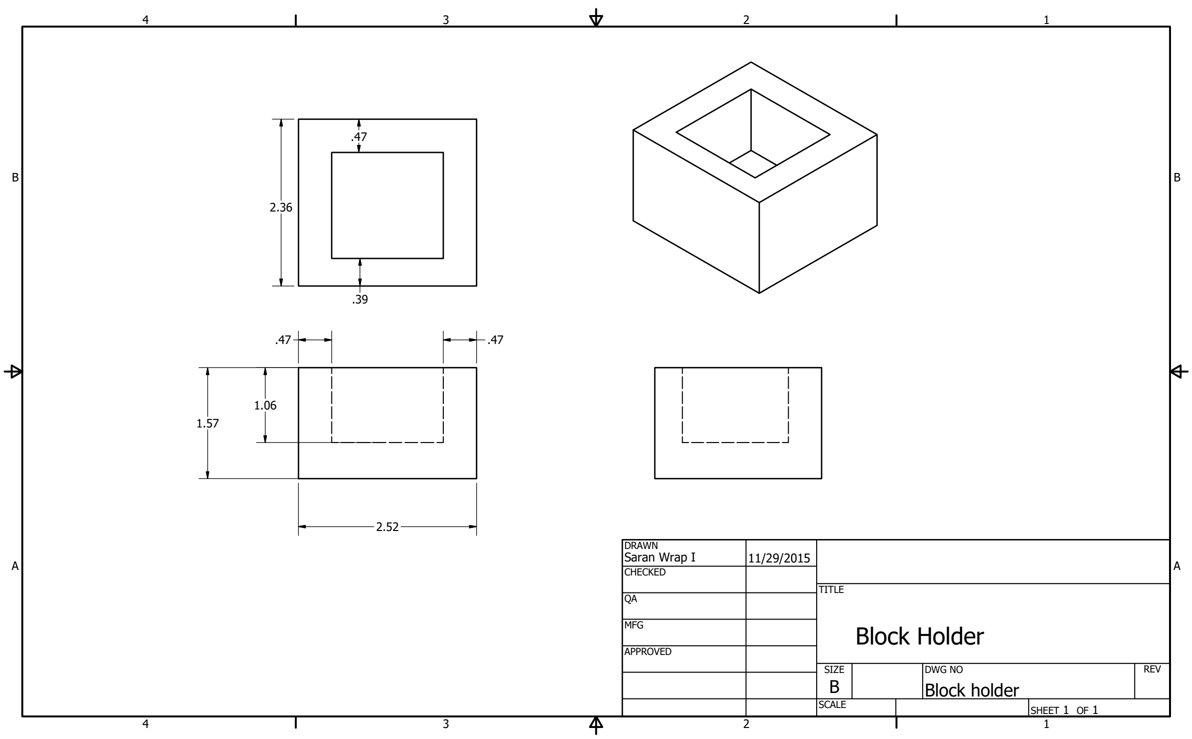
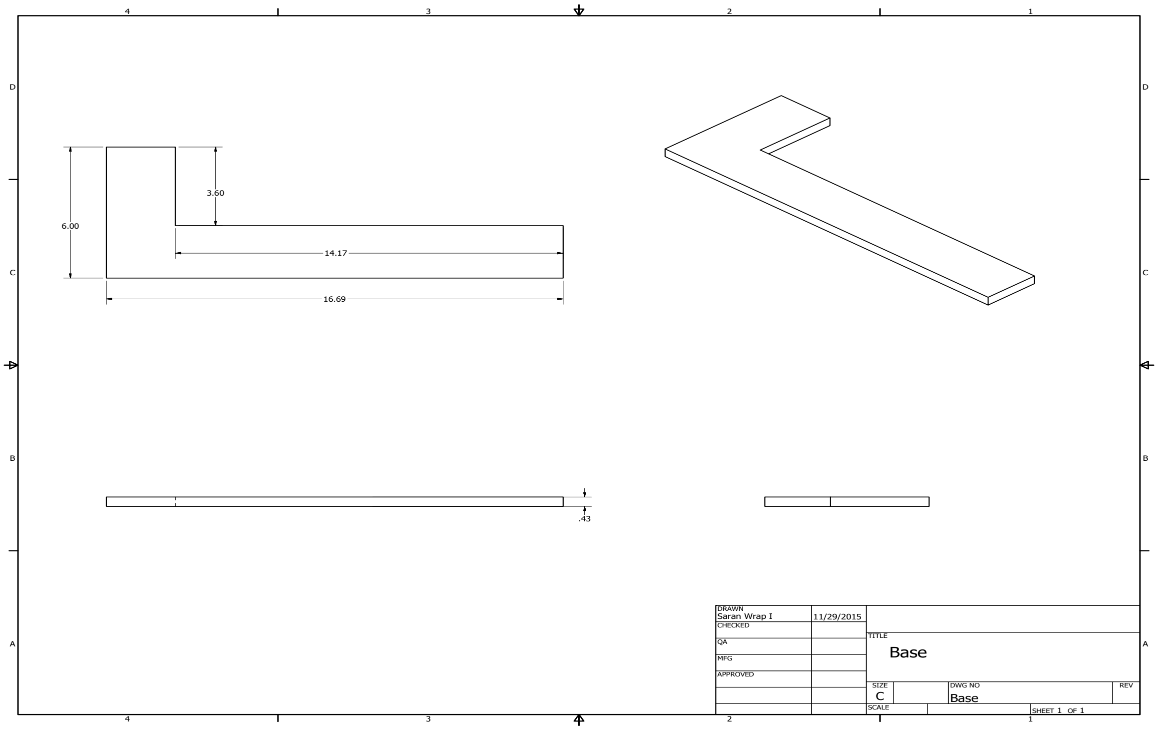
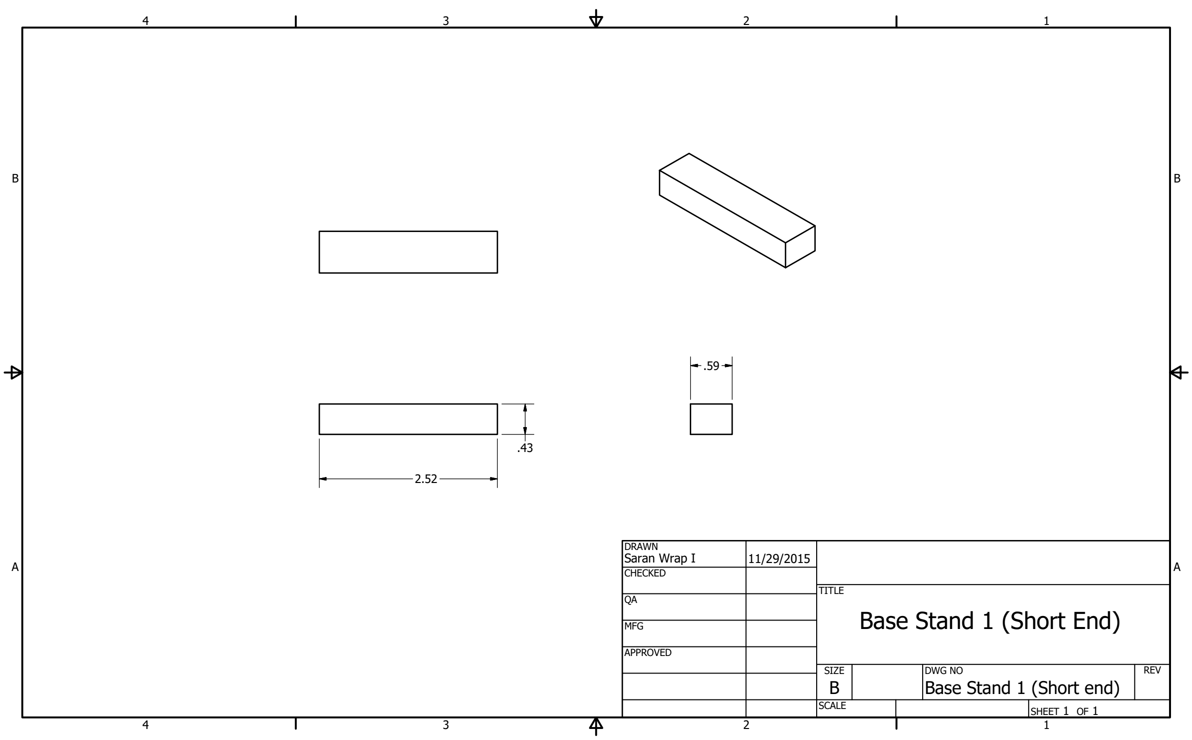
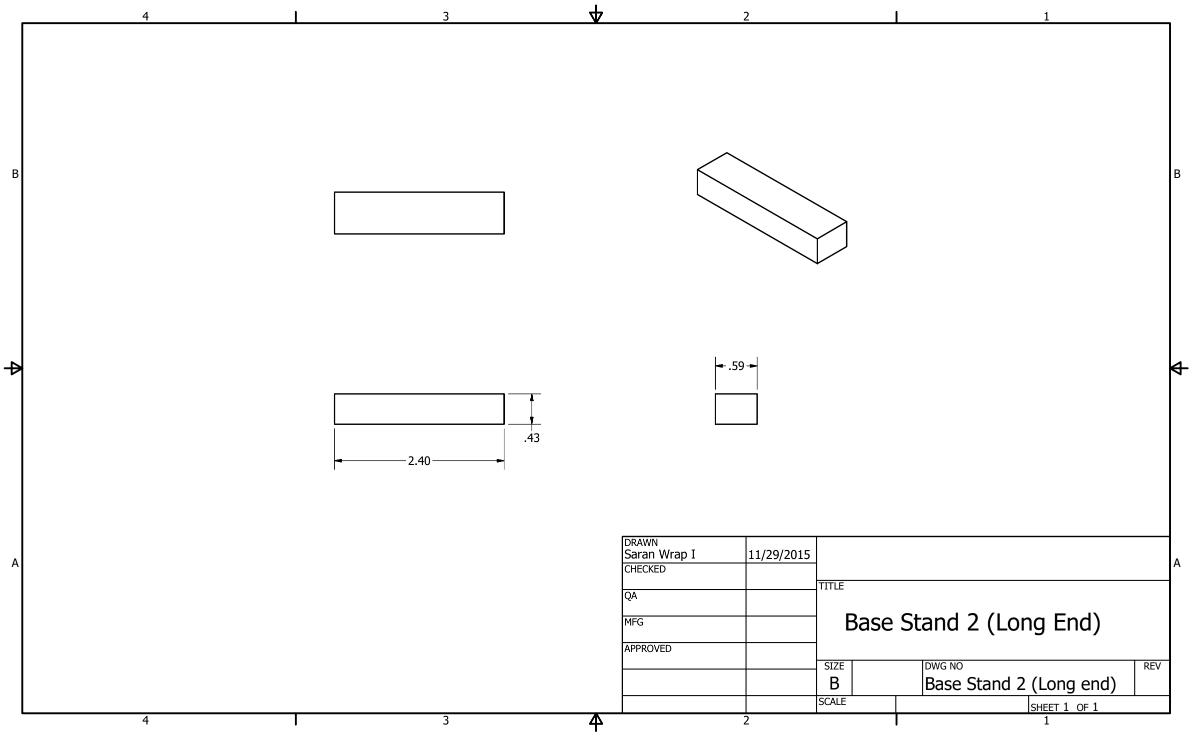
Saran Wrap I
11/29/2015
CHECKED
QA
MFG
APPROVED
TITLE
Cutter
SIZE
B
DWG NO
Cutter
REV
SCALE
SHEET 1 OF 1

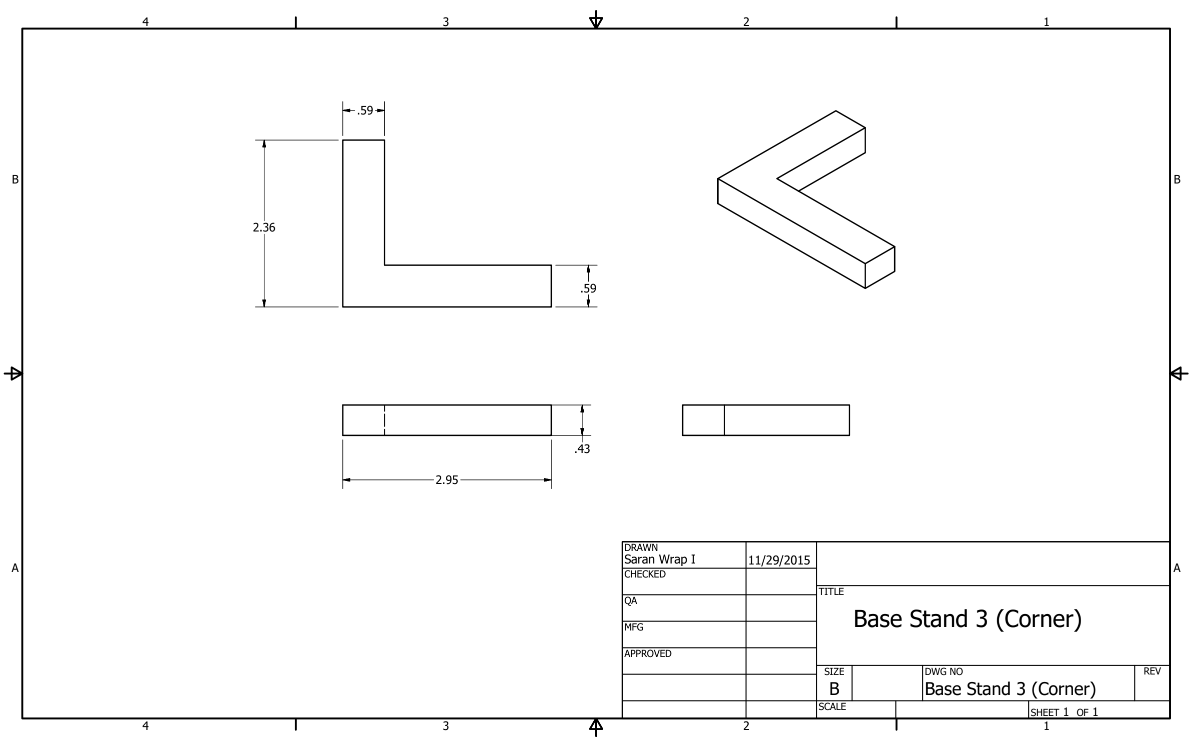


.47
2.36
.39
.47
.47
1.06
1.57
2.52
DRAWN
Saran Wrap I
11/29/2015
CHECKED
QA
MFG
APPROVED
TITLE
Block Holder
SIZE
B
DWG NO
Block holder
REV
SCALE
SHEET 1 OF 1


3.60
6.00
14.17
16.69
.43
DRAWN
Saran Wrap I
11/29/2015
CHECKED
QA
MFG
APPROVED
TITLE
Base
SIZE
C
DWG NO
Base
REV
SCALE
SHEET 1 OF 1


.59
.43
2.52
DRAWN
Saran Wrap I
11/29/2015
CHECKED
QA
MFG
APPROVED
TITLE
Base Stand 1 (Short End)
SIZE
B
DWG NO
Base Stand 1 (Short end)
REV
SCALE
SHEET 1 OF 1


4
3
2
1
B
A
.59
.43
2.40
DRAWN
Saran Wrap I
11/29/2015
CHECKED
QA
MFG
APPROVED
TITLE
Base Stand 2 (Long End)
SIZE
B
DWG NO
Base Stand 2 (Long end)
REV
SCALE
SHEET 1 OF 1


4
3
2
1
B
A
.59
2.36
.59
.43
2.95
DRAWN
Saran Wrap I
11/29/2015
CHECKED
QA
MFG
APPROVED
TITLE
Base Stand 3 (Corner)
SIZE
B
DWG NO
Base Stand 3 (Corner)
REV
SCALE
SHEET 1 OF 1

7.1.2 Sourcing instructions

The sourcing of all components can be found in the material stocks in the Machine Shop located on the first floor of Lopata Hall. Some of the metal pieces were already processed by previous users and were retrofitted to our project. The rest are raw materials that were hand crafted using basic machines during the final prototyping process.

7.2 Final Presentation

7.2.1 A live presentation in front of the entire class and the instructors (this section may be left blank)

7.2.2 A link to a video clip version of 1

https://youtu.be/G7Rxhaqfi0Q

7.3 Teardown

PROJECT: Saran Wrap I NAMES: Son Trinh INSTRUCTOR: Mark Jakiela

Yimin Hou Mary Malast

Andres Adams

Initials: ST, YH, AA

The following teardown/cleanup tasks will be performed:

- Remove the dowel and wrap from holder
- Un-screw holder from the base
- Remove metal fixture from the wooden base
- Unscrew metal block holder
- From metal fixture, unscrew and remove sliding piece
- Unscrew the wheel
- Remove the shaft
- Remove supporting items
- Put screws, ~~[illegible]~~ bolts and nuts into drawers
- Place wooden pieces in the cabinet
- Place big metal pieces in the cabinet and ~~[illegible]~~ dispose small pieces in the trash bin

Instructor comments on completion of teardown/cleanup tasks:

Instructor signature: Mary Malast; Print instructor name: Mary Malast

Date: 12/7/15

(Group members should initial near their name above.)

8 Discussion

8.1 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.

The new metrics are given in the figure below.

		Metric																	
		Length	Width	Area	Clean easiness	Number of compatible shapes	Noise level	Wrapping time	Weight	Number of safety hazards	Price	Number of attempts	Power choice	Level of deformation	No. of manual actions	Leak/Break?	Need Happiness	Importance Weight (all entries should add up to 1)	Total Happiness Value
	Need	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15			
1	SWHD is a little bigger than an average sandwich.	0.5	0.5														0.8333333	0.066	0.055
2	SWHD is lightweight and compact.	0.333	0.333						0.333								0.555	0.066	0.03663
3	SWHD holds the item together without leaking/breaking.															1	1	0.082	0.082
4	SWHD hosts a variety of shapes.					1											1	0.082	0.082
5	SWHD is quiet						1										1	0.049	0.049
6	SWHD wraps in one attempt.											1					1	0.066	0.066
7	Amount of wrap.			1													0.6	0.049	0.0294
8	SWHD wraps within 10 seconds.							1									0.6666667	0.066	0.044
9	SWHD has battery or plug-in power.												1				1	0.066	0.066
10	SWHD can be cleaned in a simple process.				1												0.75	0.082	0.0615
11	SWHD costs below $50.										1						0.6779661	0.082	0.0555932
12	SWHD makes low deformation to items.													1			0.8	0.033	0.0264
13	Minimum manual actions required.														1		0.3333333	0.049	0.0163333
14	SWHD is safe for all ages to use.									1							0.6	0.082	0.0492
	Units	cm	cm	cm^2	Integer	Integer	dB	Seconds	kg	Integer	USD ($)	Binary	Binary	Integer	Integer	Integer	Total Happiness		0.51003
	Best Value	20	20	0	5	8	0	5	2	0	1	1	1	0	2	0			
	Worst Value	50	50	100	1	1	100	20	5	5	60	0	0	5	5	5			
	Actual Value	40	10	40	4	8	0	10	5	2	20	1	1	1	4	0			
	Normalized Metric Happiness	0.33	1.33	0.60	0.75	1.00	1.00	0.67	0.00	0.60	0.68	1.00	1.00	0.80	0.33	1.00			

The needs exceeded those of the other concept designs as judged by the happiness scores. For reference to how the particular product worked for a particular need can be seen in the figure above. Some of its exceptional areas are noise, function, and price.

8.2 Parts sourcing

Overall, our parts sourcing process went very smoothly, since all our raw materials come from the metal and wood stockings in the machine shop of our engineering school. In addition, we were fortunate enough to find many previously crafted pieces of metal that can fit our design, which greatly facilitated our fabrication process.

For future projects, we should also include more outside materials available for purchase on the market to further optimize our design. In particular, plastic materials will be a very ideal addition for our wrapping device.

8.3 Discuss the overall experience:

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

The project turned out to be a little more difficult than our initial expectations, but within the reasonable range. Most of the extra difficulty comes from the subtle differences between our ideal fabrication process and the real experience with the raw materials in the machine shop.

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

Our final prototype well satisfies the project descriptions by requiring minimum user effort to the wrapping process and, at the same time, prevents regular problems of Saran wrap such as tangling. In addition, it can accommodate a wide range of objects from regular sandwiches to foot-long subways and even soup bowls.

8.3.3 Did your team function well as a group?

Throughout the project, three of us maintained a very collaborative team-working relationship. We identified each member's interests and collectively decide the responsibilities of each individual for each assignment.

8.3.4 Were your team member's skills complementary?

Each team member contributed to projects in a specific manner based on our interests and talents. Fortunately, three of us have complimentary skills that enabled us to cover the whole project without much difficulty in any specific field over the course of this semester.

8.3.5 Did your team share the workload equally?

We always study the different assignments and equally distribute the work so everyone has a fair share of progress to make towards our final project.

8.3.6 Was any needed skill missing from the group?

No specific skill was missing during our collaboration. For each specific field of work, at least one of us is willing and good at getting the job done.

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

We were in constant touch with our clients to make sure our progress is in pace with any updates in their user expectations. Overall, our clients kept a consistent list of user needs, which we were sticking to from the initial design concept till the final prototype manufacturing.

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

The design brief has been consistent overall, only with minor updates in respect to our latest prototype process.

8.3.9 Has the project enhanced your design skills?

This design project greatly enriched our understating in the design world. We were able to learn crucial design skills such as identifying and meeting user needs, as well as translating the theoretical design to a real-world product.

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

After this extensive design and prototyping process, each of us have gained a lot of experience and confidence in terms of doing future design projects in a work setting. Most importantly, we have had a first hand experience going through this entire design cycle and see our project evolved through every single step of the way to a real working prototype.

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

Now that we have tackled a real-life household problem of handling Saran wrap, we are thinking of applying our expertise to more household everyday tools and gadgets to make them even more user-friendly.

9 Appendix B - Bill of Materials

	Part	***Source***	***Supplier Part Number***	***Color, TPI, other part IDs***	***Unit price***	***Tax ($0.00 if tax exemption applied)***	***Shipping***	***Quantity***	***Total price***
1	Dowel	Home Depot	7.73205 E+11	1-1/4"X48"	$4.98	$0.50	$0.00	1	$4.98
2	Saran Wrap	Schnucks	N/A	Red package	$2.29	$0.20	$0.00	1	$2.29
3	Super Glue	Shcnucks	N/A	Red package	$3.19	$0.40	$0.00	3	$9.57
4	Metal	Machine Shop	N/A	N/A	$0.00	$0.00	$0.00	4	$0.00
5	Wood	Machine Shop	N/A	N/A	$0.00	$0.00	$0.00	3	$0.00
Total									$16.84