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Saran Wrap 2: Clip Handling Device

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Washington University in St. Louis

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The common household Saran Wrap has been in production since 1933. A common problem comes in the handling of the plastic sheet after being torn from the roll. Corners frequently fold on themselves, the sheet bunches up, and renders some pieces useless. Our objective was to create a device along with a system to eliminate these problems, without compromising the simplicity and speed of the original box cutter.

MEMS 411 Saran Wrap II

Clip Handling Device

Alex Arteaga, Brian
Lockwood, & Cameron
Adams

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

A common problem comes in the handling of the plastic sheet after being torn from the roll. Corners frequently fold on themselves, the sheet bunches up, and renders some pieces useless.

1.2 List of team members

Saran Wrap II

Alex Arteaga
Brian Lockwood
Cameron Adams

2 Background Information Study

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

A common problem comes in the handling of the plastic sheet after being torn from the roll. Corners frequently fold on themselves, the sheet bunches up, and renders some pieces useless. We want to create a device that addresses these issues while maintaining the simplicity of the task. Operating the device should not be more of a hassle than the original box cutting method. To ensure marketability the device should be cheap to manufacturer and should not take up much counter space. The device should not take up anymore more space than a microwave and the cost to produce the device should be able to be achieved for under \$20.00. Our assumption being that anything outside these constraints compromises the simplicity of the problem solution.

2.2 Summary of relevant background information See other homework for this info

US 20140225392 A1: sheet manipulating device

US 20100089010 A1: roll handling clip

3 Concept Design and Specification

3.1 User needs, metrics, and quantified needs equations.

3.1.1 Record of the user needs interview

Customer Needs Interview

Customer Data: Saran Wrap Handling Device			
Customer: Mark <u>Jakiela</u>			
Address: Washington University Medical School 2015			Date: 16 September
Question	Customer Statement	Interpreted Need	Importance
Does it have to be fully automated?	No	Simplifies handling of saran wrap	2
How quickly does it need to wrap food?	Time of completion is secondary to just simplifying the process	Simplifies handling of saran wrap	4
How big can it be?	Small enough to fit on a counter top	Device must be small/lightweight	4
How much saran wrap should it use?	It should minimize the amount of wasted saran wrap	Efficient use of saran wrap	5
What can be done to make it home-friendly?	It shouldn't require too many actions and should be reasonably affordable	Minimize human actions Minimize moving parts Minimize cost	3

3.1.2 List of identified metrics

Identified Metrics

Need Number	Need	Importance
1	Device simplifies handling of saran wrap	5
2	Device is small and lightweight	3
3	Device makes maximally efficient use of saran wrap	4
4	Device minimizes human actions	3

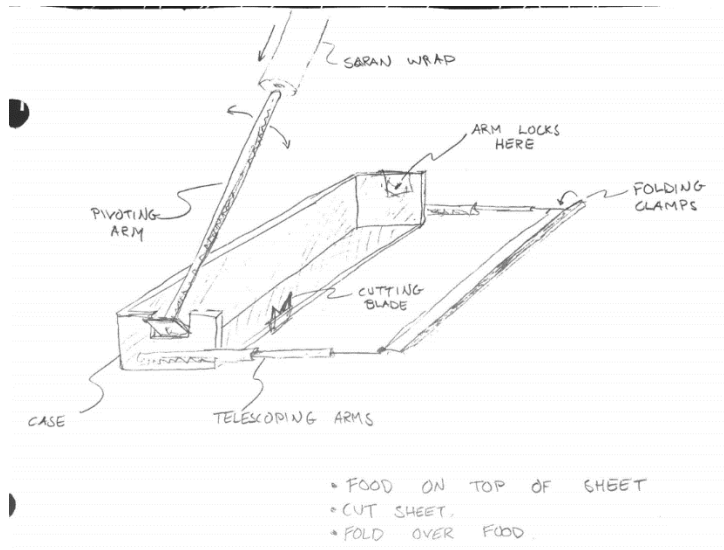
5	Device has minimal moving parts	3
6	Device is inexpensive	4
7	Time to completion	3

3.1.3 Table/list of quantified needs equations

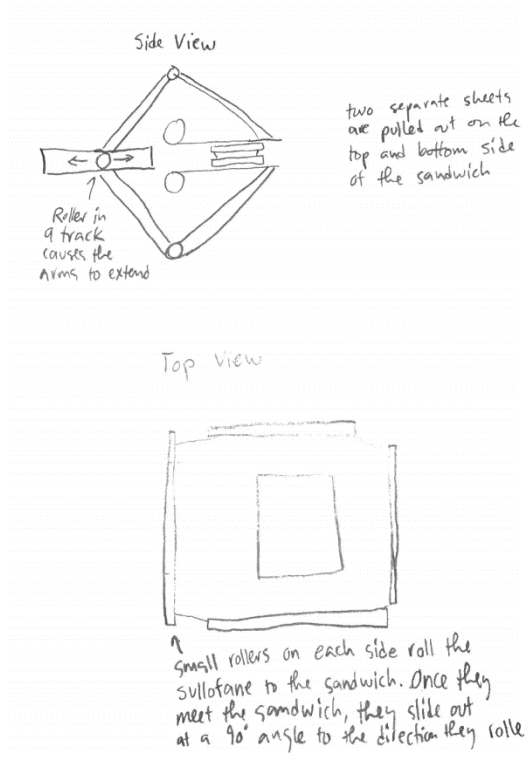
Design Metrics: Saran Wrap Handler					
Metric Number	Associated Needs	Metric	Units	Min Value	Max Value
1	2	Length	cm	30	40
2	2	Weight	lbs	1	15
3	2	Total volume	in ³	20	4,000
4	1, 4	Number of manual actions	Integer	1	10
5	1, 3	Amount of wasted saran wrap	in ²	0	60
6	1, 5	Number of moving parts	Integer	1	5
7	1	Time of completion	s	5	60
8	6	Manufacturing price	\$	1	30

3.2 Four concept drawings

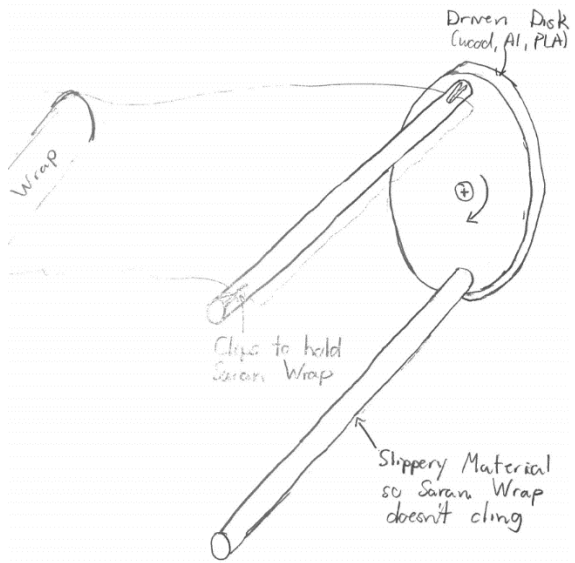
Design 1:



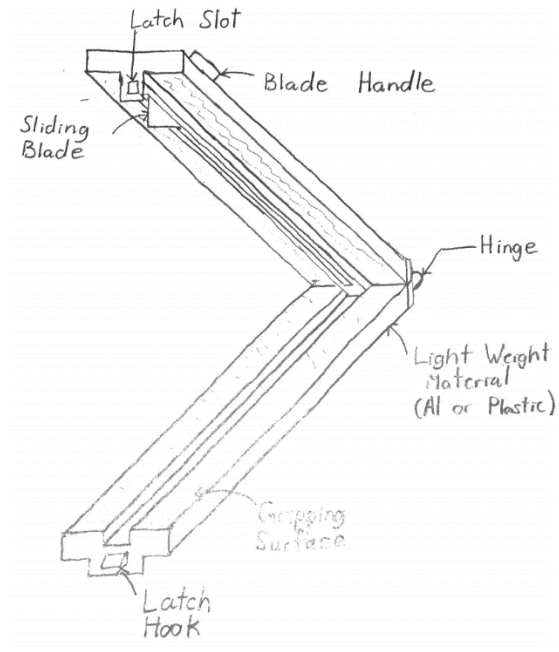
Design 2:



Design 3:



Design 4:



3.3 A concept selection process

3.3.1 Concept scoring

3.3.2 Preliminary analysis of each concept's physical feasibility

Design 1: This concept is perhaps one of the most feasible of the 4 presented above. A potential difficulty in the design of this concept is the placement of the cutting blade. As drawn the blade is placed beneath the saran wrap sheet, rendering it difficult to operate by the user. This would necessitate either relocating the blade or coming up with an alternative method of operating it. The telescoping arms may also present a challenge in that they would need to be very low friction to make this a plausible design concept. Additionally they would need to be fairly strong while minimizing weight and material needed.

Design 2: This design idea is desirable in that it could potentially do the best job of minimizing wrapping time, while also keeping human interaction to a minimum. However, as a consequence of the high level of automation, this design is fairly complex and unlikely to work well in practice. This was, in fact, the lowest scoring design based on the quantified needs equations. This was mainly a result of the complexity (too many moving parts) and the design's bulky size and shape.

Design 3: This revolving design was another low scoring concept. This was mainly a result of the large amount of wasted saran wrap involved in this method of wrapping, as well as the lengthy time required to wrap food without damaging it in the revolving parts. Size is also a concern with this design. While the parts themselves may not be of a very high volume, once in motion the device will effectively occupy a rather large amount of space. On top of that its versatility is less than desirable in that it would not handle the task of covering a bowl very well. This design would also be considerably more expensive due to the cost of a small motor to drive it.

Design 4: This design is the highest scoring concept of the 4 above. It scored very highly in metrics related to size and weight due to its compact shape. It requires very little material which minimizes both weight and cost. Additionally it has one of the best performances in terms of efficiency; it is unlikely to end up with much wasted or damaged saran wrap.

3.3.3 Final summary

WINNER: Design 4 (Edge Clamp)

Concept 4 is the best overall design because it balances the necessary metrics the best. While design 2 might be the most efficient it would be very difficult to produce in practice and would end up costing much more. Similarly, design 3 might make the process the "easiest" with its full automation, but it achieves this at the expense of weight, volume, cost and time. Concept 3 is another viable design but overall it doesn't excel in as many areas as concept 4. It does much the same thing but it's a little bit bigger, a little bit heavier, and a little more complex. When these slight shortcomings add up, concept 4 comes out as the best overall choice.

3.4 Proposed performance measures for the design

1. Length less than 16 in.
2. Wastes no more than 24 in² of saran wrap.
3. Wraps food in less than 1 minute.
4. A producer would need to charge no more than \$10.00
5. A novice could successfully use the device after only 1 demonstration of its use.

3.5 Design constraints

3.5.1 Functional

It must wrap a food item that can traditionally wrapped with Saran Wrap without taking more time or effort than currently takes place.

3.5.2 Safety

Must have any sharp components safely protected and the device should be able to be used regularly without threat of injury.

3.5.3 Quality

Must be dependable and allow for easily repeatable use without damaging the device; device will not be subjected to high levels of stress but will still have to be reliable.

3.5.4 Manufacturing

Should lend itself to easy mass production for potential commercial use.

3.5.5 Timing

Does not necessarily need to speed up the wrapping process, but should at least take a similar amount of time to the current system.

3.5.6 Economic

For commercial use, the device should be able to satisfy all other demands but at a price point that lends itself to being commercially viable.

3.5.7 Ergonomic

Should increase the ease of handling Saran Wrap, and minimize the waste while also being capable of carrying out the required task

3.5.8 Ecological

Since there are no emissions produced by this device and it isn't supposed to be easily disposable, the bulk of this concern falls on manufacturing and limiting the waste while disposing of waste responsibly

3.5.9 Aesthetic

Should look consumer friendly and like an item that someone would feel comfortable having in their kitchen.

3.5.10 Life cycle

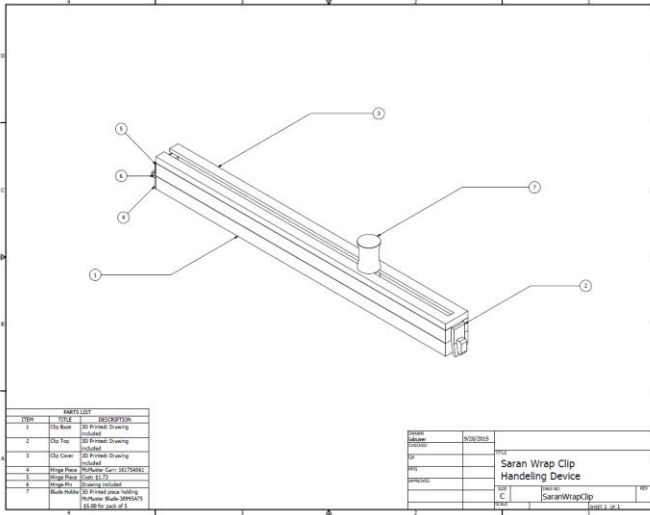
Device should be built to last for years and not a one-time use device.

3.5.11 Legal

Should be safe and avoid copying other devices or copyright.

4 Embodiment and fabrication plan

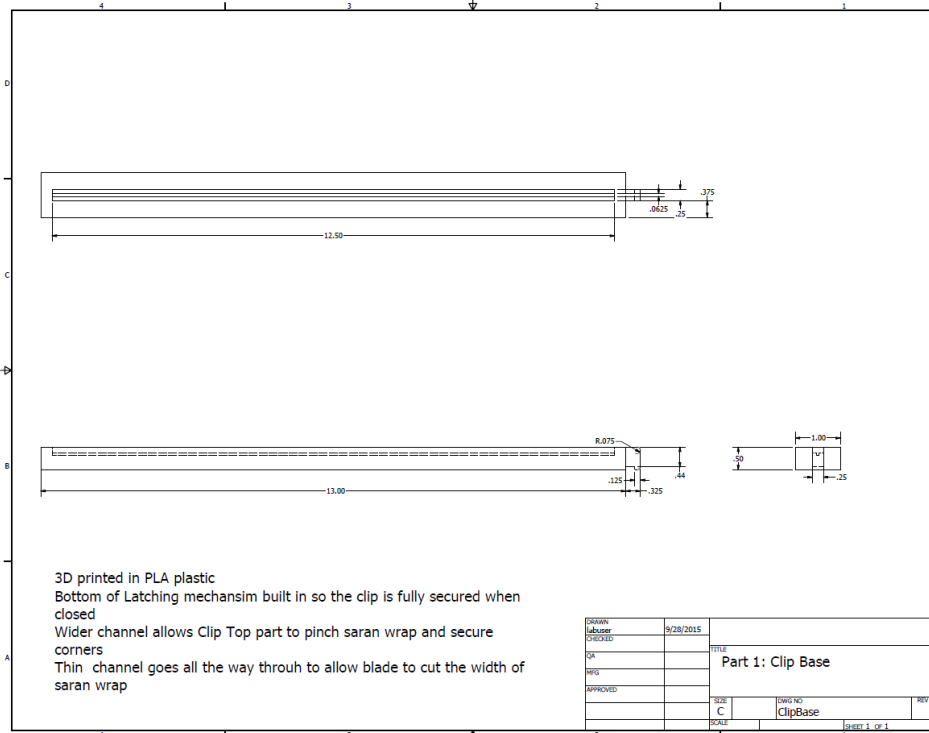
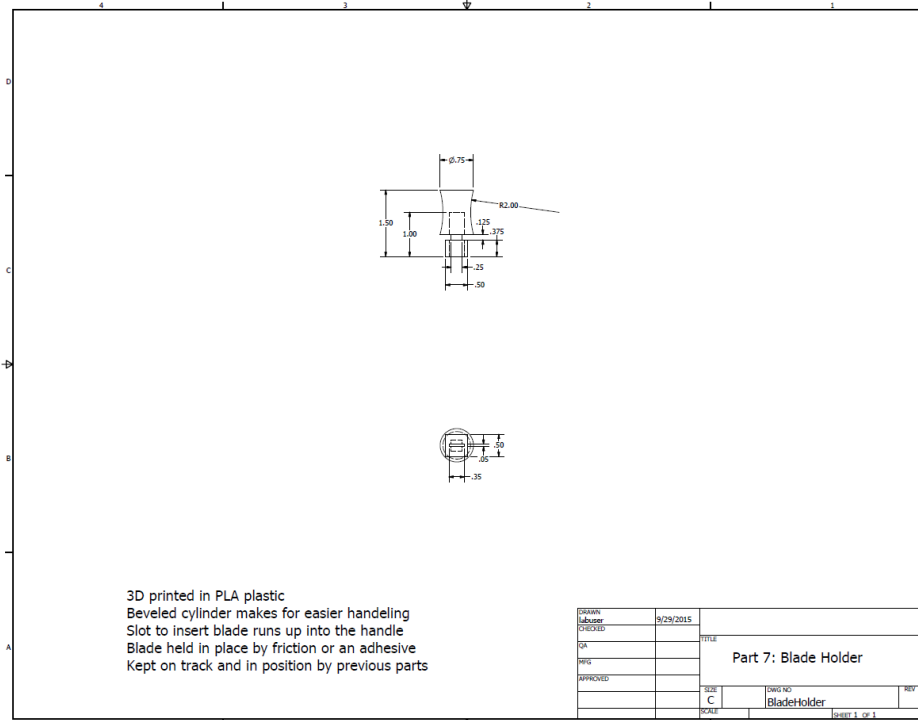
4.1 Embodiment drawing

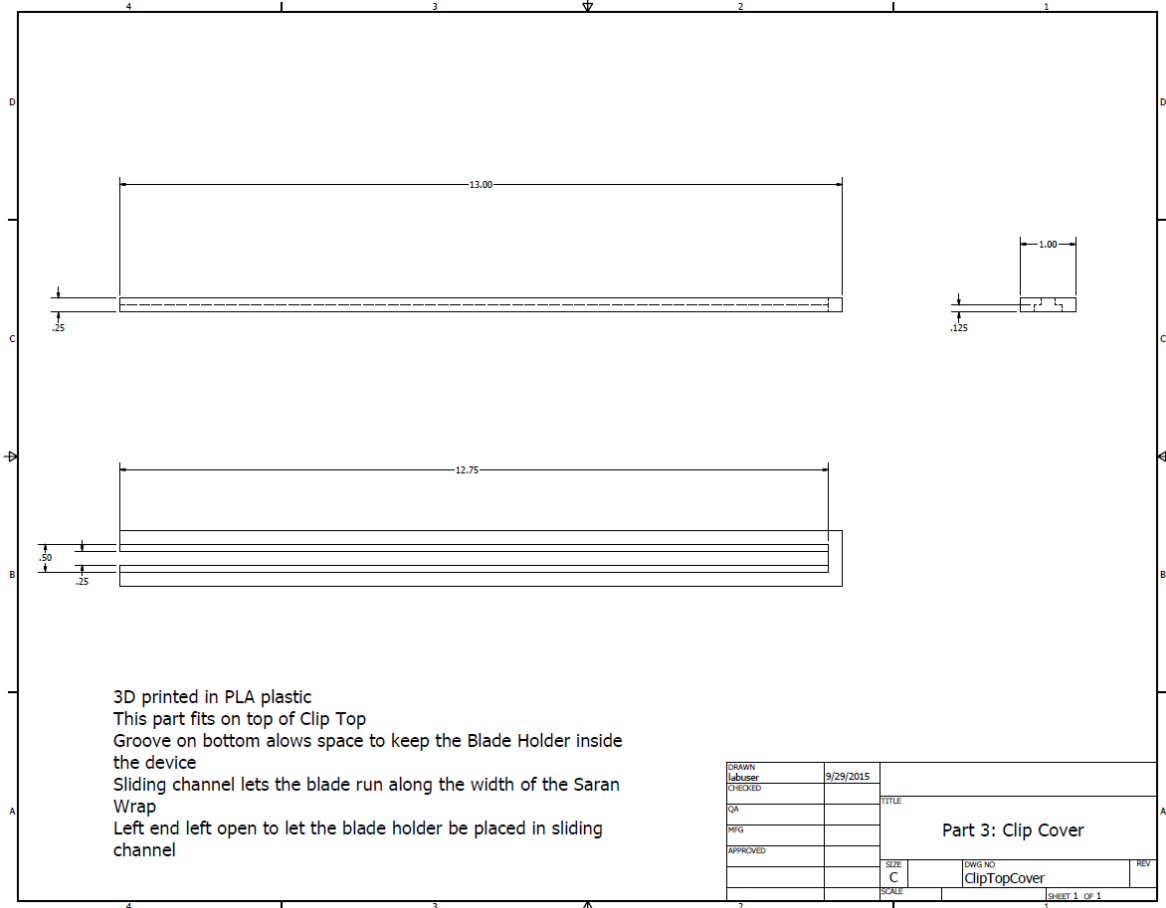
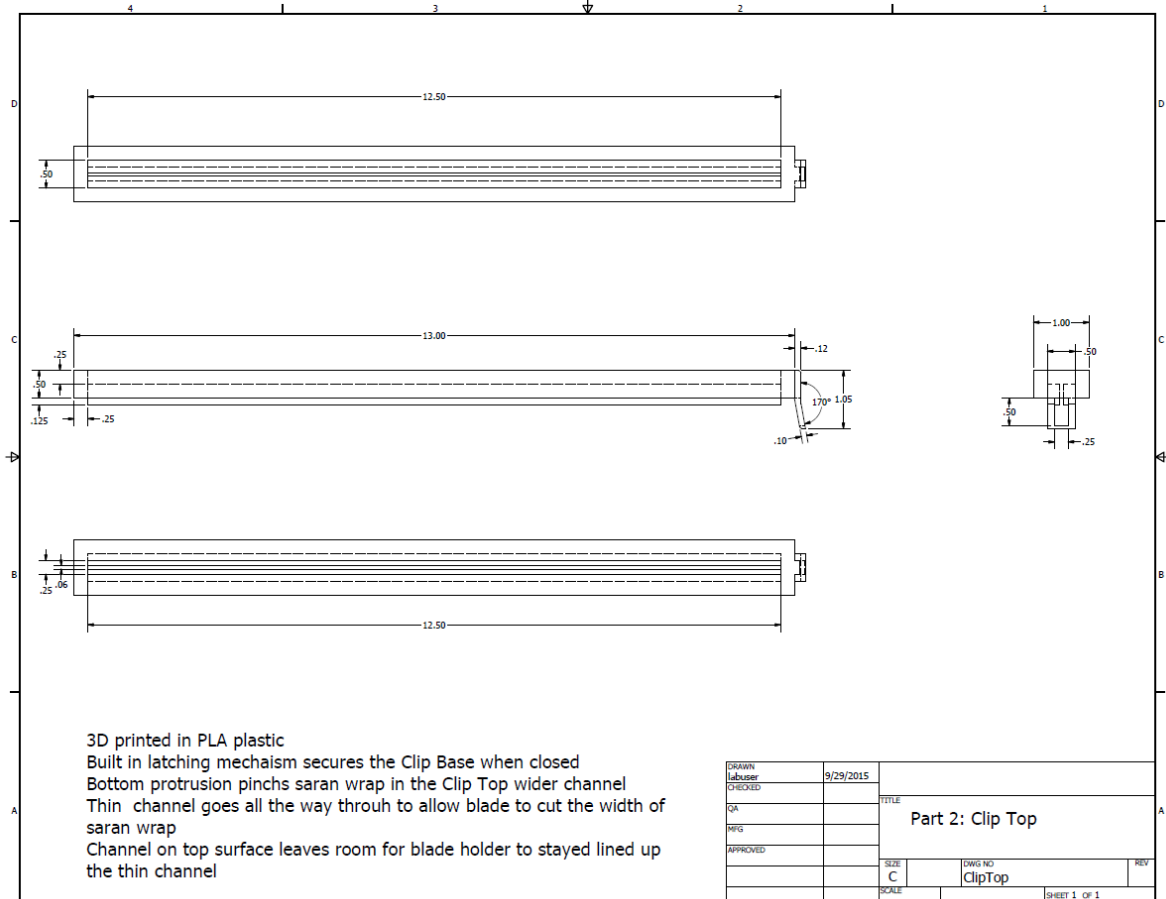


4.2 Parts List

See Drawing in 4.1

4.3 Draft detail drawings for each manufactured part





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

See each individual drawing in 4.3

4.5 Gantt chart



5 Engineering analysis

5.1 Engineering analysis proposal

5.1.1 Form

ANALYSIS TASKS AGREEMENT

PROJECT: Sandwich Wrapper NAMES: Cameron Adams, Brian Lockwood, Alex Arteaga
 INSTRUCTOR: Jakjela

The following engineering analysis tasks will be performed:

Durability: Even though this device will not be subjected to heavy stresses, this is still a key feature. The fabrication has to be able to handle the spilling of crumbs and other sandwich debris. The process needs to be repeatable without suffering from the wear and tear of these repetitive actions.

Safety: The sharp blade for cutting the sheet must be safely stored. This will allow the commercial viability of the product as it must be safe for people to use in a home setting.

Cost of construction: The final product should be able to use cheap materials. This is key for it to be a consumer good. The hypothetical customer would be less likely to be interesting in such a product if it was too expensive.

Ease of use: The device should be relatively small and lightweight. It should have components that move evenly and smoothly. There should be no heavy components or awkward motions.

The work will be divided among the group members in the following way:

- Cameron: Durability
- Brian: Safety
- Alex: Cost and ease

Instructor signature: _____; Print instructor name: _____

(Group members should initial near their name above.)

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?

The initial analysis is vital to framing the solution that we are trying to find. The problems that we identified there are the ones we sought to solve. This will help to focus the scope of the solution. Without this step, we would have a harder time identifying what 'improvement' even is

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

The analysis done had more to do with ergonomics and thus relied heavier on trial and error. We considered processes that had elaborate blade designs but these never made it farther than discussion. For the final we used the engineering ideas of friction and shear. These are simple, mechanics 1 ideas but played a big role in the actual functionality of our design.

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?

Since the scale we were working on was small and the problem was more esoteric than concrete, much of this analysis was done by trial and error. For instance, an early design showed the need for multiple clips in order to prevent having a 'naked' edge to the roll.

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

We were able to synthesize these lessons learned through experimentation to gather a strong final idea. We discovered the flaws of handling the device by testing it out and eventually realized the need for multiple clips working together. We also improved on the way it clamps down with increasing the friction within. Also increasing the shear abilities of the device by adding a serrated blade to the clips.

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.

Changes from our engineering analysis can be seen in the final prototype. The slide blade is abandoned and the box cutting serration was taken as our tearing mechanism.

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.

The Codes and Standards are attached below but nothing really stood out in considering modifications to our design:

http://www.iso.org/iso/home/store/catalogue_ics/catalogue_ics_browse.htm?ICS1=97&ICS2=40&ICS3=60

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

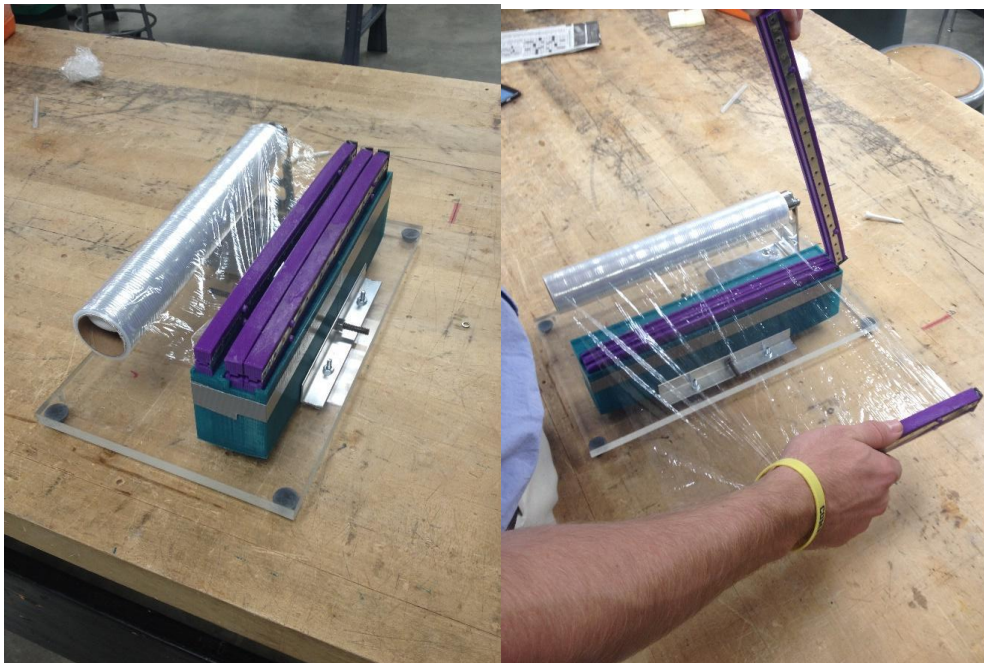
Risk area	Risk description	Probability	Impact	Mitigating actions	Responsibility
Health and safety	Exposed sharp surfaces and edges.	Worse in initial prototype improved in final	high	<ul style="list-style-type: none"> Mated clip edge is not exposed Closed clip hides exposed edge Keep away from children 	Engineer

6 Working prototype

6.1 A preliminary demonstration of the working prototype

6.2 A final demonstration of the working prototype

6.3 At least two digital photographs showing the prototype



System before operation	Mated clips open; pull saran wrap through with 3 rd clip
-------------------------	---



Tear saran wrap, leaving a single sheet with a clip on each edge

Sheet can be used to wrap bowls or food

6.4 A short video clip that shows the final prototype performing

https://youtu.be/U_-vgN1xhgg

6.5 At least four (4) additional digital photographs and their explanations



Above is a store-bought paper towel dispenser rod. A roll of saran wrap slides onto the rod and is free to rotate, allowing the user to pull sheets of it off without needing to directly manipulate the roll itself. The rod is mounted to the acrylic base with the mounting screws included with the rod.



The 3D printed loading bay serves as a place for the clips to sit during operation and between uses. Due to its length we needed to print it in 2 halves and join them together. The far, shallower slot is meant for 1 clip, which remains attached to the saran wrap after use. The nearer, deeper slot accommodates 2 mated clips which are used to tear the saran wrap along the serrated edges, shown in the pictures below.

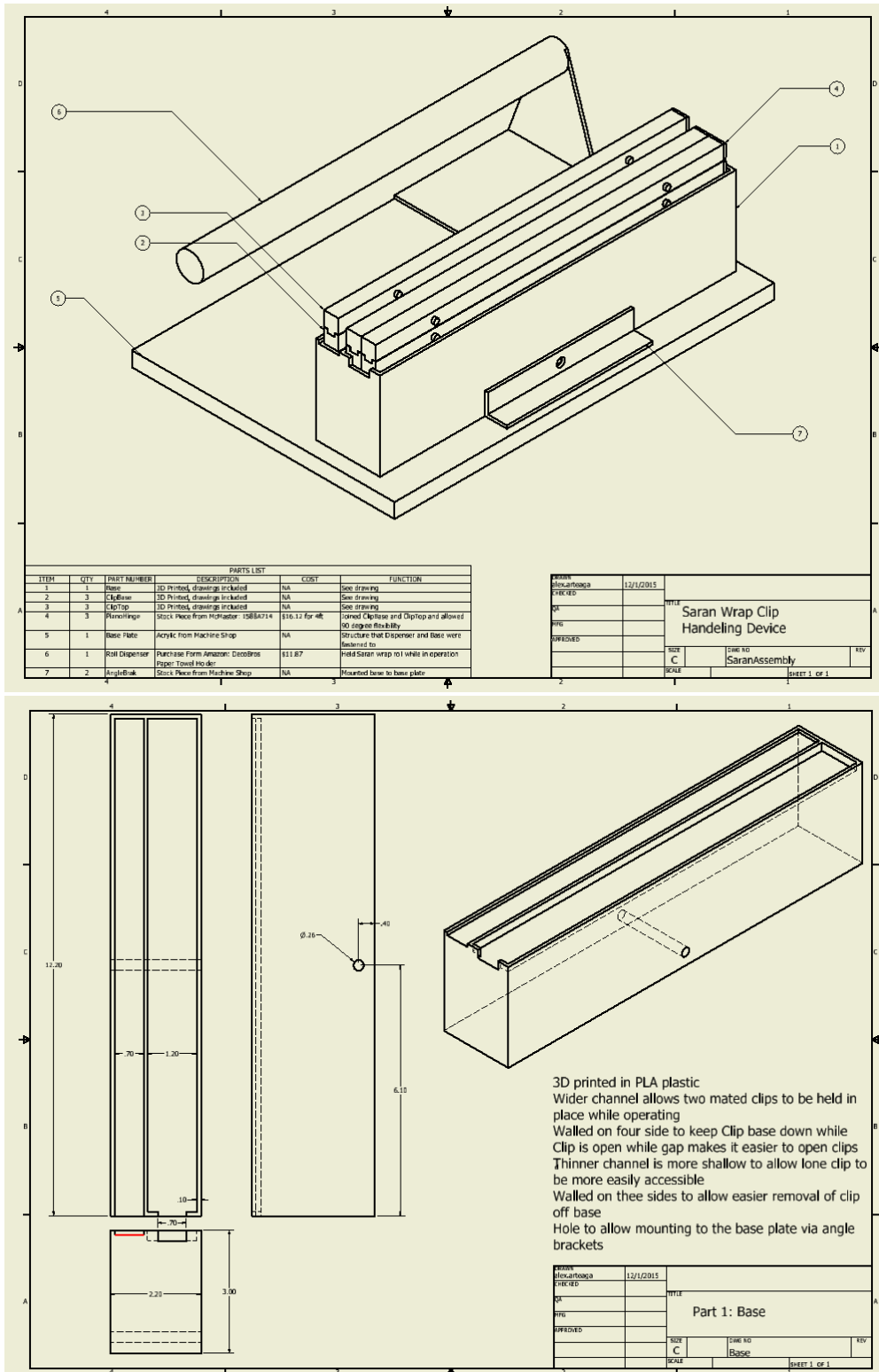


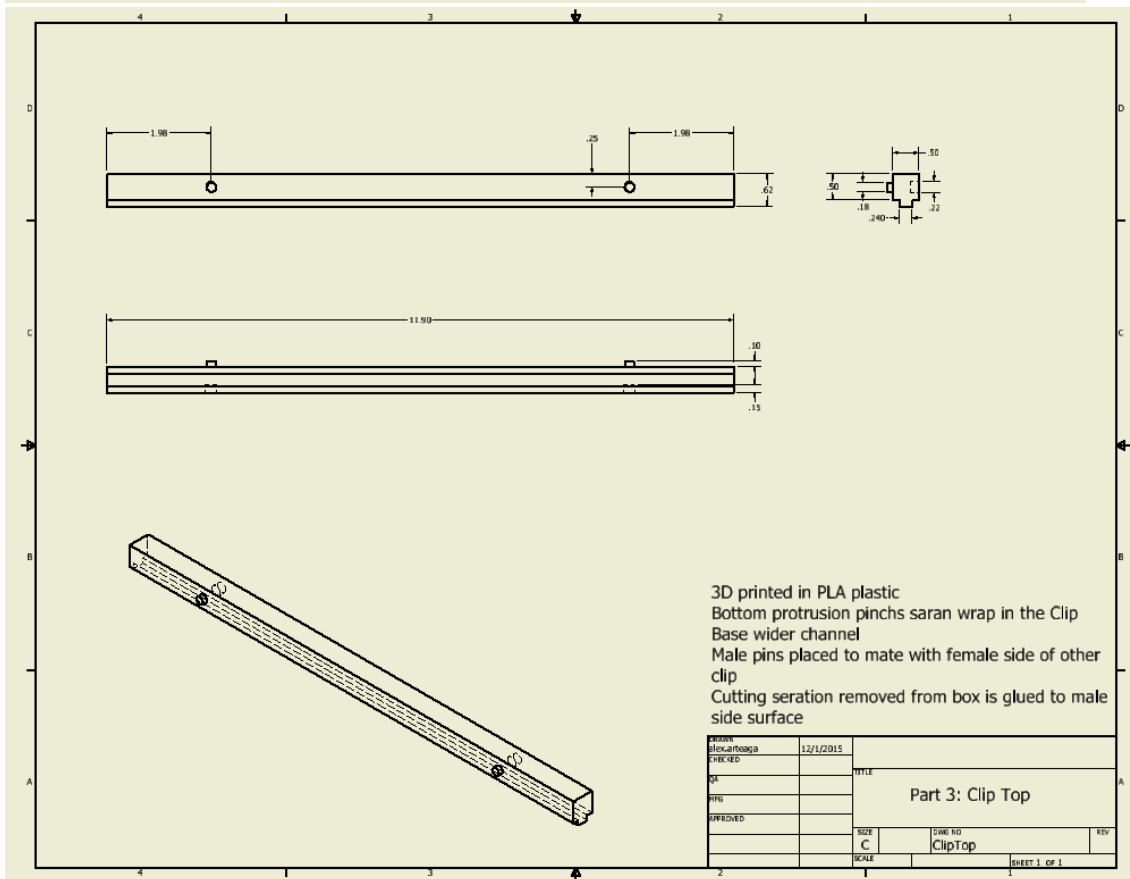
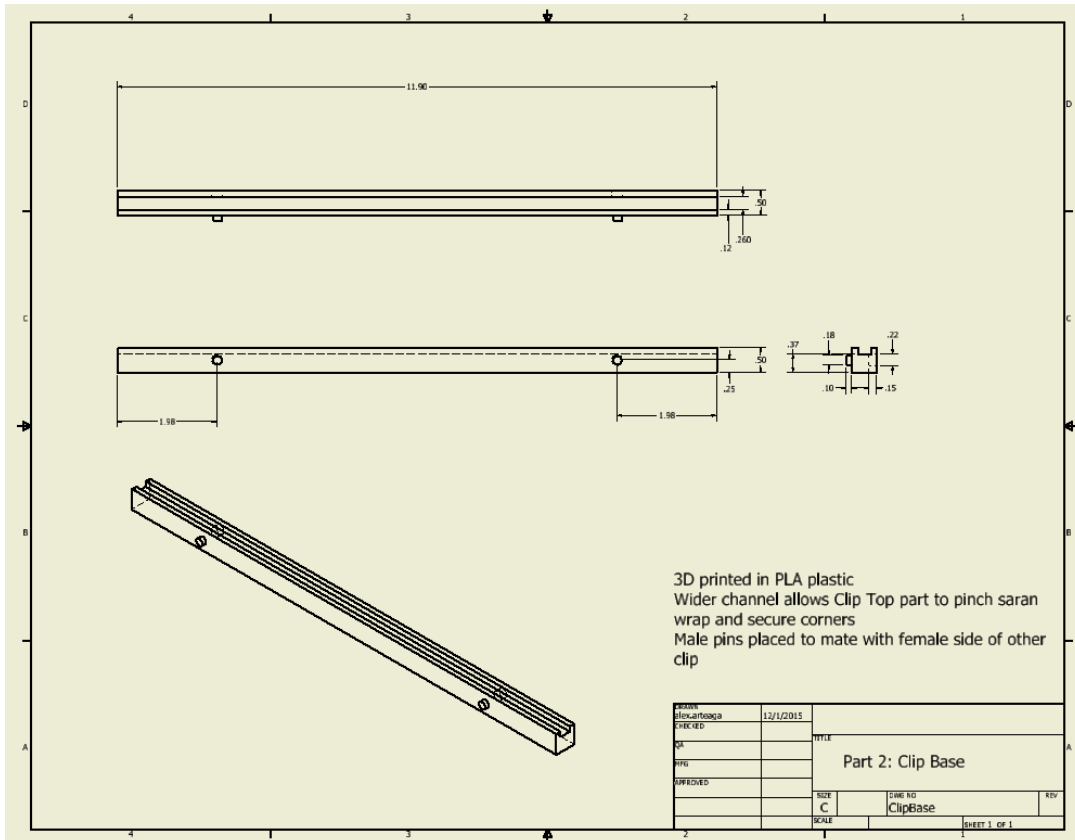
The clips themselves utilize a mating system so that any 2 clips can be joined. Joining them allows the user to open and close 2 clips at once, simplifying the step in which the user tears the saran wrap. On the “male” side (pictured on the left) is attached a serrated metal strip taken from saran wrap boxes. This allows the clips to cut the saran wrap when the user pulls them apart. The picture on the right shows the “female” side. Plastic hinges are used on the back, attached with small nails.

7 Design documentation

7.1 Final Drawings and Documentation

7.1.1 A set of engineering drawings.





7.1.2 Sourcing instructions

See drawing is 7.1.1

7.2 Final Presentation

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

7.2.2 A link to a video clip version of 1

<https://youtu.be/DLyNWszKBRc>

7.3 Teardown

TEARDOWN TASKS AGREEMENT

PROJECT: SARAN NAMES: _____ INSTRUCTOR: Malast
WRAP II Brian Lockwood EL
Cam Adams CA
Alex Ortega AA

The following teardown/cleanup tasks will be performed:

Machine Shop? Stock Material returned to cabinet or disposed of

Jolley III? Extra Wrap + boxes recycled

* Planning on keeping prototype
 no disassemble procedure

Instructor comments on completion of teardown/cleanup tasks:

Instructor signature: Mary Malast Print instructor name: Mary Malast
 Date: 12/2/15

(Group members should initial near their name above.)

8.3 Discuss the overall experience:

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

Ultimately the project was slightly more difficult than we had anticipated. Our initial design idea was perhaps too simple and fell short of achieving the stated goals to the extent we had hoped for. This meant we had to revisit the drawing board and expand the capabilities of the design to better meet our design constraints. The increased complexity of the design resulted in new challenges arising as different subsystems developed their own problems.

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

It does. We set out to design a device to simplify the process of handling a sheet of saran wrap once it is torn from the roll and our final product does exactly that. With the 3 clip system there is never an exposed saran wrap edge thus preventing the possibility of corners and edges folding on themselves and sticking. It accomplishes all of this without significantly slowing down the process compared to doing it without the device.

8.3.3 Did your team function well as a group?

We worked very well as a team. All team members were very willing to contribute to the project and there were very few problems in getting all the steps completed.

8.3.4 Were your team member's skills complementary?

In some ways they were and in others we were slightly lacking. We had a good distribution of experience and skill in 3D modeling as well as the process of mechanical design (i.e. concept generation and selection). However, none of us were very experienced in machining/manufacturing. Alex Arteaga had prior experience with 3D printing, which came in handy when making the clips and the loading bay (although, as stated before, 3D printing may not be the best choice moving forward given the tendency of the parts to warp).

8.3.5 Did your team share the workload equally?

We tended to divide work fairly equitably amongst ourselves. Sometimes, depending on the availability of different team members 1 person may have had to take the brunt of 1 part, but each of us ended up taking over some part in this manner at some point during the project.

8.3.6 Was any needed skill missing from the group?

The distribution of skill within the group encompassed enough areas that we were able to do almost everything we set out to do. It may have benefitted us to have more knowledge of manufacturing processes, but even with what we did know we were able to fabricate all of our parts to a satisfactory quality.

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

After fabricating our initial prototype we met with the customer to review its performance up to that point. The meeting turned out to be very helpful in identifying possible ways of addressing some of the problems that had become apparent during the prototyping process as well as expanding the capabilities of the device.

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

The design brief remained relatively constant during the entire design process. After our initial prototype demonstration the goal of our device was slightly expanded to include a more complete system which includes the roll of saran wrap itself, thus eliminating the box entirely. Even with this modification the overarching goal of the device was unchanged.

8.3.9 Has the project enhanced your design skills?

We learned to cope with the shortcomings of our selected manufacturing technique (“rapid prototyping”). When making our initial prototype we found that 3D printing long parts (like the clips) results in warping where the parts bow upward as they print. This deleteriously affected our first prototype as the clips no longer fit together. We compensated for this in the updated prototype by printing the 2 halves in the same orientation (this required a slight modification to the design of 1 of the halves) so that they bow in the same direction and are then able to fit together.

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

This project has at the very least helped us to better understand the details of the design process as well as to appreciate the necessity of revising one’s initial design concept as challenges make themselves apparent.

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

No; we may have gained some confidence in our design abilities but none of us think that there were any projects before this one that we could imagine being fearful of solely based on self-confidence.

9 Appendix A - Parts List

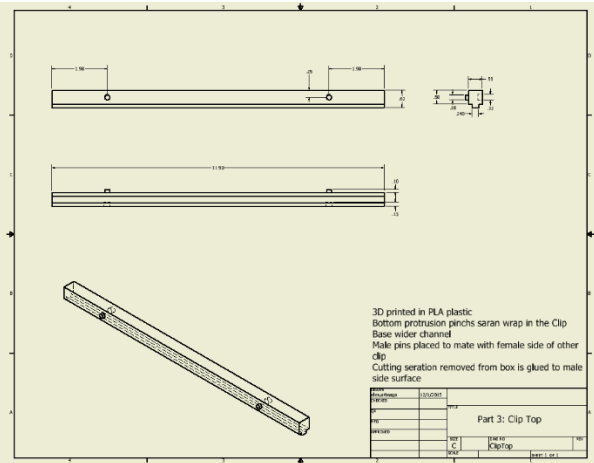
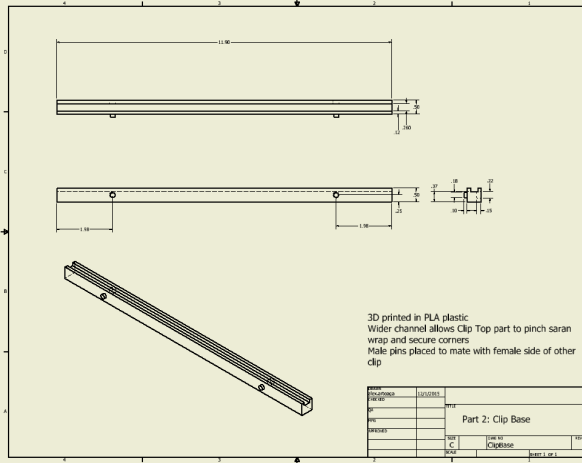
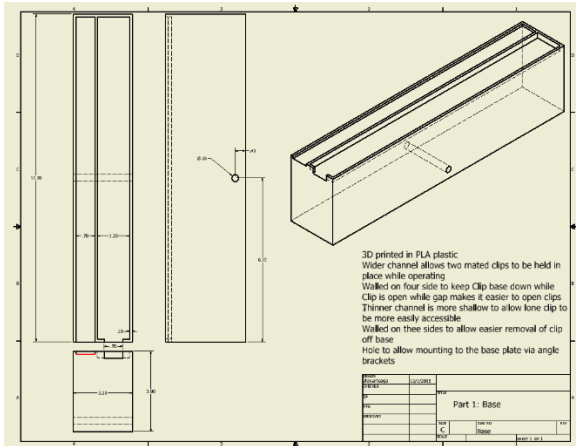
PARTS LIST						
ITEM	QTY	PART NUMBER	DESCRIPTION	COST	FUNCTION	
1	1	Base	ID Printed, drawings included	NA	See drawing	
2	3	ClipBase	ID Printed, drawings included	NA	See drawing	
3	3	ClipTop	ID Printed, drawings included	NA	See drawing	
4	3	PlanerHinge	Stock Piece from McMaster: 1588A714	\$16.12 for 4ft	Joined Clipbase and ClipTop and allowed 90 degree flexibility	
5	1	Base Plate	Acrylic from Machine Shop	NA	Structure that Dispenser and Base were fastened to	
6	1	Roll Dispenser	Purchase Form Amazon: DecoBros Paper Towel Holder	\$11.87	Held Saran wrap roll while in operation	
7	2	AngleBrak	Stock Piece from Machine Shop	NA	Mounted base to base plate	

DESIGNED	12/11/2015	TITLE	
CHECKED		Saran Wrap Clip Handling Device	
DATE		SIZE	DWG NO
APPROVED		C	SaranAssembly
		SCALE	REV
			SHEET 1 OF 1

10 Appendix B - Bill of Materials

See Appendix 1

11 Appendix C - CAD Models



12 Risk assessment matrix

Risk area	Risk description	Probability	Impact	Mitigating actions	Responsibility
Health and safety	Exposed sharp surfaces and edges.	Worse in initial prototype improved in final	high	<ul style="list-style-type: none">• Mated clip edge is not exposed• Closed clip hides exposed edge• Keep away from children	Engineer