Modified Asparagus Packaging
For
Inclined Shelving

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Abstract

The Gourmet Trading Company (GTC) is currently in need of modified asparagus packaging that will both satisfy the needs of their customers as well as provide adequate protection for their product during shipments from Central and South America to North America. Wal-Mart, one of GTC’s customers, needs the packaging to be modifiable in store to display the product vertically on inclined shelves. There currently is no way for the asparagus in Wal-Mart’s produce department to be displayed upright on shelves in stores. The existing method of display lays the asparagus down in the shelves with the butt ends facing the consumer. Wal-Mart prefers that the asparagus spears display all of their qualities by standing vertical in the shelving.

This senior project has created a package that will provide a solution to the Gourmet Trading Company’s dilemma. The project’s accomplishments include package designs that: can be modified to display the product in store, use pallet space more efficiently, and are lighter and stronger than the original package. The research, design, and testing of the packaging took place within the Cal Poly Industrial Technology Packaging labs. These procedures were overseen by Dr. Jay Singh. The data obtained by the certified testing procedures gives the user and their customer specific product specifications. The resulting data will summarize the mechanical properties of the packaging medium in a simulated shipping environment. The proposed procedure has been developed and reviewed by the American Society for Testing and Materials as well as Dr. Jay Singh, this projects student advisor.
Acknowledgements

We would like to thank Dr. Lou Tornatzky, Dr. Jay Singh, Adam Stephens and Julia Inestroza for technical support and guidance throughout the project.
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Section I

Introduction

Problem Statement:

The Gourmet Trading Company is the preferred supplier to retail chains and large food service companies of high quality fresh asparagus and blueberries on a year round basis. Wal-Mart is one of GTC’s biggest customers. They currently purchase 800,000-1,000,000 eleven pound boxes of asparagus per year. The incline angles of the produce shelving at Wal-Mart super centers are very steep. They rest at a 60 degree angle from the wall. As a result, the tall asparagus spears cannot stand up vertically and fall forward on the shelves. The asparagus is not as appealing laying flat in the shelving as it is standing vertically.

Needs:

GTC’s has given our team the task of designing a new packaging and display box that will be able to:

1) be modified in store to display and support the product on shelf
2) allow the product to stand vertically
3) withstand being stacked eight layers tall with twenty boxes per layer on a 48”x40” pallet
4) be die cut
5) be manually assembled
6) be manually packed
7) be composed of corrugated plastic
8) minimize material used
9) minimize net weight of package
**Potential Solutions:**

There are three possible solutions that the team has addressed:

Solution #1 involves a two piece package. The first piece is a bottom tray that holds the asparagus vertically in the shelving. The second piece wraps, supports and attaches to the tray via tabs, providing containment, protection, and marketing area for the product during shipment.

Solution #2 involves a two piece package similar to solution #1. The lid and tray will attach to each other via tabs and slits on the inside of the box. The lid will have tabs and the tray will have slits.

Solution #3 involves a two piece package. It will be similar to the current packaging. It will also contain a removable tray inside the package that will contain the asparagus.
For the purposes of this project, the Gourmet Trading Company would like three areas of their current asparagus packaging to be addressed. First, they would like a box to be designed that can withstand the journey from Peru, where the asparagus is harvested, to the products’ final destinations in stores throughout the United States. Second, the Gourmet Trading Company’s current display boxes are not properly designed to keep the asparagus (in the box) on display upright in stores. Lastly, the Gourmet Trading Company would like a reduction in the amount of material used in the asparagus packaging.

This literature review is important because it will address both the background of work done in asparagus packaging design, and all aspects of current shipping methods. The following will be addressed in order to support the asparagus packaging redesign; asparagus defined, asparagus behavior (post harvest), proper conditions for shipping asparagus, and lastly, previous asparagus box designs.

**Asparagus Defined**

Asparagus is a member of the lily family. The spears emerge from a base crown planted about a foot from the surface of the ground. The crown continues to produce spears after each harvest and is a perennial crop that is harvested over an eight to ten week period. Harvesting cannot occur until two to three years after the crown has been planted in order to develop a strong and fibrous root system. Once this occurs, the crown will continue to produce spears for 15 years or more. Optimal growth occurs between 55 and 85 degrees Fahrenheit (Mullen, 2010). Most varieties of asparagus grow faster at higher temperatures, although extremely high
temperatures can result in premature tip feathering (Mullen, 2010). Spears are typically cut at a length of nine inches, although the length varies by season. Most of the weight is located at the butt of the spear. “Quality, fresh asparagus will be dark green and firm with tightly closed, compact tips. Stalks are straight, tender and glossy in appearance” (Suslow, 2010).

**Gourmet Trading Company’s Product**

The Gourmet Trading Company offers two different varieties of asparagus, UC 157 and UC 115. UC 157 is capable of growing in warmer climates with mild winters. It can withstand temperatures exceeding 80 degrees without feathering. It is tolerant of harmful fungi; Puccinia asparagi and Fusarium oxysporum (Cutter Asparagus Seed, 2010). UC 115 is a variety of asparagus that produces a higher variety of marketable spears with tightly appressed bracts (Stone). This in turn allows for higher yields.

These varieties of asparagus are grown west of the Andes Mountains in a coastal strip of land next to the Pacific Ocean. This strip of land is 31 miles wide and 1554 miles long. It is desert-like land with and average temperature of 61 degrees Fahrenheit in the winter and 72 degrees Fahrenheit in summer, with temperature variation between 43 and 46 degrees Fahrenheit between day and night. This area receives very small amounts of rainfall. Because of this, all asparagus is grown on a drip irrigation system (Flor, 1996).

Once the asparagus is harvested, it will go through a number of steps that take it from the fields of Peru to the end customer. The entire process will take just under 6 days if shipped by air. If sent by ocean, the voyage will require an extra 9-13 days. To begin with, the freshly harvested asparagus is taken directly to the packing house. In the packing house it will be cleaned, classified, cut, weighed, packed, hydrocooled, palletized, and finally refrigerated. This all requires 12 hours to complete and once finished there is a final sanitary inspection to ensure a quality product is shipped. Once cleared by the inspection, the Pallets of asparagus are sent by truck in cold storage to the Lima, Peru Airport for air shipment or to the port of Callao to be
loaded on a ship. For both shipping methods, the asparagus is kept in cold storage. Once the asparagus arrives in the United States in either Miami or Los Angeles, it will undergo a USDA inspection and then fumigation. From the ports of entry, the asparagus will then be sent to a warehouse where it will be once again inspected for quality and then distributed to its final location.

**Harvesting**

Harvesting the asparagus is done by a field crew that will individually cut each spear of asparagus by hand. The spears are cut with a long knife at, or slightly below, ground level. Once cut, the spears are loaded into field trays and taken to the packing house (Inestroza, 2010).

**Packaging**

When the field trays of asparagus first arrive at the packing house, they go directly through a hydrocooling process. This step’s purpose is to remove any dirt on the product and to cool it down from higher field temperatures, which will accelerate rotting, to lower and safer temperatures of about 50 to 54 degrees Fahrenheit. Once cooled the asparagus is then graded, sorted by size, and then weighed. The Gourmet Trading Company offers 5 different size categories of asparagus according to their diameter size. These sizes are small (5-8mm), standard (8mm-11mm), large (11mm-16mm), extra large (16mm-21mm), and jumbo (21mm+)(GTC 11lbs box). During this step all defective asparagus spears will be sorted out. Defective qualities include discoloration (spear colors other than green), soft and or feathering tips, dehydration, seeding spears, and dark wet spear tips (Inestroza, 2010).

Once sorted, the individual spears are bunched into 1 lb. bundles held together by rubber bands. Once bunched, the asparagus butts are cut to create a uniform height of seven to nine inches. With this height, there will be room in the box for the asparagus to keep growing. During
the shipping process, the asparagus will grow between 1 and 1.5 inches (Inestroza, 2010). Once cut, the asparagus will be put into boxes.

The current boxes that the Gourmet Trading Company are using have dimensions of 9.75 x 9in. x 11.25in, and are made of 3mm thick corrugated polypropylene. Polypropylene is ideal for this application because it is recyclable, lightweight, waterproof, and easily printed on. Just before the asparagus is loaded into the box, a moist fiber pad is put on the bottom of the box. The purpose of this is to prevent the asparagus from drying out during shipping. Once this step is completed, eleven bunches of asparagus are added to the box. The size category differs for each box. This is based on the buyer’s specifications; however, it does not affect how many bunches of asparagus can fit into the box because all bunches weigh the same amount and are similar in size. Once boxed, the asparagus moves onto emersion hydrocooling.

**Hydrocooling**

The purpose of hydrocooling is to chill the asparagus down as low as possible without damaging it. For asparagus, the optimal temperature is just above freezing, between 32 and 35 degrees Fahrenheit (Sargent, 1988). Shelf-life will be extended at lower temperatures, because both the respiration rate and fungal growth slow down as a result of colder temperatures. “The storage life or relative perishability of a crop is reflected in its respiration rate evaluation precooling methods” (Sargent, 1988). For this emersion hydrocooling step, the boxes full of asparagus are put into a bath of cold water where they are floated until cold. Once cooled, the boxes are put onto pallets and kept in refrigeration for the duration of shipping.

**Transportation**

When palletized fully, the 11 lbs. boxes are stacked on a pallet whose dimensions are 48 x 40 inches. The boxes are stacked 6 layers tall for truck and air shipment and six to eight layers tall if it is sent by ship. Each layer will contain 20 boxes.
For ocean shipments, each container that is loaded will contain 24 pallets of 11lbs. boxes and between 120 and 140 boxes per pallet. For air shipments, there is no set quantity of pallets that will be shipped. The shipping amount can range from 20 boxes to a full Boeing747 full of product.

As soon as the asparagus reaches ports in the US, it will undergo an inspection for quality by the United States Department of Agriculture. There are 12 criteria that the asparagus is judged on. The criteria are cleanliness, freshness, uniformity of spear length, quality of trimming, spear straightness, presence of wilting spears, misshapen spears, decay, free from damage caused by spreading or broken tips, dirt, disease, insects, or mechanical or other means, at least eighty-five percent green, and all green. These criteria are judged on a pass fail system.

**Inspection and Distribution**

If and when the asparagus passes the USDA inspection, it is fumigated with Methyl Bromide, a pesticide intended to kill Copitarsia Decolora (Lepidoptera: Noctuidae) larvae. Copitarsia Decolora is a moth that can be found in central Mexico south down to southern South America (Gould, 2006). It is considered a pest and is of regulatory concern to the United States, where it is not known to occur. The egg larvae arrive in the US on cut flowers and vegetables. Once fumigated, the asparagus undergoes a final inspection to check for remaining Copitarsia Decolora larvae. Once the shipment is cleared to enter the US, it is sent by truck to warehouses where it is once again inspected for quality and then sold and distributed to stores.

**Package Design**

When considering new box design ideas, reviewing existing designs will lead to a better understanding of how to best create a new box for fresh asparagus. As discussed above, both the asparagus and its packaging must go through many trials throughout their journey from field to display on store shelves. There are seven main factors that must be considered when designing a
new box for fresh asparagus. These are efficient use of material, ability to be stacked many layers one on top of another, holes for water drainage, hydrocooling, fumigation, and ventilation, extra room for asparagus growth, and ability for the asparagus to be viewed. Below are examples of current fresh asparagus containers that are widely used.

These boxes (see appendix a-c) fulfill many of the factors for successful packaging but still have faults that must be addressed. Please note the date of the patents. The first problem is their inefficient use of material. All designs have three layers of corrugated paperboard for strength. This is a problem because it not only uses more material but also adds to the weight of the package. Many companies, including the Gourmet Trading Company, ship their packaging material to their packaging facilities and pay for the shipping by weight. Therefore, the heavier the package, the more they will have to pay per box.

The final problem with both boxes is their ability to provide a good view of the asparagus. While both boxes address this problem, they do not allow for an unobstructed view of the asparagus. For the boxes to effectively be used, as a part of the display of the asparagus in a store, they must provide an unobstructed view of the product.
Section III

Solution

The project's main goal was to create a design that will provide solutions for the Gourmet Trading Company’s asparagus problem. The packages created allow the asparagus to stand upright while on display in stores. The designs are as light (0.6 lbs.) or lighter, as well as strong or stronger, than the existing packaging. The packages are designed to safely contain 11 lbs. of asparagus for international shipments from Peru to the United States. In order to prove that the chosen design is capable, it has undergone ASTM specified Performance testing.

The design for the existing package has been laid out below. Three preliminary design ideas have been created. These include a box with a removable top via exterior tabs (S1), a box with a removable top via interior tabs (S2), and box with an inner removable tray for display rack (S3). Each design was created on ArtiosCAD Version 6.52en Build 440. The prototypes were made out of 0.115 inch thick polypropylene corrugated sheets (47.4” x 42.5”) on an Artios Kongsberg Premium Line table.

The purpose of this section is to outline the design and functions of each package and how they will work. All box designs have a five degree taper making the top of the box slightly smaller than the bottom of the box, adding additional compression strength. Each box also has similar bottom and top ventilation holes providing the same or more surface area ventilation than the original design. All of the designs require no glue, tape, or staples in their construction. The only fastening method used is tabbing.
Current Design

One piece package

Solution #1 (S1)

Box with a removable top via exterior tabs

The top and tray of this box are held together by two three inch wide exterior tabs. This solution provides an easy transfer from a box suitable for shipping to a tray that will allow for the asparagus to stand upright with optimal ability to be viewed by the customer. When the asparagus is to be put on the shelves, whoever is loading it has to pull the tabs from the outside of the tray. When this happens, the bottom asparagus tray will separate from the top of the box and fall onto the shelf. The tray is four inches tall: an adequate height to support the upright asparagus. This box also has a tab on two sides of the top of the box. Along with the tabs, there are matching holes on the tray that will allow for the boxes to nest together when stacked.
Solution #2 (S2)

Box with a removable top via inner tabs

This box is very similar to S1. The main difference between S2 and S1 is S2 has a tab, one on each side of the bottom of the lid, that attaches to the inside of the tray via 3.5 inch slits. This box also has increased stacking strength because the top of the lid has slits that allow for the protruding tabs from the box being stacked on top of the lower box to fit inside of the slits. To remove the top from the tray, the worker must hold the tray down while at the same time pulling up on the top consequently removing the top.

Solution #3 (S3)

Box with inner removable tray

This box appears similar to the current packaging except, inside of the box, the asparagus will be contained within an inner tray. When the box is to be loaded on a shelf, the tray can be pulled out of the outer box. This package has a very similar stacking system to (S1)
Section IV

Results

All three solutions were designed to include two pieces: a top portion to contain and protect the asparagus and a bottom tray to display the product. Each design differs in its method of connecting the top to the bottom tray.

Solution #1 (S1)

The advantage to the S1 design is that the tabs holding the top to the tray support the full tray lip. This design allows the tray to bear a portion of the load. This gives the package additional compression strength and prevents it from leaning under load. The tabs insert horizontally to the tray. This keeps the tab ends inside the box, protecting them from being pushed out by other boxes or surfaces. The two piece design uses minimal material and has little overlap.
Solution #2 (S2)

The S2 design has a very simple method of attaching the top to the tray. The tabs push through vertically into the tray. They are left exposed under the tray and used as package alignment for nesting. The exposed tabs allow the bottom tray to nest into the top of the box below. The disadvantage of this design is the exposed tabs. The tabs may be ejected if the package is dropped or placed too harshly.

Solution #3 (S3)

The S3 design top does not attach to the bottom tray, it encloses it. The top wraps around the whole tray, completely surrounding it. Once the package has been received in the store, it is opened and the tray slides out horizontally. The disadvantage to design S3 is that it has more overlap and uses more material than designs S1 and S2.

Chosen Solution

Design S1 was chosen because it has the desired structural integrity and functionality. It also uses minimal material. It will be constructed, filled and stacked similar to the existing design. This will allow the assemblers and packers to adopt the design with little additional training. The structure will allow the package to withstand the forces of transit. The minimal amount of material will cut down on shipping and material costs. See appendix E for sheet layout and orientation on a 2.26 meter wide sheet.
**Package Testing**

Design S1 was subjected to testing procedures created by the American Society of Testing and Materials (ASTM). ASTM is a voluntary international standards development organization. The standard procedures provide a guide for the “evaluation of shipping units in accordance with a uniform system, using established test methods at levels representative of those occurring in actual distribution.” (ASTM Standard D4169-09) The tests are performed sequentially on the same containers in the given order. The shipping unit remains unopened until the sequences of tests are completed. The purpose is to understand the shipping unit’s reaction to the distribution environment. The unit is subjected to a series of anticipated hazard elements encountered in various distribution cycles.
Distribution Sequence
DC 1 - General Cycle - Undefined Distribution System
Elements: ADFGA
Assurance Level II

Shipping Unit Information

Description: Gourmet Trading Company
11 lb Asparagus Package

Container Type: Box

Construction: Corrugated Container
No interior stress bearing packaging
Percentage of Load supported directly by Product: 0.0%

Shipping Unit Size:
Length: 10.0 in (254 mm)
Width: 9.0 in (229 mm)
Height: 11.5 in (292 mm)

Weight: 11.4 lb (5.2 kg)

Stack Height:
Vehicle: 96.0 in (2438 mm)
Warehouse: 192.0 in (4877 mm)

Acceptance Criteria: No Visible Damage
Product Intact
Schedule A - Manual Handling
Assurance Level II

The test levels and the test method for this element of the distribution cycle are intended to determine the ability of the shipping unit to withstand the hazards occurring during manual handlings such as loading, unloading, stacking, sorting, or palletizing. The main hazards from these operations are the impacts caused by dropping or throwing. Size, Weight, and Shape of the shipping unit will affect the intensity of these hazards. Presented below are recommended drop heights, number of drops, and the shipping unit orientations at impact:

For purposes of this procedure, the bottom of a small parcel is the surface on which the parcel rests in its most stable configuration.

Test Methods
ASTM D 5276 - Drop Test of Loaded Containers by Free Fall
ASTM D 5487 - Simulated Drop of Loaded Containers by Shock Machines

ASTM D 5276 DROP SEQUENCE:

<table>
<thead>
<tr>
<th>Drop Height</th>
<th>Impact Orientation</th>
<th>Damage: 1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 in (381mm)</td>
<td>Top</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>15 in (381mm)</td>
<td>Bottom Edge</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>15 in (381mm)</td>
<td>Adjacent Bottom Edge</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>15 in (381mm)</td>
<td>Bottom Corner</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>15 in (381mm)</td>
<td>Diagonally Opposite</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>Bottom Corner</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>15 in (381mm)</td>
<td>Bottom</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>
Drop Sequence
**Schedule C - Vehicle Stacking**

**Assurance Level II**

The test levels and the test methods for these elements of the distribution cycle are intended to determine the ability of the shipping unit to withstand the compressive loads that occur during vehicle transport or during warehousing. The required loading must consider the effects of length of time in storage, vibration, the alignment or stacking pattern of the container, variability in container strength, moisture content, temperature, previous handling, and method of load support.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Peak Force (lbs)</th>
<th>Defl @ Pk (in)</th>
<th>PreLoad (lbs)</th>
<th>Test Speed (in/mm)</th>
<th>Temp (def F)</th>
<th>% RH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orig Des</td>
<td>303.5</td>
<td>0.27</td>
<td>50.0</td>
<td>0.50</td>
<td>71.8</td>
<td>42.7</td>
</tr>
<tr>
<td>S1 #1</td>
<td>365.8</td>
<td>0.36</td>
<td>50.0</td>
<td>0.50</td>
<td>71.7</td>
<td>42.9</td>
</tr>
<tr>
<td>S1 #2</td>
<td>394.4</td>
<td>0.35</td>
<td>50.0</td>
<td>0.50</td>
<td>71.5</td>
<td>42.8</td>
</tr>
<tr>
<td>S1 #3</td>
<td>387.1</td>
<td>0.34</td>
<td>50.0</td>
<td>0.50</td>
<td>71.4</td>
<td>43.2</td>
</tr>
<tr>
<td>S1 #4</td>
<td>390.0</td>
<td>0.36</td>
<td>50.0</td>
<td>0.50</td>
<td>71.3</td>
<td>43.2</td>
</tr>
<tr>
<td>S1 #5</td>
<td>329.0</td>
<td>0.23</td>
<td>50.0</td>
<td>0.50</td>
<td>71.4</td>
<td>43.4</td>
</tr>
</tbody>
</table>
Compression Testing
Schedule D - Stacked Vibration
Assurance Level II

The test levels and test method for this element of the distribution cycle are intended to determine the ability of the shipping units to withstand the vertical vibration and dynamic compression resulting from transport and vehicle stacking. The test levels and method account for the magnitude, frequency range, duration, and direction of vibration. Perform the test along the vertical axis with the load in the normal shipping orientation. It is permissible to use a concentrated dead load to simulate an upper unit load or mixed commodities. The concentrated load may be calculated from the formulas in Schedule C with the F factors set equal to 1.

Test Method - Random Vibration
ASTM D 4728 - Random Vibration Testing of Shipping Containers Method A or B

The following power spectral densities, as defined by their frequency and amplitude breakpoints, and test durations are recommended.

Truck Profile
Overall Grms: 0.52  Test Duration: 180 min

<table>
<thead>
<tr>
<th>Frequency (Hz)</th>
<th>PSD (g²/Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.00005</td>
</tr>
<tr>
<td>4</td>
<td>0.01</td>
</tr>
<tr>
<td>16</td>
<td>0.01</td>
</tr>
<tr>
<td>40</td>
<td>0.001</td>
</tr>
<tr>
<td>80</td>
<td>0.001</td>
</tr>
<tr>
<td>200</td>
<td>0.00001</td>
</tr>
</tbody>
</table>
Touch Test Random Vibration

![Graph showing PSD vs Frequency for Touch Test Random Vibration](image-url)
Schedule A - Manual Handling
Assurance Level II

The test levels and the test method for this element of the distribution cycle are intended to determine the ability of the shipping unit to withstand the hazards occurring during manual handlings such as loading, unloading, stacking, sorting, or palletizing. The main hazards from these operations are the impacts caused by dropping or throwing. Size, Weight, and Shape of the shipping unit will affect the intensity of these hazards. Presented below are recommended drop heights, number of drops, and the shipping unit orientations at impact:

For purposes of this procedure, the bottom of a small parcel is the surface on which the parcel rests in its most stable configuration.

Test Method
ASTM D 5276 - Drop Test of Loaded Containers by Free Fall

DROP SEQUENCE:

<table>
<thead>
<tr>
<th>Drop Height</th>
<th>Impact Orientation</th>
<th>Damage: 1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 in (381mm)</td>
<td>Vertical Edge</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>15 in (381mm)</td>
<td>Side Face</td>
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<td>None</td>
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</table>
Cape Palletizing and Packaging Evaluation

Cape is palletizing and packaging optimization software. It determines the most efficient orientations and quantities of shipping units on pallets. It also determines orientation and quantities of pallets in trucking. It calculates the area and cube space used on the pallets and trucks.

A 40”x48” pallet stacked six, seven, or eight tiers high with 20 shipping units per layer can accommodate 120, 140, or 160 shipping units respectively. The pallets have no overhang and must be banded or wrapped.
<table>
<thead>
<tr>
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<th>Pallet Group</th>
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<td>Product Code</td>
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<tr>
<td>Datafile Name</td>
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<td>Load Ref.</td>
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<td>Area Used</td>
<td>99.0 %</td>
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<td>1 S</td>
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<tr>
<td>Truck Area Used</td>
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<tr>
<td>Volume</td>
<td></td>
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<tr>
<td>0.55 cuft</td>
<td></td>
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</tbody>
</table>

| Trapesoi(OD)  | Product 47.500 | 40.000 | 60.500 in | 56.000 | 1596.000 lb | 98.51 cuft |
| Load 48.000   | 40.000 | 66.000 in | 1596.000 | 1646.000 lb | 95.55 cuft |
| Product 472.000 | 88.000 | 86.000 in | 33516.0 | 34566.0 lb | 2067.19 cuft |
| 40HICUBE 474.500 | 92.250 | 105.500 in | 34566.0 | 40959.0 lb | 2672.16 cuft |
Section V

Conclusion

In conclusion, a box was created that exceeded the Gourmet Trading Companies needs. The new packaging is both stronger and weighs 0.2 pounds less than the current packaging. It passed all testing to prove that the packaging can sufficiently protect the asparagus during shipping. With a lighter package, GTC will save money on shipping costs. Second, a stronger package will provide a higher probability that all asparagus will be received by the grocery store undamaged. The increased strength allows the package to be stacked at a maximum of eight tiers high as opposed to the previous limitation of six tiers. Most importantly, the package can be altered to display the product vertically on the produce shelving in store.

As a group, we have learned a great deal. First and foremost, we have proven that we have made a package that goes beyond the minimum requirements provided by GTC and exceeds the limitations of the current package in use. Their goal for this package redesign was to create a box that could allow for the asparagus to stand upright in Wal-Mart Supercenter’s at a high angle and meet structural strength requirements for shipping.

The new packaging does not have any deficient qualities in comparison to the current packaging. The new box is ready to be put into production and in the future the box will be die cut on larger sheets than used in prototyping. This will allow for a much higher production rate compared to cutting the box out on the Artios Kongsberg table. There may be tolerance issues when the design is used to create the die for production. Further alterations to the design may be necessary to account for this. There will be far less variance between cuts once the design has been altered specifically for die manufacturing. The Artios Kongsberg does not have the capability to manufacture the design exactly to specifications and tolerances from the ArtiosCAD
drawing. Incorrect tolerances will cause difficult and improper assembly of the package. This is a problem that will be solved by use of a die.

The assembly of this package at the packaging facilities will be simple and easy for the assembly workers in Peru and Mexico. Both pieces of the box are attached with one side left open for packing. In fact, the packing of asparagus into the box will be no different than the current process being used today.

The new packaging has sufficient ventilation holes. This will allow for no change in the processing of the asparagus. In other words, the hydrocooling and pesticide spraying steps can remain the same.

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Section VI

References


Stone, N. K., & Roose, M. Asparagus hybrid named DePaoli. *Department of Botany and Plant
Appendix

A. Patent # 4,127,228
B. Patent # 5,462,220
D. Dimensional Drawing
E. Sheet Layout