Detachable Point of Sale Material for Asparagus Shipper

Michael Thomas

Industrial Technology Department

Orfalea College of Business

California Polytechnic State University

March 14, 2013

ABSTRACT

Gourmet Trading Company is a fresh fruit and vegetable distributor specializing in asparagus, blueberries, and blackberries. The company currently mails a 7” by 11” sign to be displayed with their asparagus which arrives in a 28 pound shipper. The signs are intended to be displayed in stores to give consumers information about the asparagus. Unfortunately, many of the signs do not get displayed since they are shipped separately. The purpose of the project is to redesign the 28 pound asparagus shipper to include a detachable point of sale sign.

A literature search was conducted to further understand the needs of the project. This included research on shipping and packaging fruits and vegetables as well as packaging functions in produce. A similar asparagus package was discovered as well. Three alternative solutions were developed which all included the detachable point of sale material. The alternatives underwent distribution testing using the ASTM D4169 test schedule. All of the packages successfully passed the testing without damage to the asparagus. The best solution was the one that was easiest for the end user to remove, which was an asparagus shipper that had a removable flap. The flap used 3/8” perforations along the edge for simple and easy removal. The end product successfully protects the asparagus and is easy to use.

ACKNOWLEDGEMENTS

I would like to thank everyone involved with this project that made it possible. First of all I would like to thank Gourmet Trading Company for taking the time to create this project. They were able to identify a need and provide me an opportunity to help solve it. Gourmet Trading Company was gracious enough to provide asparagus samples that made distribution testing more symbolic of a real shipping environment. I specifically want to thank my technical advisor at Gourmet Trading Company, Chloé Varennes. She was able to promptly answer any and all of my questions regarding the project with accurate responses. Chloé was invaluable to the project and was a significant help.

Next, I would like to thank and acknowledge Cal Poly's Industrial Technology program as well as Cal Poly's Packaging department. This project would not have been possible without the resources provided by the departments. The facilities and software that were available were utilized for the project including ArtiosCAD, the packaging dynamics lab, and the Kongsberg table. The Packaging department provided the plastic corrugate sheets which made this project come to fruition. I would like to thank my faculty advisor, Dr. Jay Singh, for all of his help and guidance throughout the process. I would also like to thank David Guadinini for his assistance in the packaging dynamics lab. Thank you to all of these people. Without them this project would not have been possible.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

SECTION I
INTRODUCTION

Gourmet Trading Company is a fresh fruit and vegetable distributor headquartered in Los Angeles, California. The company was founded in 1982 and focuses on the cultivation and distribution of asparagus, blueberries, and blackberries. Gourmet Trading Co. has partners all over the world including Central and South America, Canada, Australia, and New Zealand. These strong grower relationships allow them to supply fresh fruits and vegetables year round. The company takes pride in their products and ensures they have complete control over all aspects from farm to store. They manage their own farms in Peru, Mexico, and California to monitor the product from the beginning. Gourmet Trading Company has a state of the art packing facility in Pasco, Washington which allows them to further control the quality before shipping the product out to distributors. The complete control over the supply chain allows Gourmet Trading Co. to offer the best products possible.

Problem Statement:

The purpose of this project is to redesign Gourmet Trading Company's asparagus shipper to include a detachable point of sales sign. Currently, the company mails a 7" by 11" sign to be displayed with their 28 pound asparagus shipper. The point of sale signs are supposed to be displayed in the store to give consumers information such as serving suggestions and how to prepare the product. Unfortunately, many of these sign never make it to the store shelf because they are shipped separately. Gourmet Trading Company, along with its consumers, do not benefit from this because the signs are never seen. The signs have a much higher chance of being used if they are sent as part of the asparagus shipper.

The goal of the project is to create an easy to use detachable point of sale sign. It should be self-explanatory because workers at the store have to be able to figure out how to detach it without instructions. The result of the redesigned shipper should be seen in stores with the signs displayed by the products. This will allow grocery store consumers to see the point of sale sign and follow the recommendations on it. The goal of the redesigned asparagus shipper is to have the signs displayed in stores, thus improving customer relations with the company as well as boost sales and awareness of the product.

Needs:

Table 1: Importance of Needs

Description of Needs	Importance
Easy to detach	4
Point of Sale sign is legible	3
Protects asparagus	4
Easy implementation for store employees	3
Maintains package quality	4

*Importance Scale: 1= Low; 4= High

There are 5 primary needs for the project. Most of them deal with the detachable point of sale material. The detachable material has to be very simple to use and be understandable to everyone. Even though many performance aspects will not be modified, it is still very important that the package still successfully protects the asparagus. It is imperative that the package can protect the asparagus as good as or better than the current model. The needs that are ranked the highest are the ease of detachability, protection of the asparagus, and maintaining package quality. It is important that the point of sale material is easy to use so it will have a better chance of being displayed in store.

In order to most successfully accomplish all of the project needs, it is important to implement all of the key features from the current design. Some of these include nesting features, viewing windows, as well as holes for ventilation.

Background/ Related Work:

Gourmet Trading Company specializes in shipping asparagus as well as blueberries and blackberries. The company needs to use specialized packages to ship their products safely. Special features like ventilation holes are needed for shipping these fruits and vegetables where many products do not need them. The current design of the asparagus shipper successfully transports the product keeping it fresh and protected. Other companies have their own version of shippers as well.

The literature search process yielded results that were for a similar product as Gourmet Trading Company's. There is an earlier version of a shipper for asparagus that filed for a patent in 1995. Mark Bacchetti owns the patent. The design includes features to display the product, drain water from it, ventilate it, and also stack well with each other (Bacchetti 1995). The current design that Gourmet Trading Company uses has several of the same features as this older design. The literature search also found information regarding food packaging. The functions of food packaging are discussed and how it adds value to the product. Different aspects of food and packaging are also explored such as ways the product can be harmed through transportation. One of the major factors is spoilage due to microbial growth.

Objectives:

The objective of this project is to recommend a new solution to Gourmet Trading Company for their 28 pound asparagus shipper which includes a detachable point of sale material. The objectives for the new shipper include:

- A detachable point of sale sign
- Easy to implement design
- Clear implementation for stores
- Maintain high quality of product

It is important that the new design is easy for the packaging facility to implement. The new package will contain similar features to the current design to ensure the package is properly designed for asparagus. It is also important that the new design can be made with Gourmet Trading Company's machinery.

Contribution:

The contribution from this project will have a bigger impact beyond packaging. This project will help Gourmet Trading Company with their current problem with their display signs. While this project includes the adding of the point of sale material to the package, the biggest contribution will be in sales. The new package will create a much higher chance of the sign being displayed by the product, which in turn will generate an increase in consumer purchases and customer satisfaction. The main contribution will be a higher chance that the point of sale sign will be displayed in stores. This will also increase customer relations with the company. The consumers will have a better chance to see the signs on display. This will help them learn more about the product and different recipes they can use.

Scope of Project:

The scope of this project is to focus on redesigning the current asparagus shipper to include a point of sale sign. Because the current design protects the product successfully, the focus is on keeping the package as similar as possible while adding the point of sale material. This project does not look into a better way to protect the product or any changes in the material. This can be done while keeping all of the current key design features the same. Due to time constraints, the final recommendations are based on results found in the Industrial Technology packaging dynamics lab. Unfortunately, there was not enough time to do any field studies. The success of the lab results will depend on how well the package can protect the asparagus; however the freshness of the asparagus will not be tested.

SECTION II
LITERATURE SEARCH

The purpose of this project is to apply the knowledge learned through the Industrial Technology program in order to redesign Gourmet Trading Company's asparagus shipper to include a detachable point of sale material. The need for this project is drawn from an ineffective method where the current point of sale signs are rarely used. The redesigned packaged will be used as a better delivery method to increase the chances that stores will display the attached signs next to the product in a retail environment. The literature search is an essential research method to deliver the best end product possible. It also shows the importance of peer-reviewed journals. The literature search provides a deeper understanding for what currently exists in the marketplace and what similar products have been developed. The literature search provides detailed information about existing asparagus shippers and shipping methods. It provides a deeper understanding about shipping asparagus and details about the process. Also, the literature search allows other similar packages to be discovered and benchmarked against the new package being designed.

The literature search is also a great tool to get a deeper understanding of the necessities of food packaging. There are very major differences between shipping produce and shipping nonperishable goods. This section provides the opportunity to explore these differences and assist in a more knowledgeable design for the asparagus shipper. The research covers the following topics:

- Shipping and Packaging Fruits and Vegetables
- Packaging Functions in Produce
- Similar packages
- Test methods (ASTM)

Shipping and Packaging Fruits and Vegetables

Special considerations must be taken into account when packaging food, specifically fruits and vegetables. Unlike many other packaging applications, fruits and vegetable are living organisms and need to be packaged specially to prevent spoilage. The produce continues to develop even after it is harvested. Extra measures need to be taken when transporting and storing the fruit and vegetables. The produce experiences different developmental periods throughout its life including growth, maturation, physiological maturity, ripening, and senescence (Watada 1984). The fruit and vegetables have the highest chance of spoilage during the latter two periods. These periods happen to typically occur during shipping and storing. The proper packaging enables the products to arrive unspoiled and without physical defects. Most fruit and vegetable cannot be shipped in a closed container because the absence of oxygen creates undesired qualities. Most fruits and vegetables are packaged with ventilation holes to allow the produce to respire.

Microbial Growth

It is common for bacteria and other microorganisms to grow in fruit once it is harvested. There are several factors that are ideal for microbial growth in produce. Vegetables nearly have a neutral pH which is ideal for some microorganisms. The produce uses starch as a storage polymer, so microorganisms use the starch for its own growth. This in turn degrades the starch which leads to decay. Microbial growth can be slowed by cleaning the fruit and vegetables at the time of harvest and immediately cooling the temperature. Cleaning the produce at the time of harvest removes any microbes on the surface. The lower temperatures slow the produces metabolism which reduces the microbial growth rate (Barth 2009). A lot of produce needs to be shipped in a refrigerated truck to prevent spoilage.

Packaging Requirements for Fruits and Vegetables:

Fruits and vegetables can decay and wither very rapidly if in the wrong situation. The correct packaging can prolong the shelf life of the produce. There are several different factors to

consider when shipping food including the relative humidity and permeation. The permeation rate has to be right. If the moisture barrier is too strong then the relative humidity will be too high, and vice versa. Both circumstances lead to microbial growth which in turn leads to faster spoilage (Matche). These factors can be controlled by selected the proper films that have an ideal permeation rate for any product that will be fully enclosed. Other methods are using packages that have ventilation holes.

Types of packaging:

There are over 1,500 different types of packages in the United States that are used for produce. The most common types include bags, crates, hampers, baskets, cartons, bulk bins, and palletized containers (North Carolina State University, 1996). The types of packaging can be further broken down into three different sections; consumer packaging, transport packaging, and unit load packaging. The products are packaged differently depending on who the package is intended for. Consumer packaging is the final package that the consumer receives and is usually prepackaged. These typically come in bags, net bags, sleeves, and trays. They are all designed with the consumer in mind to deliver the most convenient package for them. The next type of packaging is transport packaging. The main function of this is to provide the easiest package to ship. Transport packages are usually smaller so a single person can carry it, but bigger packages are also available and need to be transport with a forklift. The standard types are wooden boxes, corrugated fiberboard boxes, plastic corrugated boxes, plastic crates, and sacks. Lastly, packages can be designed for palletization. This would use larger, heavier boxes, and be designed to fit well onto a pallet (Matche).

Figure 1- Consumer packaged onions in a net bag (Mr. Grocers, 2012)

Packaging Functions in Produce

Packaging is a necessity when shipping products. However, it has a bigger impact than just transporting a product from point A to point B. This section describes the different functions of a package, specifically for packaging produce. Many fruits and vegetables have a soft skin and are easily prone to physical damage and spoilage. A properly designed package prevents these and allows the product to reach the destination in the desired condition. The main functions for a produce package include containment, protection, and identification.

Containment

Containment may seem like an obvious attribute for a package, but it is extremely crucial in delivering a quality product. The package must properly enclose the product and prevent it from shifting excessively. It must be designed with efficiency in mind because additional material means additional unnecessary costs. Some produce needs to have a specially designed package in order to extend the shelf life. For example, many fruit and vegetable containers have deliberate holes in the package so the product can breathe.

Protection

Another critical function of a package is protection. This is even more important when working with produce because of the delicacy of the product. Even small bruises are seen as defects on fruit and vegetables and can occur easily. The package must protect the product from physical damage along with environmental conditions. The container needs to possess strong stacking strength because it will be stacked and palletized. The package must also secure the contents well enough to reduce the produce from damaging each other. The shipping environment will include vibration so the contents must be secure. Produce packages should also be designed to extend the shelf life of the product. Some ways to do this are to create breathing holes in the package, have the correct permeation rate, or adding a modified atmosphere inside the package.

Identification

Produce packages must be designed to include any and all necessary identifying aspects. The package needs to include information about the product such as the name, brand, grade, quantity, etc. Bar codes are also typically necessary for the package. The bar codes are used in order to identify the product and are used throughout the distribution process.

Other Functions

It is becoming more common for companies to focus on the recyclability of packages because of trends towards sustainability. If a package is recyclable then it adds value to the product. Also, if something like a plastic crate is used then the company will incur lower costs since it can be reused. Another additional function is marketability. The package is the last thing seen at the point of sale, so an attractive package can be the difference between a consumer purchasing the product or not (North Carolina State University, 1996).

Similar Packages

Previous asparagus packages have been developed that protect the product as well as display it. Mark R. Bacchetti submitted a patent in 1995 for a design of an asparagus package that protected the product as well as let it breathe. Below Figure 2 shows the submitted design. The package has circular display windows on all four sides. It also has holes to allow the asparagus to breathe. The protruding tabs on the top are designed for shipping purposes. The bottom of the box has holes that can receive the tabs which would add to unitize the load during shipping. The holes provide additional ventilation and can be used to hydro-cool multiple units together (Bacchetti 1995).

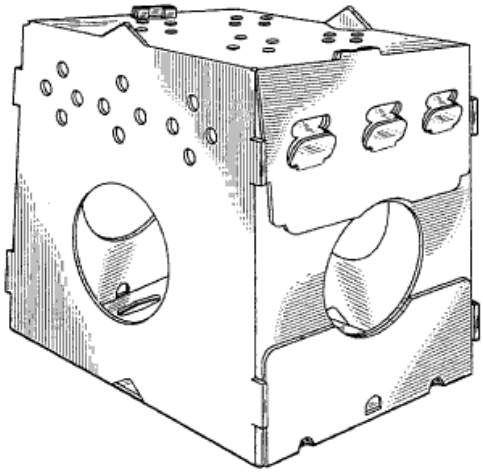


Figure 2- Asparagus shipper created by Mark Bacchetti

Test Methods

Studies are conducted to test the performance of packages. Two different types of studies can be conducted; field tests and accelerated tests. Field tests consist of actually sending a package through a real distribution environment and tracking different factors along the way. These are a lot more reliable, however they are very time consuming and more expensive. Accelerated tests are done in a lab with machinery designed to replicate a distribution environment. The tests are more repeatable and save a lot of time and money (Singh 2011).

There are numerous different test methods available for distribution testing depending on the desired application. The most common test method for distribution testing is ASTM D4169. According to the standard,

> This practice provides a uniform basis of evaluating, in a laboratory, the ability of shipping units to withstand the distribution environment. This is accomplished by subjecting them to a test plan consisting of a sequence of anticipated hazard elements encountered in various distribution cycles. This practice is not intended to supplant material specifications or existing preshipment test procedures (ASTM 2009).

The test standard is used for a variety of different uses varying from single parcel shipment to palletized truckloads.

Table 2- Needs explored by publication

Description of Needs	Covered by publication	Reason
Easy to detach	1	There was no publication that discussed a detachable point of sale material.
Point of Sale sign is legible	1	There was no publication discussing the quality of point of sale materials.
Protects asparagus	5	A couple of the articles discussed the protection of the package. The ASTM test standards discussed can be used for testing the package.
Easy implementation for store employees	1	There was no publication discussing implementation for point of sales material.
Maintains package quality	5	The articles found discussed the quality of packages and the benefits of a high quality package.

All of the needs were addressed by the various publications explored. Every publication was very constructive in understanding the project better. It is important to keep all of these needs in mind while reviewing the literature search.

Conclusion

The literature search was very beneficial to the project. Information from other related studies was helpful in finding what was previously done. For example, the patent that was found was extremely helpful. It showed that a similar package was previously created. It was valuable to see why some of the features were created, like the nesting features on the top and bottom of the package. Some of the other sources were helpful as well. The sources about the functions of packaging were helpful in creating ideas for the redesigned package.

The redesigned package will add on what was found in the literature search. Previous models have been created that are similar to the current design of Gourmet Trading Company. However, the new design will add a detachable point of sale sign. This has not been done with the asparagus package before. The addition of the point of sale material will change the overall asparagus shipper and add value to it. The new shipper can be used for more purposes than just transporting the product.

SECTION III
SOLUTIONS/ PROCEDURES

The purpose of this project is to redesign Gourmet Trading Company's 28 pound asparagus shipper to include a detachable point of sale material. The point of sale material must be easy to use with clear directions how to remove the sign. This section discusses the solutions and methods taken to resolve the company's current problem. Three different alternatives are explored in order to find the best possible solution.

Alternative Solutions

Three different packaging designs will be created to find the optimal package design. Each package will consists of the same basic package; however they will primarily vary in the location of the point of sale material. The purpose is to add the point of sale material without negatively affecting any performance aspect of the package. All new designs will be similar in structure to the current shipper and will be made of the same material; polypropylene. Figure 3 shows the current design.

Figure 3- Gourmet Trading Co. 28 lb. asparagus shipper

Alternative 1

The first solution is to make the point of sale material from the flap. The same structural design as the original shipper was used. Figure 3 shows a flap on the right side of the package. The proposed solution adds 3/8" perforations along the edge of the flap. Therefore, the flap can be detached when the product arrives at the desired location. The holes would also be removed from that side so the sign will look better. Instructions and arrows will be added so the user will know how to detach the flap. The tabs are perforated as well so those can be removed once it arrives in store.

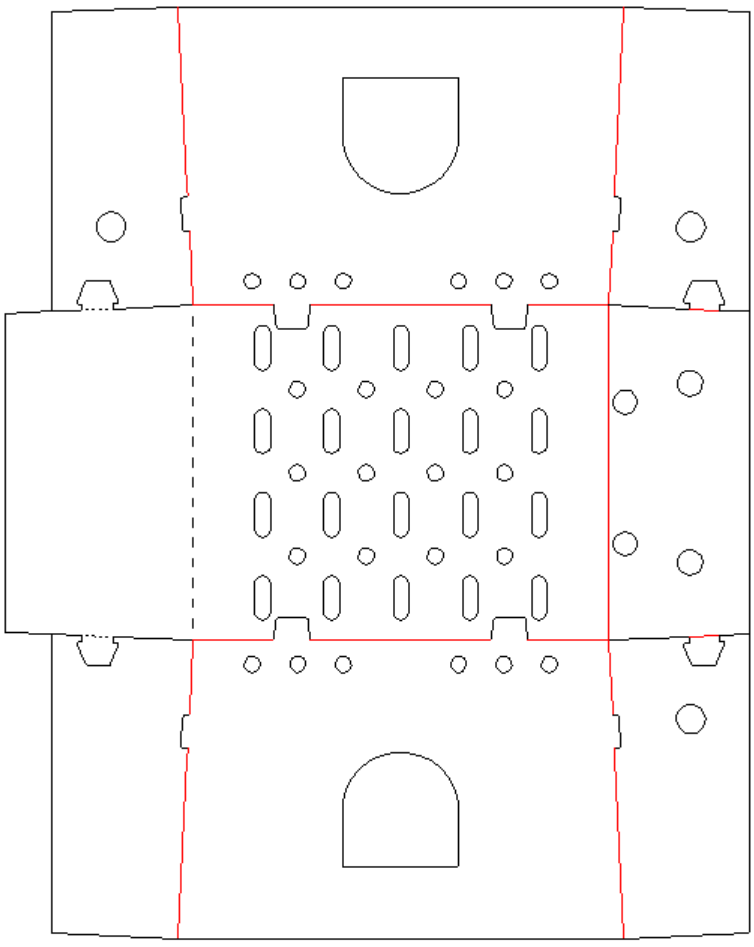


Figure 4- CAD drawing of alternative 1

Alternative 2

The second alternative adds a point of sale material to the flap in a similar fashion as the previous alternative. The difference is the size of the perforations. This alternative has bigger perforations that are 1/2". The advantages of testing both types of perforations are for two reasons. First, they can be compared for the ease of removal. Secondly, they can be compared to see which one holds up better after distribution testing.

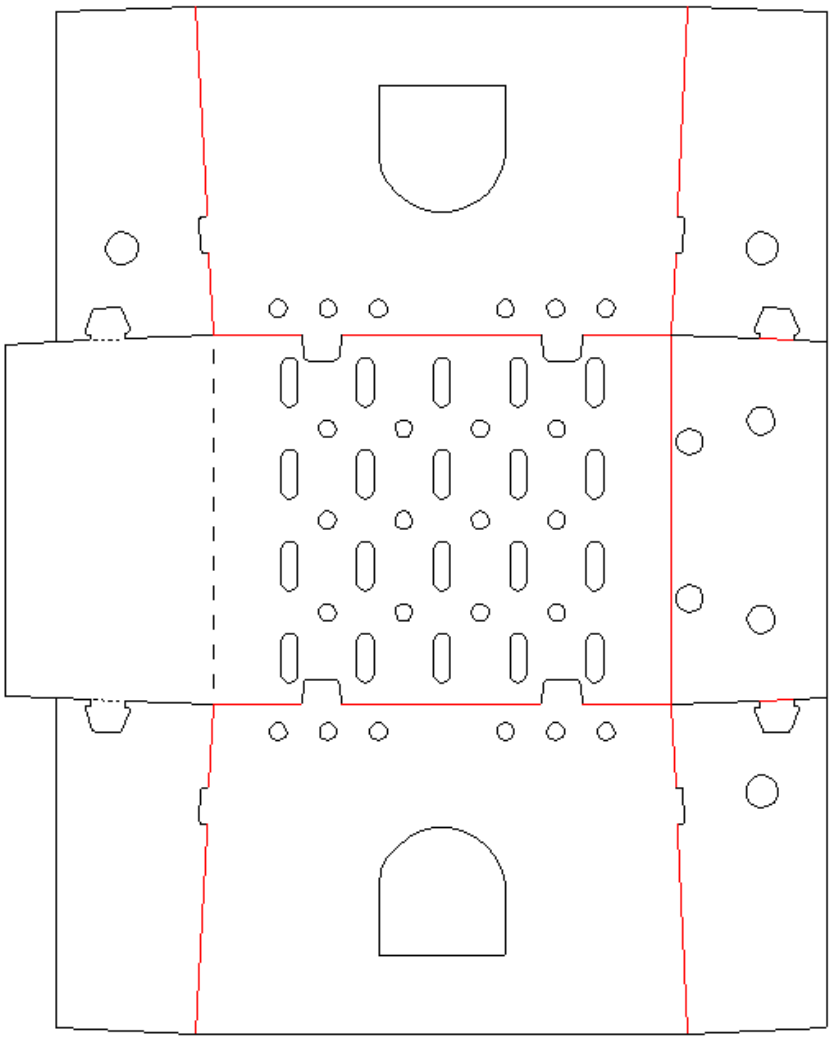


Figure 4- CAD drawing of alternative 2

Alternative 3

The last solution also adds the point of sale material to the flap but in a different fashion. The flap is larger than the other two versions. A strip of perforations are used a little below the edge of the flap. It has a small portion sticking out for ease of removal. This is expected to withstand distribution testing better than the previous solutions because it is stronger along the edge.

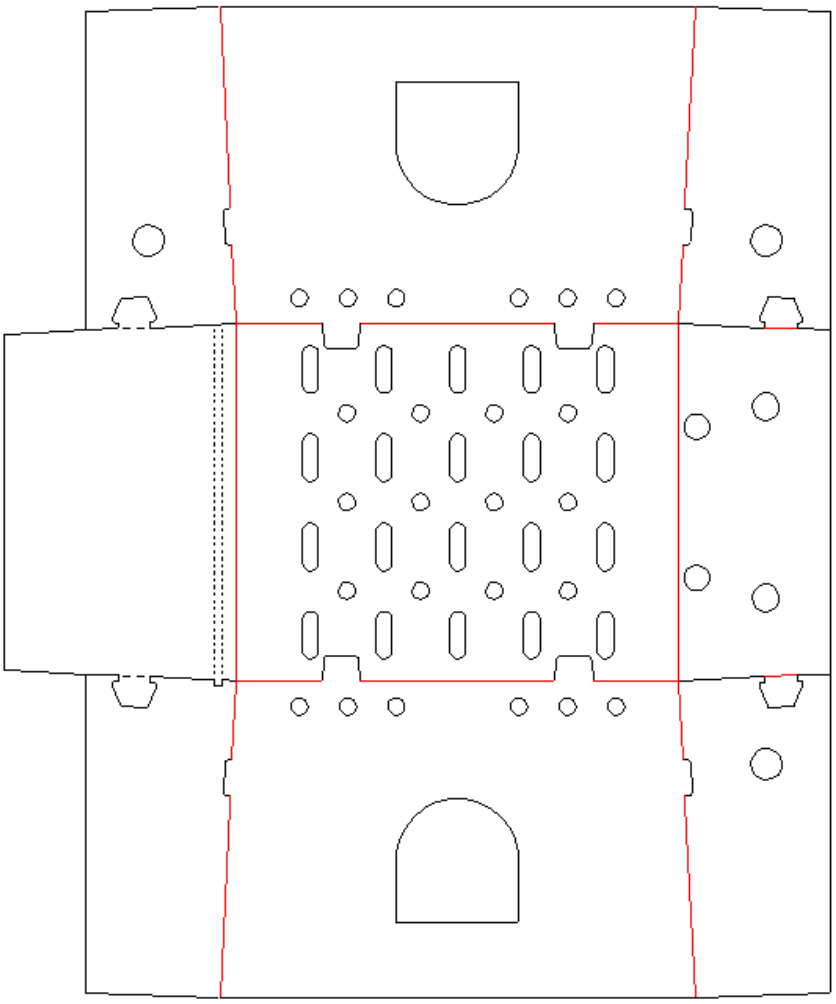


Figure 4- CAD drawing of alternative 3

Plan for Statistical Testing

Hypothesis: If the asparagus shippers undergo distribution testing, then the structural performance will be the same as the current design and the asparagus will be undamaged.

Independent Variable: The addition and the location of the perforation for the point of sale material.

Dependent Variable: The structural performance of the package and whether or not the point of sale material stays attached throughout testing.

Control Variables: The bottom tray is the same design for each. Also, the features are the same for each package. Environmental factors like temperature and relative humidity remained constant.

ASTM D4169 Test Schedule

Distribution testing is completed to see how the products would react in a real distribution environment. This project does not have the time or resources for a field study, so the lab tests are done instead. The testing completed represents the asparagus shippers being transported on pallets stacked 4 high. The test is done to represent the product being transported on a truck.

Distribution Cycle for 28 lb. Asparagus Shipper

Table 3- Package Information

Package Description	Total Weight	Miscellaneous
Type: Plastic corrugate asparagus shipper	*Package 1:21.6 lbs*	*Ambient Temperature:* 60° F
	Package 2:24.2lbs	*Relative Humidity:* 50%
*Length:*16 ¾”	*Package 3:29.5 lbs*	*Flute Type:* C-flute
Width: 13 ½”	*Package 4:22.2 lbs*	
Height: 11 ¾”		

Schedule A: Initial Manual Handling

Overview:

Test Standard: ASTM D5276

Date: 2/21/13

Test Engineer: MT

Duration: 20 minutes

Testing Equipment:

Name: Lansmont Precision Drop Tester

Model Number: PDT-56ED

Calibration Date: June 2005

Procedure:

Drop Height- 13 in.

Table 4- Initial Drop Test Impacts

Drop Number	Impact Orientation	Impacted Member
1	Top	1
2	Bottom edge	5, 3
3	Adjacent bottom edge	4, 3
4	Bottom Corner	6, 2, 3
5	Diagonally opposite bottom corner	4, 5, 3
6	Bottom	3

Table 5- Initial Drop Test Results

Box Number	Description	Photo
1	Minor deformation	
2	Bottom corner tear	
3	No damage to package Small amount of asparagus chipped off	
4	Bottom slight bowed out	

Schedule C: Vehicle Stacking

Overview:

Test Standard: D642

Date: 2/21/13

Test Engineer: MT

Duration: 20 minutes

Testing Equipment:

Name: Lansmont Touch Test Compression Tester

Model Number: 152-30K

Calibration Date: December 2006

Procedure:

Load unit in compression tester. Compress to computed value and hold for no longer than 3 seconds, then release.

Notes/ Calculations:

Computed Load

$L = M_f \times J[(l \times w \times h) / K] \times [(H - h) / h] \times F$

L= 325.5 lbf

where:

L= 325.5 lbf

M_f= 10 lb/ft^3

J= 1 lbf/lb

l= 16 ¾ in

F= 7

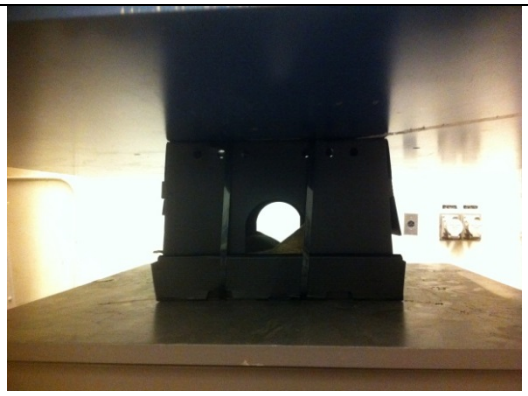
w= 13 ½ in

h= 11 ¾ in

K= 1728 in^3

H= 47 in

Table 6- Compression Test Results

Box Number	Description	Photo
1	No structural damage	
2	Did not pass	
3	No structural damage	
4	No structural damage Tabs popped out	

Graph:

TouchTest Compression

Lansmont

Sample ID	Peak Force (Lbs)	Defl @ Pk (In)	PreLoad (Lbs)	Test Speed (In/min)	Temp (deg F)	%RH	Time	Date
28 lb. Asparagus Shipper #9	325.6	0.17	50.0	0.50	65.1	37.3	06:49 PM	21-Feb-13
28 lb. Asparagus Shipper #8	326.0	0.19	50.0	0.50	65.0	37.2	06:46 PM	21-Feb-13
28 lb. Asparagus Shipper #7	213.9	0.21	50.0	0.50	65.1	37.0	06:43 PM	21-Feb-13
28 lb. Asparagus Shipper #6	326.4	0.13	50.0	0.50	65.1	36.9	06:40 PM	21-Feb-13

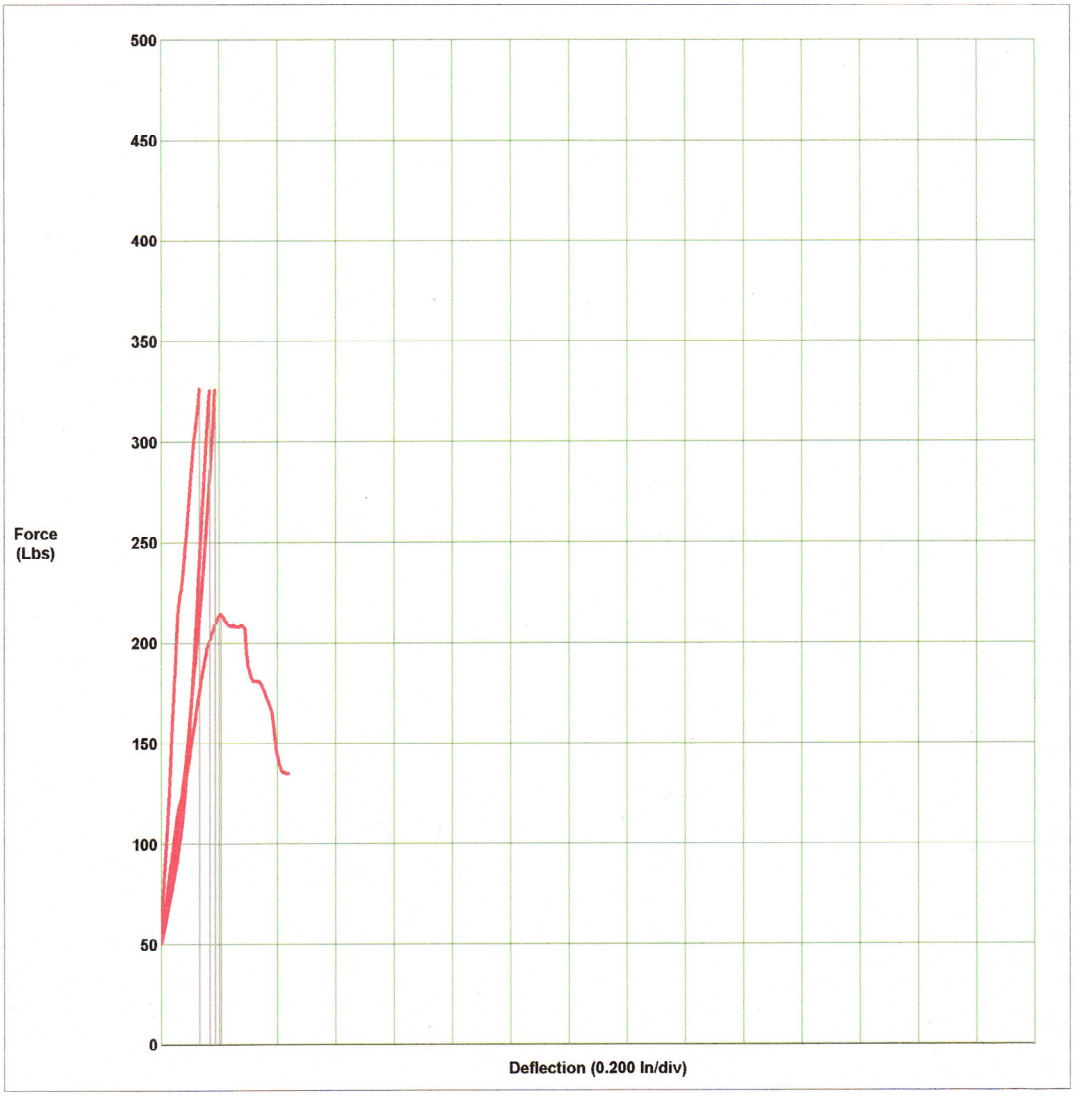


Figure 7- Compression test graph

Schedule E: Vehicle Vibration

Overview:

Test Standard: ASTM 4728

Date: 2/22/13

Test Engineer: MT

Duration: 180 minutes

Testing Equipment:

Name: Lansmont Touch Test Vibration

Model Number: 760C893A

Calibration Date: Unknown

Procedure:

Place test specimens on vibration table. Select truck distribution. Test for 180 minutes.

Results:

No additional damage occurred to any of the packages

Schedule A: Final Manual Handling

Overview:

Test Standard: ASTM D5276

Date: 2/22/13

Test Engineer: MT

Duration: 20 minutes

Testing Equipment:

Name: Lansmont Precision Drop Tester

Model Number: PDT-56ED

Calibration Date: June 2005

Procedure:

Drop Height- 13 in.

Table 7- Final Drop Test Impacts

Drop Number	Impact Orientation	Impacted Member
1	Vertical edge	4,6
2	Side face	6
3	Adjacent side face	4
4	Top corner	1,2,6
5	Adjacent top edge	1,2
6	Bottom face*	3

*Drop 6 is from 26 in.

Table 8- Final Drop Test Results

Box Number	Description	Photo
1	Minor corner scuff	
2	Additional damage to bottom	
3	Temporary corner dent	
4	Flaps opened	

Data Analysis Method

The best package will be selected based on how well the package performs in distribution testing and whether or not the point of sale material harms the package structurally. This will be analyzed based on how well each package did with the predetermined pass/ fail criteria.

Pass/ Fail criteria are needed to evaluate whether the package-product system passed the distribution testing or not. It needs to be determined prior to the start of testing. The package will be judged by using the following:

- Package remains closed
- Package compresses less than 10%
- Point of sale material remained attached
- All features stay the same
- Asparagus remains unbroken
- Asparagus remains visually appealing

Tools Used

This project uses two different tools to acquire the desired solution. First, the project uses CAD software to develop the new package. The primary software will be ArtiosCAD. The package will be cut on a Kongsberg table that is uses the CAD drawing from ArtiosCAD. Once the prototypes are created they will be tested on the machines located in the Industrial Technology Dynamics Lab located at Cal Poly. Several machines will be used for distribution testing including a drop tester, compression tester, and vibration table.

SECTION IV
RESULTS

The purpose of this project is to redesign Gourmet Trading Company's 28 lb. shipper to include a detachable point of sale material. The point of sale material must be easy to implement by the company as well as be easy to use by the stores. It is imperative that the new design does not compromise any structural capabilities of the original design. The goal is to add the detachable point of sale material while maintaining the structural standards of the original package to deliver the product undamaged.

Table 9- Summary of Results

Solution #	Solution 1 (Dummy Load)	Solution 2 (Dummy Load)	Solution 3	Benchmark (Dummy Load)
Weight (lbs.)	21.6	24.2	29.5	22.2
Schedule A- Initial Manual Handling (Drop Height, in.)	13	13	13	13
Top	No damage	No damage	Minor asparagus chipped	No damage
Bottom edge	No damage	No damage	No damage	No damage
Adjacent bottom edge	No damage	No damage	No damage	No damage
Bottom Corner	Minor deformation	Bottom corner tear	No damage	Bottom slightly deforemed
Diagonally opposite bottom corner	No damage	Bottom corner tear	No damage	No damage
Bottom	No damage	No damage	No damage	No damage
Schedule C- Vehicle Stacking (325.5 lbf)	No damage	Did not pass	No damage	Tabs popped out
Schedule E: Vehicle Vibration	No damage	No damage	No damage	No damage
Schedule A: Final Manual Handling (Drop Height, in.)	13 (Final drop 26)	13 (Final drop 26)	13 (Final drop 26)	13 (Final drop 26)
Vertical edge	No damage	Further damage to bottom corner	No damage	No damage
Side face	No damage	No damage	No damage	No damage
Adjacent side face	No damage	Additional bottom damage	No damage	No damage
Top corner	Minor scuff	Minor scuff	Minor temporary dent	Opened side flaps
Adjacent top edge	No damage	No damage	No damage	No damage
Bottom face	No damage	No damage	No damage	No damage

Solution 1

This solution added perforations to the top edge of the flap. The perforations are used for quick easy removal of the point of sale material. The package uses 3/8” perforations to enable the flap to stay attached during shipping. The tabs on the flap also have perforations so they can be removed as well. The end result is a trapezoidal sign that can be displayed in stores.

Advantages

The package uses many of the same key features of the original design. It is a two piece design which has a bottom piece that the asparagus rests on and a top piece that covers and protects the asparagus. The bottom has nesting features so the shippers can be stacked on top of each other. It also has vent holes on the bottom which also allows water to drain out. The top has a viewing window on two sides of the package. It also has vent holes on the top and the sides. Also, there are tabs on the top which allows for nesting. The sides have tabs which makes the package stay closed.

The biggest advantage of solution 1 is the smaller perforations for the point of sale material. This allows for the easiest removal of the flap compared to all the other alternatives. The store employee can easily grab the flap and remove it with no problems. The tabs also have perforations for easy removal as well. The sign is the same size as the previous solution.

Disadvantages

The biggest advantage can also be viewed as a disadvantage for this solution. Since the flap is the easiest to remove it also has the highest chance of coming off during delivery. The distribution testing proved this wrong however as the flap successfully stayed attached the entire time.

Solution 2

This solution is very similar to the first design. It uses all of the same key features as the original design. The main difference is that it uses bigger 1/2” perforations than solution 1. The perforation is still located along the edge of the flap. This package did not pass the compression test during distribution testing. This was not due to the package design however. The package was cut out with the flute directions in the wrong way, so the flutes were not supporting the package in the right orientation. This was a user error and the package would have passed compression testing if oriented correctly. This was not a big issue since the main thing being tested was whether or not the point of sale material would stay attached. Solution 2 passed that test which was much more important.

Advantages

This solution differs from the others because of the perforations used. The larger perforations mean that the flap will stay on better and handle distribution testing better. This means that the point of sale material will stay attached during shipping but can be removed when it arrives in store.

Disadvantage

The main disadvantage of this design has to do with the location of the perforations. Because it is located along an edge it has a higher chance of detaching during transportation. The larger perforations allow it to stay attached better, but there is still a chance that it could be detached. However, that is unlikely and the package successfully passed distribution testing with the point of sale material staying attached. A disadvantage of having larger perforations does make it a little harder to remove. Smaller perforations would be more effective for removal.

Solution 3

Solution 3 takes a different approach to adding the point of display material. It still uses perforations to remove the flap, but it is done in a different fashion. The perforations are located on the same side as the previous solutions. It uses a strip of perforations located on the flap instead of on the edge. There is a tab that slightly protrudes from the edge so it can be grabbed for easier removal.

Advantages

The primary advantage of this design is the location of the perforations. Since it is located further down the flap as opposed to the edge, the point of display material has a stronger design. There is little to no chance that the flap will fall off during transportation. The added tab allows for simple removal by just grabbing and pulling on it. It is self-explanatory and very simple to use.

Disadvantages

While this tab can still be removed fairly easily, it is still harder to remove than the previous solutions. One of the main goals of this project is to have the point of sale material easy to remove. This solution is still easy to remove, however the perforations along the edge, like in the previous solutions, are even easier to remove.

Table 10- Table of Needs vs. Alternatives

Description of Needs	Solution 1	Solution 2	Solution 3	Benchmark
Easy to detach	5	4	3	Not applicable
Justification	Point of sale material stayed attached during testing, but was very easy to remove when needed	Point of sale material stayed attached during testing, but was moderately easy to remove when needed	Point of sale material stayed attached during testing, but was a little difficult to remove when needed	Original design did not have a detachable point of sale material
Point of Sale sign is legible	No print on prototypes	No print on prototypes	No print on prototypes	Not applicable
Protects asparagus	5	5	5	5
Justification	Dummy load used, but would have protected the product well	Dummy load used, but would have protected the product well	Protected asparagus successfully	Dummy load used, but would have protected the product well
Easy implementation for store employees	5	5	5	Not applicable
Justification	Easy to use	Easy to use	Easy to use	Not applicable
Maintains package quality	5	3	5	5
Justification	Performed as well as benchmark	Did not pass compression testing due to flute orientation	Performed as well as benchmark	Was the benchmark

*Scale: Lowest= 1, Highest= 5

Best Solution

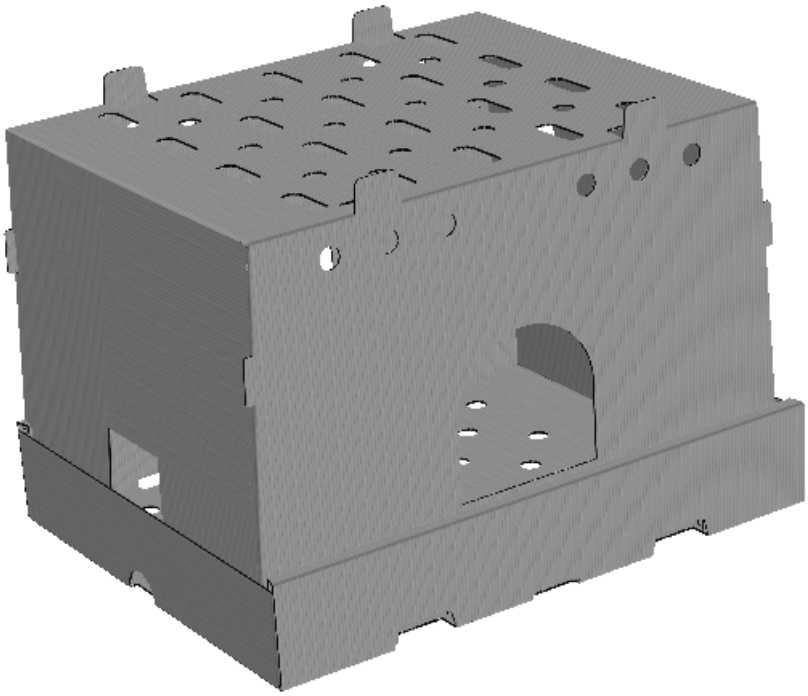


Figure 8- 3D CAD Drawing for Solution 1

The best solution was solution 1. It performed on par with the benchmarked asparagus package and the point of sale material was able to stay attached. This was selected based on the pass/ fail criteria that were developed prior to distribution testing. The pass/fail criteria were the following:

- Package remains closed
- Package compresses less than 10%
- Point of sale material remained attached
- All features stay the same
- Asparagus remains unbroken
- Asparagus remains visually appealing

After distribution testing the package was able to successfully pass all of the criteria. Additionally, this solution worked well for the removal of the flap after testing. According to the results, the package only deflected 0.17 in. This was only 1.4% deflection, and the package was not permanently deformed. This package did use a dummy load, but the asparagus did remain intact and visually appealing for another solution. This package would have protected it equally as well if it were loaded with asparagus.

The package also performed well against all of the original needs from the project. Solution 1 performed at the highest level for every need, as shown in the previous table. All of the packages performed well during the testing, so the ease of removal was the main determining factor. This design was the easiest to remove due to its location and small perforations. It is easy to remove and very self-explanatory.

SECTION V
CONCLUSIONS

The purpose of the project was to successfully redesign Gourmet Trading Company's 28 asparagus shipper to include a detachable point of sale sign. This section explains all of the steps that were taken to reach the final result. It also discusses the final result and the benefits it provides. The conclusion reflects back on the product and talks about different challenges that came up and the lessons learned from them. Lastly, it discusses further steps that need to be taken in order to implement the final product.

Summary of Work

This project had to undergo many tasks in order to reach the final solutions. The project began by researching similar products and methods of food packaging in order to gain a deeper understanding of the project. The literature search was useful in finding out what asparagus packages have previously been developed and also researching the necessities of food packaging. Once a deeper understanding was reached it was time to begin designing the packages.

ArtiosCAD was used for all of the CAD designs for the project. This process first began by observing and measuring Gourmet Trading Company's original 28 lb. shipper. It was important to keep the package structurally similar. Thus, the basic size and layout of the package were measured and designed to be similar. Once the original layout was finished in CAD then the alternate solutions were worked on. All of the alternative solutions used the same basic design, but each had different modifications added to it. The CAD designs were completed and prototypes were made. A Kongsberg table was used to cut out the designs. The plastic corrugated sheets were supplied by Cal Poly and they were used as the prototype material. Each model was cut out on the Kongsberg table and constructed to be ready for testing.

Fresh asparagus was used for one package for testing. The rest were filled with 20 pound sand bags to simulate the asparagus. First, the packages underwent an initial drop test to simulate manual handling. After that each one went through compression testing to simulate stacking compression. Next, the packages went through a vibration test to simulate truck shipping. Lastly, they went through a final manual handling to represent the unloading of the packages.

Conclusions

All of the alternatives created would work to add a point of sale material to Gourmet Trading Company's 28 lb. shipper. Every one of the point of display flaps was able to successfully stay attached during the distribution testing. The packages were able to successfully protect the contents of the package as well. The determining factor between each model was the ease of removal for the flap. The point of sale material that was easiest to detach was solution 1 with the 3/8" perforations along the edge. It used small perforations and was easy to detach from the package, however it was able to easily stay attached during shipping. The attached perforated tabs were also able to function well during testing yet were easy to remove when desired. This is the best option moving forward and will be simple for store employees to use.

Lessons Learned

This project provided many learning outcomes throughout the duration of the project. First of all, the author learned the different aspects of shipping fresh fruits and vegetables. It is very specialized and many things can go wrong if the right precautions are not taken. The products are still living and can spoil if they are not shipped in the right environment.

The author faced many challenges when designing the new asparagus package. This provided a chance to grow and expand many skills in CAD through prolonged use with ArtiosCAD and a Kongsberg cutting table. The program is very powerful but can be tricky at times. It does not always perform how it should. The author was able to learn how to overcome these hurdles by spending time on ArtiosCAD and becoming comfortable with it. The same applied when cutting the designs out on the Kongsberg table.

Lastly, aspects of box manufacturing were learned. The design is reliant on whether or not the product can be actually produced in a high speed box manufacturing environment. Different aspects such as the size of features and the overall layout of the blank are important. Since cutting dies are used, a feature cannot be too small. The success of the project relies on the feasibility to actually produce the package.

Project Problems

A few problems arose during the project. One of the main problems had to do with the plastic corrugated sheets that were used for the prototype. While they were readily available in lab for use, every one of the plastic corrugated sheets in lab was warped. The majority of them were severely warped and unusable. The ones used for the prototypes were the least warped sheets; however they were still not very straight. This caused some complications while the prototypes were being cut on the Kongsberg table. Eventually, the sheets had to be held down by metal weights to best cut out the blanks.

Another issue that arose concerned the Kongsberg table. It seemed to be rather unreliable and would break down often. This made it harder to cut out prototypes and delayed testing. The last had to deal with human error. One of the prototypes was cut out and tested with the flutes facing the wrong direction, which gave the prototype less strength vertically. However, this only affected the results for compression testing for the one prototype.

Table 11- Course Knowledge Applied for Project

Senior Project Capstone Experience						
Industrial Technology Courses			**Slightly Used**	**Moderately Used**	**Heavily Used**	**Description**
IT	330	Issues of Packaging		**X**		Learned the basic functions of packaging; learned about box manufacturing
IT	407	Applied Business Operations				Overall process of idea creation to fabrication
IT	408	Paper and Paperboard Packaging			**X**	Learned ArtiosCAD and package design
IT	409	Machinery for Packaging		**X**		Learned some packaging machines needed to produce package
IT	475	Packaging Performance Testing			**X**	Learned about all the machinery needed for package testing; learned ASTM test methods and how to operate machinery
Support Courses						
STAT	217	Statistical Concepts and Methods		**X**		Statistical testing
GE Courses						
FSN	230	Elements of Food Processing	**X**			Learned some requirements for food packaging

Future Work

This project covered the design and testing aspects of the new package, however some more work would be beneficial to the final outcome of the project. First of all, further testing should be completed with the actual asparagus samples. It was not feasible to do testing with all asparagus samples in this early stage of the project, but if it were to move forward further testing would be very valuable.

After more lab testing occurred it would be wise to do some sample runs in the field. This could be completed by shipping a batch of asparagus with the redesigned shipper. Once it arrived at the desired location it can be checked to ensure that no damage occurred to the asparagus. If all went well then it can be transitioned to the asparagus line. The company would need to inform their customers of the change and to be aware of the new detachable sign.

Facets of Implementation

A few steps need to be taken in order for this new package to be implemented. First of all, Gourmet Trading Company has to approve the package and view it as a viable option for sending point of sale signs. Next, the feasibility has to be analyzed to determine whether it can be manufactured in the box plant. Most of the features remain the same as the previous model, however there are some differences. Therefore, some new cutting dies will be needed to manufacture the new product. These steps are all very feasible and the design can be implemented.

SECTION VI
REFERENCES

ASTM Standard D4169, 2009, " Standard Practice for Performance Testing of Shipping Containers and Systems1," ASTM International, West Conshohocken, PA, 2003, DOI: 10.1520/C0033-03, www.astm.org.

Bacchetti, M. R., Heiskell, R. E., & Theys, E. E. (1995). *U.S. Patent No. 5,462,220*. Washington, DC: U.S. Patent and Trademark Office.

Barth, M., Hankinson, T. R., Zhuang, H., & Breidt, F. (2009). Microbiological spoilage of fruits and vegetables. In: W. H. Sperber & M. P. Doyle (Eds.), *Compendium of the microbiological spoilage of foods and beverages, food microbiology and food safety*. New York: Springer Science+Business Media.

North carolina state university. (1996, September). Retrieved from http://www.bae.ncsu.edu/programs/extension/publicat/postharv/ag-414-8/index.html

Matche, R. S. PACKAGING ASPECTS OF FRUITS AND VEGETABLES.

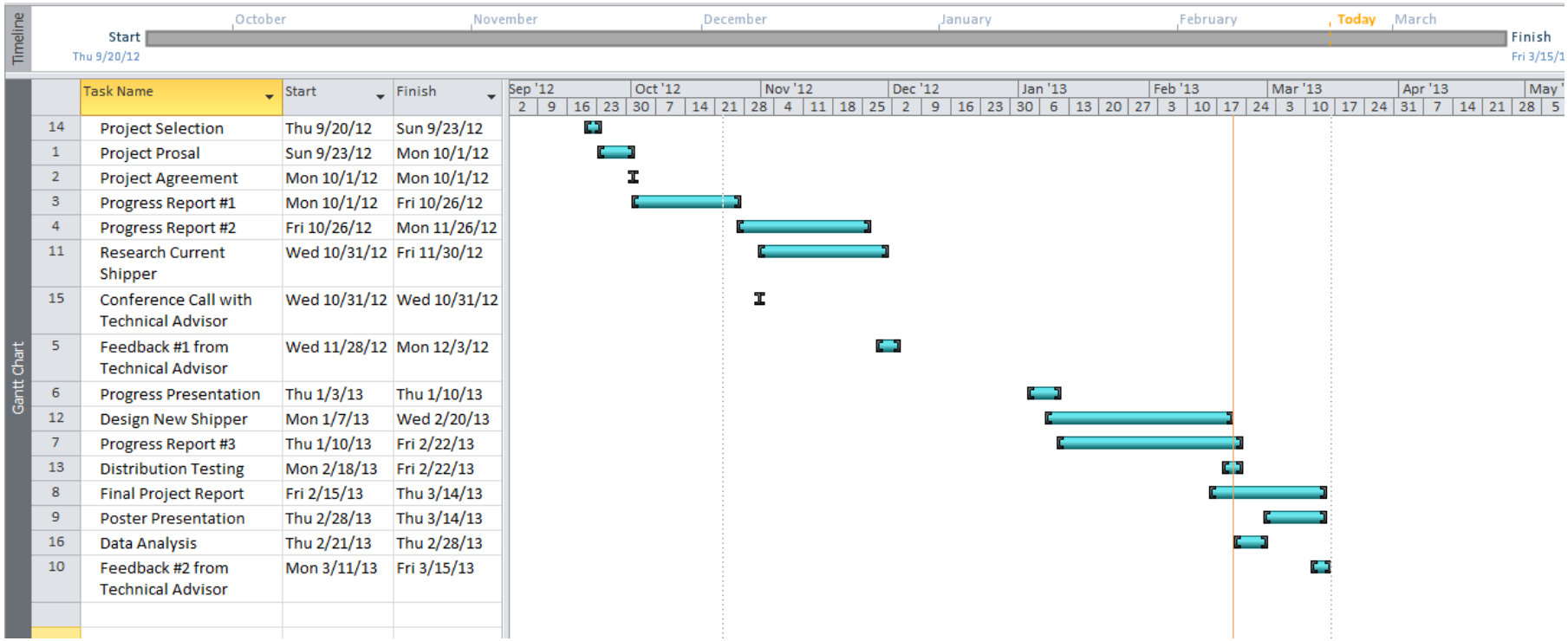
Mr. Grocers. (2012). *Organic bagged yellow onions*. Retrieved from http://mrgrocers.com/organic-bagged-yellow-onions-1709

Singh, Jay. (2011). “Lecture 1”. IT 475 Packaging Performance. Page: 13.

Watada, E. A., Herner, R. C., Kader, A. A., Romani, R. J., & Staby, G. L. (1984). Terminology for the description of developmental stages of horticultural crops. *Hortscience*, *19*, 220–21.

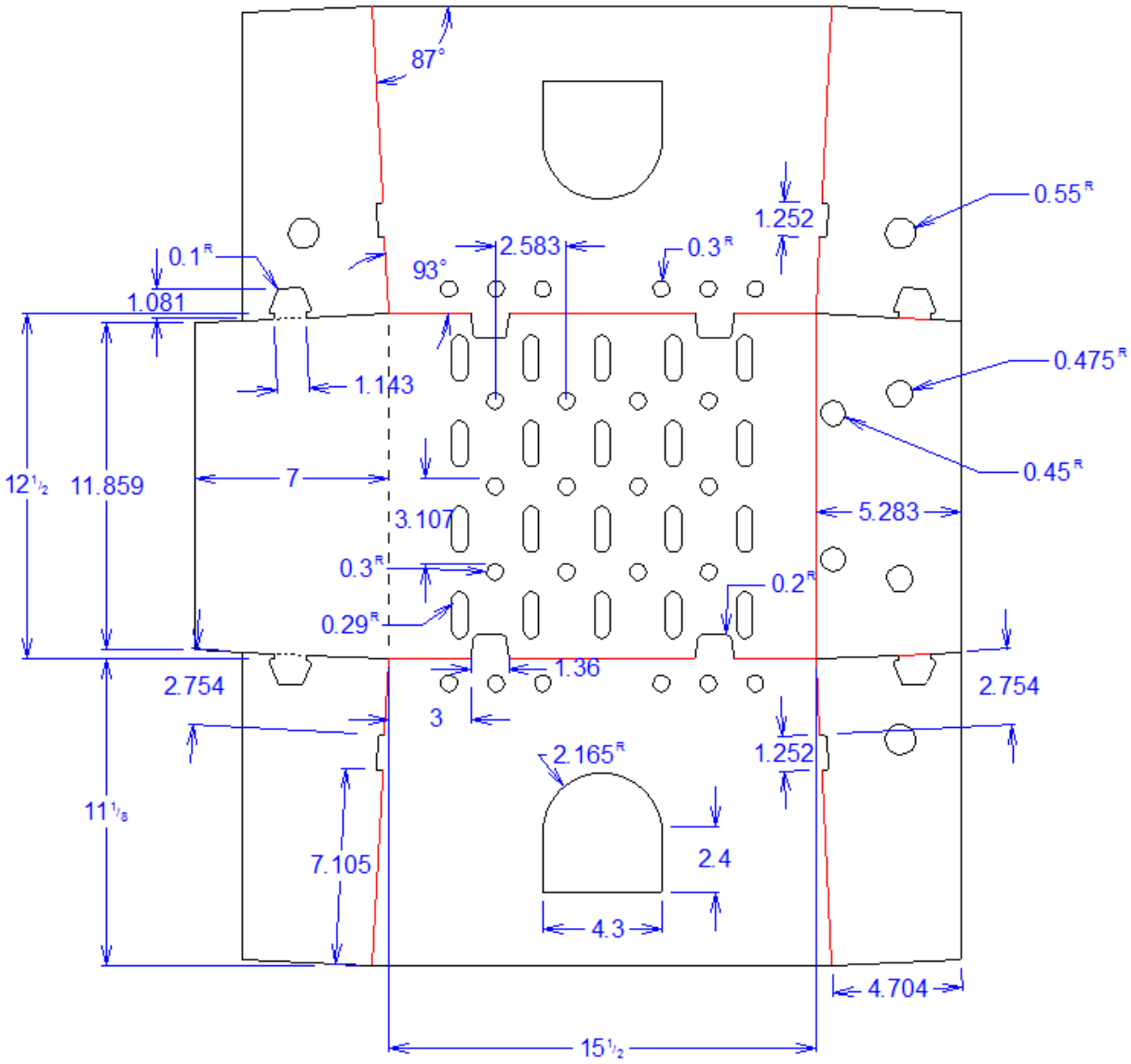
APPENDIX

Appendix I- Gantt Chart

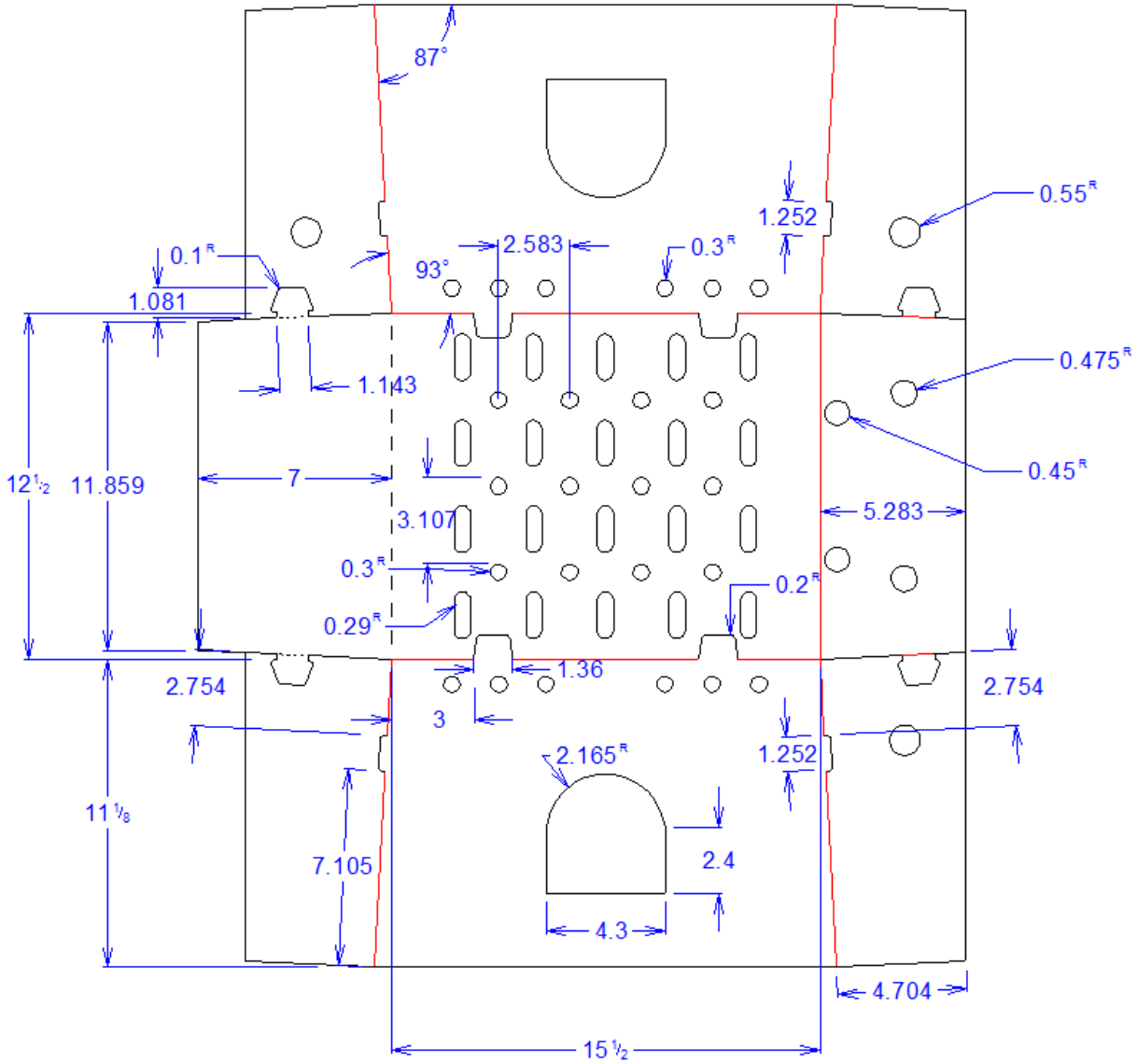


	Task Name	Start	Finish
14	Project Selection	Thu 9/20/12	Sun 9/23/12
1	Project Prosal	Sun 9/23/12	Mon 10/1/12
2	Project Agreement	Mon 10/1/12	Mon 10/1/12
3	Progress Report #1	Mon 10/1/12	Fri 10/26/12
4	Progress Report #2	Fri 10/26/12	Mon 11/26/12
11	Research Current Shipper	Wed 10/31/12	Fri 11/30/12
15	Conference Call with Technical Advisor	Wed 10/31/12	Wed 10/31/12
5	Feedback #1 from Technical Advisor	Wed 11/28/12	Mon 12/3/12
6	Progress Presentation	Thu 1/3/13	Thu 1/10/13
12	Design New Shipper	Mon 1/7/13	Wed 2/20/13
7	Progress Report #3	Thu 1/10/13	Fri 2/22/13
13	Distribution Testing	Mon 2/18/13	Fri 2/22/13
8	Final Project Report	Fri 2/15/13	Thu 3/14/13
9	Poster Presentation	Thu 2/28/13	Thu 3/14/13
16	Data Analysis	Thu 2/21/13	Thu 2/28/13
10	Feedback #2 from Technical Advisor	Mon 3/11/13	Fri 3/15/13

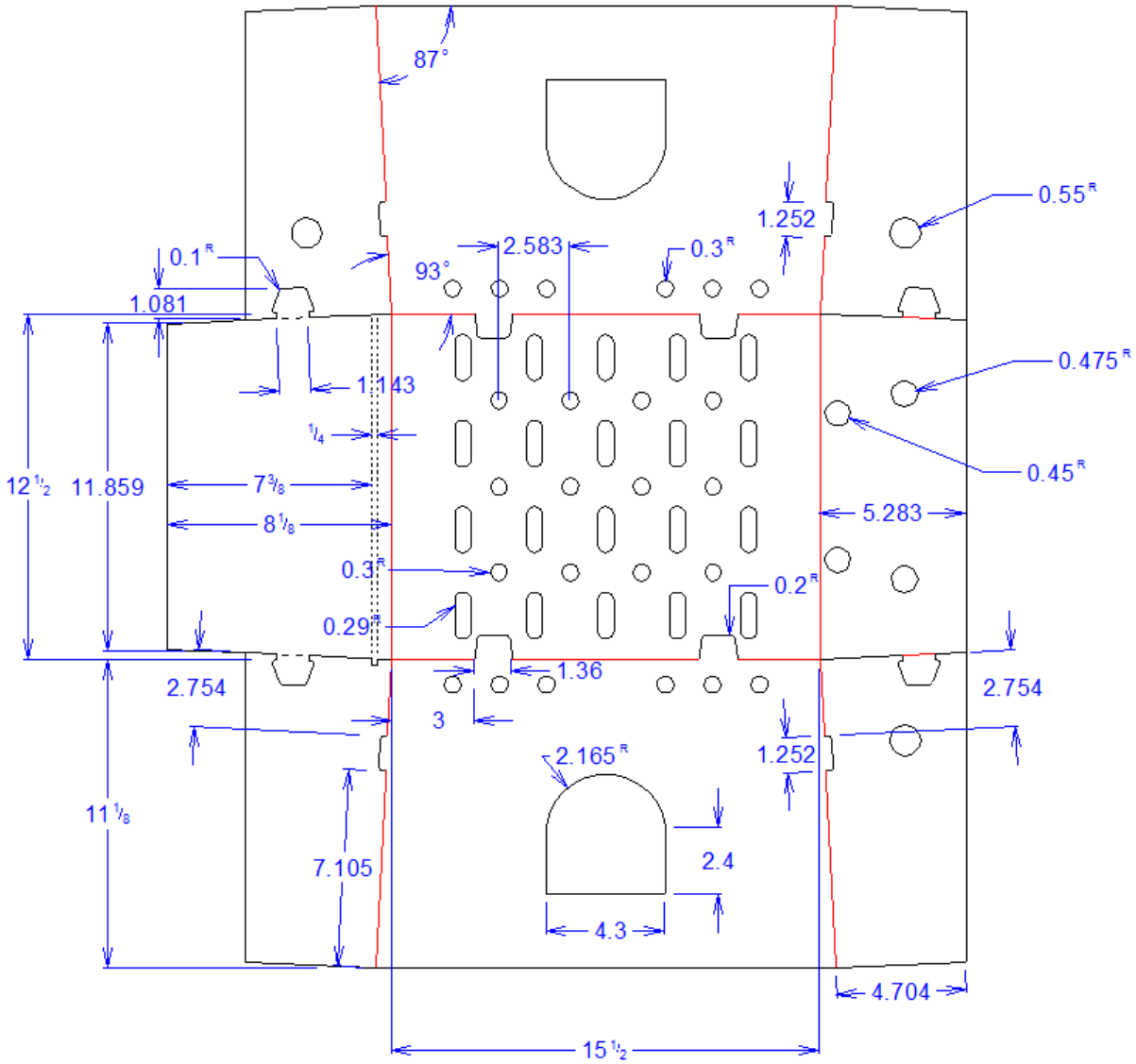
Appendix II- Dimensioned CAD Drawing for Solution 1



Appendix III- Dimensioned CAD Drawing for Solution 2



Appendix IV- Dimensioned CAD Drawing for Solution 3



Appendix V- Dimensioned CAD Drawing for Bottom Tray