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Multiple Apple Box Lift 1/10th Scale Model

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Multiple Apple Box Lift (1/10\textsuperscript{TH} Scale)

By

Kyle Burlingame
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Introduction

Motivation
Van Doren Sales builds fruit packaging equipment. One of their customers, Chelan Fruit approached the company with a problem. They currently store their apples in cardboard boxes stacked on pallets that are several rows high. After they take the apples out of storage they need to check the quality of the apples to ensure they are in good condition. Currently they check the apples by using a mobile staircase to climb to the top of the pallet. Then they grab a top level box and carry it back to a mobile cart where it is inspected. After the apples are shipped to the customers there have been complaints that the apples in the middle rows are not as good of quality. Chelan Fruit wants Van Doren Sales to develop a way that they can get access to a middle box of apples on the pallet before it is shipped.

Function Statement
A mobile device is needed that can lift multiple boxes of apples.

Requirements 1/10th Scale
The requirements for this project are as follows:

- The device must cost less than $400 dollars
- The device must provide a proof of concept at a 10th scale.
- The device must weigh less than 2 pounds.
- The device must be able to lift 2 pounds of weight.
- The device must cost less than $400 dollars, not including labor or design time to ensure a profitable product.

Engineering Merit 1/10th Scale
Additional engineering merit has gone in to redesigning a 10th scale model. Engineering merit has taken place with the redesign of a scale model and figuring out how to prove the concept of the large scale device using a smaller scale.

Scope of Effort 1/10th Scale
The project funding was cut for this project. The scope of this project is to prove the
functionality of this device at a 10\textsuperscript{th} scale.

**Success Criteria 1/10\textsuperscript{th} Scale.**
The success criteria is to have a working 1/10\textsuperscript{th} scale model of this device by March 9\textsuperscript{th}, 2016. This will prove that the concept of the design should work similarly on the larger scale design.

**Design and Analysis**

**Proposed Solution 1/10\textsuperscript{th} Scale**
Since project funding was cut, the new solution is to 3D print a 10\textsuperscript{th} scale model to prove the function of the design. All the original parts for the full sized model will be scaled down and 3D printed with minor adjustments. Lego Pneumatic cylinders and linear actuators will replace the full sized components.

**Description**
The first proposed design to lift the multiple levels of apples boxes can be seen below in figure 2. It has two plates used to squeeze the boxes, which are attached to their component lever arms. The lever arms are attached to the top frame as a pivot point. Connected to the top of the lever arm is an air cylinder used to apply the necessary force to squeeze the box. Attached to the top frame is a vertical frame that moves up and down to provide the lifting force by using electronic linear actuators. Finally, wheels are attached to the bottom of the device to allow mobility.

**Benchmark**
There are two bench marks for this project and one is a forklift. The reason a forklift cannot be used in this situation is because of the limited space. In the warehouse one pallet of apples is surrounded by other pallets of apples with only 36 inches between pallets. They store the apples as tight as possible because they have limited warehouse space.

The other benchmark is a robot that uses a squeezing mechanism to lift single boxes and stack them on pallets. There are companies already using this technique in the fruit industry. For the first design something similar to this concept will be used to squeeze multiple boxes at one time.
Performance Predictions 1/10th Scale
These are the following predictions made for the project and what they are based on.

- After completing a Solid Works rendering, the predicted volume will end up at about 30in³.
- After completing the Solid Works rendering the device should weigh about 1.2 lbs.
- After looking at the cost of parts and 3D printing this is approximately a $400 dollar project.
- The device should be completed in 1 week once 3D printing begins.

Description of Analyses
First of all the different stacking patterns will be collected. Next determine how much each box configuration weighs and the surface area for lifting. All maximums and minimum values will be taken in to consideration for the calculations of the device. Key factors here are determining what surface area is available to squeeze and how much weight will be lifted. Once this is determined the plates of the design can be optimized to the correct size. After the plates are sized, the force required to squeeze the boxes without slipping can be calculated from the weight of each pattern and the respective surface area. From there the torque required from the lever arm can be calculated as well. The air cylinders have to make the needed force to apply this torque to the arm. Once the weight of the boxes is known, the force needed to lift the boxes can be calculated. After these calculations are completed, the structure will need to be optimized to handle these forces and stresses without failure. Hopefully the forces and stressors are small enough to use a light weight material such as aluminum in order to meet the weight requirements and the ease of transportation. However, if this is not the case and a heavier material is needed the device may have to be redesigned to be a powered device.
Description of Analyses 1/10th Scale
The description of analyses is very similar for the 10th scale model it is just at a smaller scale.

Scope of Testing and Evaluation 1/10th Scale
The 10th scale model will be tested to prove the functionality of the design. Other things that will be tested are how much pressure the plates exert on the boxes and the weight of the device.

Analysis
Approach: Proposed Sequence
Design: 1, 2, 3, & 4

Figure 2: This is the first proposed design for this project.
Figure 3: This is the second proposed design for this project. At this point the design still needed a way to apply a squeezing force.

Figure 4: This is the third proposed design for this project. The design still needs minor parts added to the device and the electronic linear actuators. The customer has a few modifications that they want to make to this design and after that is done this will be the design that will be built.
Figure 5: This is the 4th proposed design for this project and this is at a 10th scale. The Lego air cylinders and Lego actuators are colored yellow.

Device Shape 1/10th Scale:
The device shape will now be a 10th scale of the original and modified slightly to accommodate using Lego air cylinders, actuators and small cardboard boxes.

Device Assembly, Attachments 1/10th Scale
The device will now be assembled using 1/8 in pins, 3/16” pins and glue. The remainder of the parts will be connected in the 3D printing process.
Tolerances, Kinematic, Ergonomic, etc.
Tolerance is important on this device. The holes drilled in the lever arm must be centered on both the x and y axis of the arm. They cannot be out of tolerance by more than .030in. Also the distance between the three holes needs to be within tolerance of .010in. That way when the distances are used to calculate forces and torque the values are precise. Also, when welding together the structure, all 90 degree connections cannot be out of tolerance by more than ½ a degree to insure even loading to the structure.

Tolerances, Kinematic, Ergonomic, etc. 1/10th Scale
Tolerance is really important when 3D printing the parts because the printer only has a .010” resolution. The parts must be designed accordingly to produce good parts.

Technical Risk Analysis, Failure Mode Analyses, Safety Factors,
The pneumatics system and electrical system will be purchased components and will be installed by the Van Doren pneumatics team and the Van Doren electronics team.

Methods and Construction 1/10th Scale
The 10th scale device will be built at the CWU campus. It will be printed using their 3D printers. Other minimal machining operations will take place in the CWU machine shop.

Description 1/10th Scale
This device is held together by 3D printed parts, glue and pins. Everything else will remain the same except at a 10th scale.

Drawing Tree 1/10th Scale
The drawing tree shows the main assembly and all the parts needed to make the assembly. All the part drawings and assembly drawings can be referenced by the part number in Appendix B.

Parts List and Labels
The parts list is referenced in appendix C. In that appendix the part number and quantity needed to build each part to successfully build one Multiple Apple Box Lift and one 10th scale model apple box lift can be found. Also, all the drawings corresponding to these part numbers can be referenced in appendix B based on the part number.
Manufacturing Issues 1/10th Scale
The main manufacturing issue so far with the 10th scale model is the 3D printing resolution. The parts that need to be printed are small. The way the printer prints the parts leaves space in the material making them weak. Also the printer prints holes undersized and with an oval shape. This will result in having to drill and ream all the holes. Another manufacturing issue is the printed parts sometimes have bent features and will somehow have to be straightened out.

Discussion of Assembly, Sub-Assemblies, Parts, Drawings 10th Scale
The assembly of this device became much simpler now that it’s only a 10th Scale model. All the parts will be printed at the same size and then assembled with glue and pins.

Testing Method
Introduction 1/10th scale
The testing of this device will take place at Central Washington University, specifically in the hydraulics lab. In the hydraulics lab, they have the necessary pressure gauges hoses and fittings.

Method/Approach
These are the methods used to test the deliverables and how they compare to the predicted values.

The weight of the device will be weighed on a scale and the actual weight will be compared to the prediction made from the solid works rendering.

The pressure on the plates will be measured by using a pressure gauge and the value will be compared to the calculated value and must be less than 1psi, so it does not crush the apples or apple boxes.

The load capacity will be tested by lifting a load that is greater than any load the customer will be lifting with a safety factor of 1.25. This number will be computed from the total weight of the apple boxes being lifted plus the portion of the device being lifted multiplied by 1.25. If the device can lift that weight without failure this test will be a success.

The lateral force to move the device will be tested by using a scale and then compared to the calculated value.

The cycle time of the device will be measured with a stopwatch.
Test Procedure
Weighing the Device:
Materials: Scale, multiple apple box lift
Procedure:
⦁ Zero the scale.
⦁ Use forklift to lift the device on the scale. (do not try to lift device manually)
⦁ Make sure the device is stable on the scale and remove the forklift
⦁ Record Weight
⦁ After weight is recorded use a fork lift to lift the device off the scale

Making sure the device can lift the required load.
Materials: 2lbs of something inside of boxes, pallet, multiple apple box lift
Procedure:
⦁ Stack boxes with weight inside them on a pallet in such a way the device can lift up the boxes.
⦁ Apply enough squeezing force so the boxes don’t slip and then lift the boxes up.

Recording the cycle time
Materials: Stopwatch, multiple apple box lift
Procedure:
⦁ Place the multiple apple box lift in a location close to the pallet of apple boxes.
⦁ Start stopwatch
⦁ Record the total cycle time. 1 cycle consists of positioning the device; squeezing and lifting the apple boxes, having an employee remove an apple box from a middle row, complete their inspection of the apples in that box, replace the apple box, and then lower the boxes back on to the stack. Then the cycle time is complete.

Measuring the lateral force
Materials: Force measuring device, multiple apple box lift
Procedure:
⦁ Attach the force measuring device to the multiple apple box lift.
⦁ Pull on the force measuring device and record the amount of force it took for the device to start rolling.

Deliverables
These are the deliverables that will be found from testing.

- Squeezing pressure
- Load capacity
- Cycle time
- Required lateral force to move the device
- Weight of the device

Budget/Schedule/Project Management

Estimate total project cost 1/10th scale.

The estimated total cost of the 10th scale model is about $400. $100 has already been spent on a Lego pneumatics kit, another $30 on Lego electric actuators and $80 on Lego motors. The remainder of the device will be printed from the 3D printer. The device will use at least 30in³ of plastic material which will cost about $180. Pins have been donated so there is no cost for the pins for this project. There is about a $40 dollar buffer for unforeseen costs and any parts that have to be reprinted.

Funding source(s) 10th scale

This project will be funded by Kyle Burlingame.

Proposed schedule 10th scale.

A new project schedule for the 10th scale model has been placed in appendix E.

Project Management

Human Resources:
These are some of the human resources and mentors available for this project.

Greg Kemp: Engineer
Patrick O’Brien: Lead sales project estimator
Steve Cochran: Lead Research and Development.
Lance Web: Lead Electronics engineer
Several fabricators and welders on staff.
Brett Pittsinger: President
Brian Huan: CEO
Physical Resources:
The machines available for this project with operators include: 3D printer, lathes, mills, laser cutter, press brake, band saw, welders and many other tools.

Discussion
This project was a huge task to take on as a senior project. Even with the support of a well-established company with much knowledge and support this project has been difficult. The time spent on this project was far more than expected, many hours have been put into the design, analysis and proposal of this project. It was quite devastating to hear they would not be moving forward with the proposed design and would be cutting the funding to the project. However, a lot was learned from this experience. Always try to be ahead of the game and make sure the right people are giving you the design requirement. Overall the 10th scale redesign of this project has been a success, after several hours of redesigning and finding parts that would work for a 10th scale model. The scale model should be able to prove the concept of how the device would have worked at full scale. This has been a huge setback because several hours had to go back into the proposal phase and planning phase.

Design Evolution / Performance Creep
The design evolution of this device is quite interesting. The basic movements of the device have been established from almost day 1. The device will squeeze and lift the boxes of apples. The part of the device that continues to be changed and redesigned is how the lift and squeeze technique will be performed. The first idea for this project was that the squeeze and lift would be driven by hydraulics. This quickly changed because the fruit company did not like the idea of hydraulic fluids being around the fruit. Also a hydraulic system was overkill for the amount of load the device needed to lift. The next idea was to move to pneumatics to drive the squeeze and lift force. This then came up for discussion because air is a compressible fluid. Before any lifting or squeezing occurs the device has to be able to be positioned so that the plates start at a certain height for that specific box configuration. Using air would make it hard to pin point certain heights for different box configurations since when adding air to a cylinder the movement is quite jerky. Also the layers of boxes have some glue between the layers so before the boxes could be lifted, air would be compressing in the cylinders until the glue bond between layers was broken resulting in uncontrolled lift acceleration. This potentially could cause boxes to tip over. After all this was taken into account the company decided that pneumatics would be the best solution for the squeeze force of this device and that the lifting force would be provided by a linear electric actuator. The linear actuator provided precise, smooth movement. The only thing left to be determined on this device is it will need its own batteries and compressors to run the device. There will be a lot of help from the Van Doren Electric and pneumatic team for sizing batteries and compressors. Lastly, the funding of the project was cut and now it is redesigned at a 10th scale.
Success 1/10\textsuperscript{th} Scale
This project will be successful if the device proves the concept of how the full scale model could work.

Next Phase 1/10\textsuperscript{th} Scale
The next phase for this project is to 3D print the 10\textsuperscript{th} scale model parts and then prove the concept of the design.

Conclusion
The full-sized Multiple Apple Box Lift is 100\% ready to be taken to the manufacturing phase. The device was designed by an engineer who is graduating from an accredited engineering program in June 2016. This project is also backed by several human resources who are experienced in certain fields pertaining to specific parts of this project. Most importantly this project is backed by Van Doren Sales the experts in fruit packaging equipment since 1946. However, since the original customer that wanted this device rejected the proposal, a 10\textsuperscript{th} scale model is being built to prove the concept of the design and the full-sized drawings will be placed in the Van Doren archives to be possibly sold to different customers or slightly redesigned.

Acknowledgements:
Several people have helped with the design stage of this project.

One of the most important people helping with this device is Jeff Burlingame. He has helped with some of the ideas and designs for this project. He has also been available to bounce ideas off of and discuss potential problems. Jeff also helped with some preliminary pressure tests.

Greg Kemp has been another important individual in the development of this design. He has been around to critique and offer suggestions on the design. He also has been the go to guy to get things done that need to happen within the Van Doren Company.

Patrick O’Brien is another individual who has helped critique and offer suggestions to the design of the device.

Bret Pittsinger is also very important with the development of the device. Bret is the reason this project was able to happen, he met with the customer who needed the device. He is also taking care of all of the cost of this project. With the backing of Bret and the Van Doren Company this device has the potential to make it to a mass production
phase of making 18-100 of these devices if the device is successful.

Ted Bramble has also been an important resource when discussing the manufacturing process of how some of the devices parts will be made.

Dr. Johnson and Professor Pringle have also been very helpful for providing feedback on the proposal of this device and the overall concept of this project.

Without the help of these seven individuals this project would not have been possible.

References:

Appendix A – Analyses
A-1 General Analysis

Pallet: 48" x 48" x 48" (old)

Spots Between Pallets: 26"

Device must accommodate max height of 100.5" and a minimum height of 76.5".

The pallet is slightly larger than all the box stack patterns.

\[ H = \text{Pallet height} + (\text{Box height}) \times \# \text{ of Boxes} + \text{Stack Height} \]

\[ H_{\text{Max}} = 6'' + (6.75')(1) + 0 = 100.5'' \]

\[ H_{\text{Min}} = 6'' + (10.5')(7) - 5'' = 76.5'' \]

With Box = (Pallet x 3/4)(Wish)

With Box = (3)(12.75) = 38.25" (Stack)

Length x Box = (2)(19.50") = 39.00" (Pallet)

Squeeze needs to accommodate multiple box configurations. Figure out min and max width to get range squeeze will accommodate.

\[ L = (\# \text{ of Boxes}) \times \text{Weight} \]

\[ F_x = (20)(5016) = 1050lbs. \text{ NOT Max Load} \]

See (4-
A-2 Pressure test on a cardboard box.
A-3 Calculations to find the forces the linear actuators must supply.
A-4 Calculations for the friction force and squeeze force needed to lift boxes without slipping.
A-5 Calculations for the max pressure applied to the apple boxes when undergoing the max squeeze force.
A-6 Calculations needed for the force of each of the four air cylinders that must be applied to the lever arms.
A-7 Air Cylinder Analysis

Given: Force per cylinder of 409,163 N
Find: Safety factor and size of cylinder bore

\[ s^2 = \frac{P}{A} \]
\[ A = \frac{F}{p} \]
\[ A = \left( \frac{409,163}{80^2} \right) \]

\[ F = PA \]
\[ F = 80 \text{ PSI} \times 71.5 \]
\[ F = 565163 \text{ N per cylinder} \]

Safety Factor = Max安全

\[ \frac{F}{A} \]

\[ \frac{565163}{409,163} \]

\[ s_F = 1.38 \]

Use 4 3” Air cylinders at 80 PSI with a safety factor of 1.38
A-8 This sheet shows the max shear and moment on the lever arm. Max normal stress and shear stress have been calculated.
A-9 This shows the max force in each of the 3 pins.
A-10 These are the calculations for determining the pin sizes. The company decided to go with 5/8" OD.
A-11 Calculation A-8 was recalculated because the thickness of the material was changed from ½"-3/8" to utilize Van Doren's laser cutter.
A-12 This sheet shows the calculations for the required lateral force to move the device.
A-13 This sheet shows the amount of force required to tip the device over when applying forces to different sides.
A-14 Scale Model Calculations.

Table A-1
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TABLE A-1 General stacking patterns for Chelan Fruit apples.

Appendix B – Drawings full sized model
Removed For Device Copyright Protection
Appendix B2- 10th scale model

B1-10th Scale assembly
B1-1 Legs for 10th scale model
B1-1 Leg extensions for 10th scale model.
B1-4 Motor mount for 10\textsuperscript{th} scale model.
B1-5 Frame for 10th scale model.
B1-6 Large arms for 10th scale model.
B1-7 Small arms for 10th scale model.
B1-8 Plates for 10th scale model.

Appendix C – Parts List full sized model.
### Appendix C – Parts List 10th scale

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<td>1/4&quot; UHMW</td>
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**Other Parts**

- 649080897: 8 Air Cylinder Air Cylinder
- 49502124: 8 Mounting Bracket Pro Mount
- 606455257: 8 Pivot attachment Pro Connectors

**U1.2**

- 32 UHMW 1.375" OD .625 ID .375 Thick Spacer

**U1.3**

- 32 UHMW 1.375" OD .625 ID .375 Thick Spacer

**U1.4**

- 4 UHMW 1.375" OD .625 ID .375 Thick Spacer

**N1.1**

- 32 Stainless Steel 1/4-20 Thread 1 3/4" long Hex Cap Screw for Top Mount

**N1.2**

- 8 Stainless Steel 1/2-13 Thread 3.5" long Socket Head Cap Screw for Top of Axonar

**N1.3**

- 4 Stainless Steel 1/2-13 Thread 3-3/4" long Hex Cap Screw for Bottom of Axonar

**N1.4**

- 16 Stainless Steel 1/2-13 Thread 3-3/4" long Hex Cap Screw for Wheel Bracket Connection

**N1.5**

- 1/2 Stainless Steel 1/2-13 Thread Hex Nut For Bottom of Axonar and Bottom of Wheel Bracket

**N1.6**

- 32 Stainless Steel 5/16-18 Thread Nylon Lock Nuts For all Pins
### Parts List 10th scale model

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Appendix D – Budget
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Appendix D2 – Budget 10\textsuperscript{th} scale model.
### Appendix E – Schedule

#### Budget 10th scale model

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**Figure C2: Winter Quarter Schedule**
Appendix F - Expertise and Resources

The Van Doren Company has a full machine shop. In the machine shop the laser cutter will be used to cut several parts from aluminum plate. A lathe will be used to turn and part off the pins. Several other processes will take place in the machine shop at Van Doren’s including milling, grinding and drilling. Also there are several welding units in the machine shop which will come in handy since most of the subassemblies need to be welded. Van Doren Sales also have fabricators available to run these machines. They will be utilized in making parts for this project.

Appendix G - Testing Data

<table>
<thead>
<tr>
<th>Test Description</th>
<th>Predicted Value</th>
<th>Actual Value</th>
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<td>Does the Device work</td>
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<td>Weight of the Device</td>
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<td>Force required to move the device</td>
<td>1lbs or less</td>
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<td>Amount of load able to lift vertically</td>
<td>1.5625lbs</td>
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<tr>
<td>Squeeze load needed to lift</td>
<td>N/A</td>
<td>N/A</td>
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</table>
Maximum pressure applied to the boxes to lift without slipping | 25psi | 37psi
---|---|---
Time required for one cycle | 2 min | 1 Minute 23 Seconds

Appendix H – Evaluation Sheet

Appendix I – Testing Report

Introduction to Testing 1/10th scale
The testing of this device will consist of using the Multiple Apple Box Lift to lift 28 mini apple boxes. The testing of this device can take place at any location that has compressed air available and a flat surface. Most likely the testing will be done at the designer’s home and Central Washington University.

Testing Requirements
The testing requirements for this project are as follows:

Parameters of Interest
- What is the optimal operating pressure for this device?
- At what operating pressure will the mini wood boxes begin to slide down the plates?
- How long will one cycle take?

Performance Predictions
- The mini boxes will begin to slide at an operating pressure of 25 psi.
- One cycle will take less than 5 minutes.
- The device will weigh 1.2 lbs. according to the Solid Works model.

Data Acquisition
The data that will be recorded is pressures, weights and cycle times. These will be recorded by using a scale, pressure regulator and stopwatch.

Schedule
There has been a lot of testing done on this device beginning in early March and there will continue to be more testing done through the beginning of May.

Important test dates can be found in the Gnatt chart located in the appendix.

Test demo one: Testing the device’s concept and optimal pressure was completed on
April 11, 2016.

Test demo two: Testing the device’s scale factor and weighing the device took place on April 25, 2016.

**Method/Approach**

**Materials/Resources**
- 1 1/10th scale Multiple Apple Box Lift
- 49 mini wooden boxes
- 1 mini pallet
- 1 air tank with 45+ psi of air
- 1 pressure regulator
- 1 scale
- 1 operator

**Data Capture/Doc/Processing**
- Test sheets will be used to keep track of all of the data see appendix for test sheet.
- Writing utensil
- Scale to weigh the device and the amount of weight the device will lift.
- Pressure regulator to record the pressure needed when lifting loads.
- USB to save the test sheet on with typed up data.

**Test Procedure Overview**

These are the methods used to test the deliverables and how they compare to the predicted values.

The weight of the device will be weighed on a scale and the actual weight will be compared to the prediction made from the solid works rendering.

The operating pressure and slipping pressure will be found from a pressure gauge that is attached to the system and compared to calculated values.

The load capacity will be tested by lifting a load that is greater than any load the customer will be lifting, with a safety factor of 1.25. The total weight of the mini apple boxes is 1.25 lbs. Therefore to insure a safety factor of 1.25, the device must be able to lift 1.5625 lbs. If the device can lift that weight without failure, this test will be a success.

The cycle time of the device will be measured with a stop watch. One cycle consists of
squeezing the boxes, lifting the boxes, removing one box, replacing the box, lowering the boxes back down, and finally releasing the squeeze.

**Operational Limitations**

- Operating pressure shall not exceed 45 psi, because the hoses will burst or become disconnected.
- The load being lifted shall not exceed 1.5625 lbs

**Precision and Accuracy**

There are a lot of variables with this device that will affect the accuracy of the device. One is the plate placement. The plate height needs to be set to grab the entire face of the lowest box layer. Also, the plates need to be centered with the load. Establishing the same surface area contact is crucial for replicating the results. Another variable is making sure an even amount of force is applied to each side. This can be done by making sure both sides of the lever arms are at the same angle. The precision of this device is based on the pressure regulator being used which reads in increments of about 1 psi.

**Data Storage and Presentation**

The data will be recorded on the test sheets provided on the last page of this document. The data will then be typed up in the data sheets for presentation comparing predicted values vs actual values. The files will be backed up to a USB drive.

**Test Procedure**

**Weighing the Device:**

Materials: Scale, Multiple Apple Box Lift

Procedure:
- Zero the scale.
- Gently lift the device up and place it on the scale.
- Record the weight on the test sheet.
- Remove the device from the scale

**Lifting 28 Mini Boxes by squeeze and lift.**

Materials: 49 mini boxes, 1 mini pallet, 1 Multiple Apple Box Lift, 1 air tank 2+ gallons that can handle 100psi, 1 pressure gauge, 1 pressure regulator, and a stop watch

Procedure:
- Fill up the air tank to about 100 psi. (Do not exceed pressure listed on the tank you are using).
- Attach the pressure regulator to the tank that will allow you to regulate the pressure between 0 and 45 psi. Set the pressure to 0 psi.
• Stack the mini boxes on the mini pallet using the stack pattern template on the test sheet. Rotate the pattern 180 degrees every layer.
• Using the quick connect on the pressure regulator connect the Multiple Apple Box Lift air lines.
• Set the three staged valve to the middle position. This blocks the flow of air.
• Start a stopwatch.
• Set the pressure regulator to 30 Psi.
• Listen for leaks, also make sure no movement of the device takes place. If no leaks or movement happens, proceed to the next step. If a leak occurs turn the pressure regulator back down to 0 psi and troubleshoot leaks and make sure the valve is set to the center position.
• Switch the valve direction to the lever pointing towards the black air line.
• Position the Multiple Apple Box Lift over the pallet of boxes so the top frame clears the top layer of boxes. The top frame may have to be raised so the device will clear the boxes. Use the up direction on the up and down control box to raise the top frame.
• Center the multiple apple box lift with the pallet, with this orientation see the picture.
• Next adjust the height of device so that the plates will fully grab the top four layers of the pallet stack. Do this with the up and down controls on the control box.
• Once the device is centered with the pallet stack and the height is set switch the valve position to the yellow air lines. The device should now be squeezing the boxes.
• Now lift the boxes by using the up direction on the control box. If the device does not successfully lift all the boxes lower the boxes back down open the plates and increase the pressure at 1 psi increments until the device lifts all of the intended boxes. Do not exceed 45 psi.
• Record the successful lifting pressure on the test sheet.
• Remove one center box from the row of boxes beneath the lifted load.
• Replace the center box.
• Lower the lifted stack of boxes back down on top of the boxes below using the down switch on the control box.
• Once the boxes are lowered switch the valve to the black air line position.
• Change the pressure on the regulator back to 0 psi and switch the valve back to the center position.
• Repeat steps 6-20 three times and record the cycle times on the test sheet.

**Determining Slipping Pressure**

• Repeat steps 1-13 from the lifting 28 mini boxes procedure above.

57
- Then slowly reduce the pressure on the pressure regulator 1 psi at a time
- Record the pressure when the boxes start to slip from the plates on the test sheet.

**Safety Factor Test**

**Materials:** 1.5625 lbs. of weight, Multiple Apple Box Lift

**Procedure:**
- Double check that the pressure regulator is set to 0 psi and the pressure valve is set to the middle position.
- Increase the pressure on the regulator to 35 psi.
- Using your hand hold the weighted blocks in such a way the device will be able to squeeze and hold the blocks.
- Using the same pressure control valve as above squeeze the 1.75 lbs weighted block at 35 psi.
- Change the pressure control valve to the black air line this should make the device squeeze the weighted block.
- Once squeezed use the up and down control box to lift the weight up with the device.
- Record success or fail on the test sheet based on if the device was able to lift the block.

**Deliverables**

These are the deliverables that will be found from testing.
- Optimal squeezing pressure
- Slipping pressure
- 1.25 safety factor load test.
- Cycle time
- Weight of the device

**Testing Results**

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<th>Predicted/calculated</th>
<th>Requirements</th>
<th>Actual Average Values</th>
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<tbody>
<tr>
<td>Weight of Device</td>
<td>1.2lbs</td>
<td>Less than 2lbs</td>
<td>1.43</td>
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</table>
Optimum operating pressure (recommend 3 trials) | >25psi | Less than 45psi | 37 PSI Recommend 40 psi
--- | --- | --- | ---
Cycle time (recommend 3 trials) | 5min | Less than 5 min | 1:23
Slipping Pressure | 25psi | Must not slip at operating Pressure | Pass
1.25lb SF load test | Pass | Must pass | Pass

Table 1: This table shows the key results from testing the Multiple Apple Box Lift.

**Success Criteria**
The device passed all the requirements. Overall the project was a success. The average pressure to lift the mini boxes was 37 psi which meets the requirement however the device did not successfully lift the boxes every time at 37 psi. To insure the lifting of all the boxes without slippage, I would suggest an operating pressure of 40 psi. The cycle time was significantly less than what was predicted. The cycle time may be biased based on the operator, because the more times you do the test the faster you perform it.

**Conclusion**
The testing of the device was very successful. The device met all of the requirements. It would be an engineering solution to a common fruit company’s problem. The problem of which is not being able to reach the center box of the stacked pallet of apple boxes for quality control purposes. The scale model was so successful that the presentation will be given to the owner of Van Doren Sales and the future of the device will be discussed. The company has already been talking about presenting the scale model to potential customers who might want to purchase a full scale model from the company.

**Appendix**
Figure 1: Test results data.

Test Images:
Image 1: This image shows the weighing of the device.
Image 2: This image shows the mini apple boxes lifted at a pressure of 40 psi.
Image 3: This image shows the device lifting large blocks that proves the device has a safety factor of at least 1.25.
## Multiple Apple Box Lift Test Sheet Table

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<td>&gt;25psi</td>
<td>Less than 45psi</td>
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<tr>
<td>Cycle time (recommend 3 trials)</td>
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<td>Less than 5 min</td>
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<td>Slipping Pressure</td>
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<td>1.25lb SF load test</td>
<td>Pass</td>
<td>Must pass</td>
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### Stack Pattern

Figure 2: Stack pattern used, rotate 180 degrees each layer.

### Schedule:
Procedure Checklist.

- 1/10th Multiple Apple Box lift
- 49 mini apple boxes
- One mini pallet.
- Stopwatch
- Scale
- 10 Gallon air tank
- Safety glasses
- Access to 100psi Compressed air
- Pressure gauge/regulator
- Record all values in test sheet
- Back up test sheet to USB drive

Appendix
Appendix J – Full Scale Model Proposal.

Requirements

The requirements for this project are as follows:

- A device is required that can lift 1225 pounds of apple boxes. (A-3)
- The device must fit through a 3’ aisle. (A-1)
- The device must fit around a 4’X4’ pallet. (A-1)
- The device must be less than 15’ tall when fully extended.
- The length of the device must be less than 10’. (A-1)
- The device must weigh less than 1250 pounds.
• The device must be moved by applying less than 30lbs of force. (A-12)
• The device must complete one lifting cycle in 5 minutes or less.
• The device must cost less than $15000 dollars, not including labor or design time to ensure a profitable product.
• The device must accommodate several different box dimensions and stacking patterns. (Table A-1)
• Each individual apple box cannot exceed a crushing pressure of 1 psi. (A-2)
• Each squeeze plate must apply at least 1225lbs of force. (A-4)
• The device must be driven by air cylinders that apply a pressure of at least 80 psi. (A-7)

Engineering Merit
This device will be lifting apples boxes. Engineering merit will take place in calculating loads and stresses on the structure as well as other parts of the project. Engineering merit will also take place in the lifting mechanism, stresses and loads will need to be calculated. This project will use air cylinders and electronic linear actuators to lift the apple boxes. Calculations dealing with pressure will need to be calculated to find the forces the air cylinders provide. Also, engineering merit will go into the overall design of the project.

Scope of Effort
This project will focus on the structure of the device and the squeeze/lift function that will be used to lift the top levels of boxes. Using some purchased parts that already have engineering specifications, for example the wheels, air cylinders and linear actuators.

Success Criteria
The goal of this project is to have a successful working device by the end of spring quarter. The device will be successful if it can lift the apple boxes and meets the customer’s requirements. If the device meets the customer’s requirements and they are satisfied with the product, there is a potential of making 18 more of these devices for them.

Approach: Proposed Solution
As stated above, a device is needed that can lift multiple apple boxes. There are several requirements dictating the design of this device. The requirements that have the most impact on this device are the size constraints and being able to lift the apple boxes without damaging the fruit or boxes. The first proposed design will consist of four linear columns of metal tubing that are on wheels. There will be some cross members to help support the structure which has to lift a heavy load. Attached to the structure there will be two plates used to squeeze and lift the top levels of apple boxes. The ultimate question is will this device be able to lift 1225lbs of apples using a squeeze technique? The answer to this question will be answered the following way: First, a compression test will be done to a variety of the cardboards to see what pressure the boxes can withstand before deformation. Using the pressure equation F/A. Once that number is determined, the plates
will be designed to maximize the surface area for all the configurations. Then using a simple physics formula, \( F = \mu N \) a friction force will be calculated to establish the normal force that is required by the plates to prevent the boxes from slipping. After the normal force is calculated then divide it by the surface area of the plate contacting the boxes. If the pressure is less than the allowable pressure this design should meet the requirement of not damaging the fruit or boxes.

After the first requirement is met the design will then have to fit the size constraints. Once the size constraints are met, the analysis of the structure will need to be calculated to make sure the size of the device is still capable of lifting up to 1225lbs without failure. The analysis of the structure will be figured out by using strengths and materials and statics calculations. Maximum normal and shear stress will be calculated in the arms that transmit the squeezing force using the Equations \( \sigma = \frac{Mc}{I} \pm \frac{F}{A} \) and \( \tau = \frac{VQ}{IT} \). The maximum shear stress will also be calculated in the pins using the double shear formula \( \tau = \frac{F}{2A} \). The calculated stress will be related to material properties to insure there will not be failure.

The lifting force will be provided by electronic linear actuators. The needed force of the actuators will be calculated using the \( \Sigma F_y = 0 \). The Van Doren Sales electronics team will be helping tremendously in this section of the project.

The device needs to be mobile. Hence it needs to be on wheels so it can be pushed through the aisle easily. To meet this requirement the device will be built with the thought, the less it weighs the better. The rolling friction force equation \( F = \mu XW/r \) will be used to figure out the necessary force required to move the device after the design is completed.

The design needs to be built at the lowest cost possible. This goes hand in hand with weight because if the device cannot be moved easily by a human then it will have to be powered and that will increase the cost.

**Performance Predictions**

These are the following predictions made for the project and what they are based on.

- After completing a solid works rendering, the predicted mass will end up at about 1200lbs.
- After looking at the cost of parts and labor this is approximately a $15000 dollar project.
- Based on the amount of people at the company, and with all the different skills and knowledge, this device should be completed in five to eight weeks.

**Description of Analyses**

First of all the different stacking patterns will be collected. Next, determine how much each box configuration weighs and the surface area for lifting. All maximums and
minimum values will be taken into consideration for the calculations of the device. Key factors here are determining what surface area is available to squeeze and how much weight will be lifted. Once this is determined the plates of the design can be optimized to the correct size. After the plates are sized, the force required to squeeze the boxes without slipping can be calculated from the weight of each pattern and the respective surface area. From there the torque required from the lever arm can be calculated as well. The air cylinders have to make the needed force to apply this torque to the arm. Once the weight of the boxes is known the force needed to lift the boxes can be calculated. After these calculations are completed, the structure will need to be optimized to handle these forces and stresses without failure. Hopefully the forces and stressors are small enough to use a lightweight material such as aluminum in order to meet the weight requirements and the ease of transportation. However, if this is not the case and a heavier material is needed the device may have to be redesigned to be a powered device.

Scope of Testing and Evaluation
The main thing that needs to be tested on this device is the allowable squeezing pressure that can be exerted on the boxes without damaging them. This is crucial to the success of the project because the fruit cannot be damaged. There are several individual pieces that need to be tested. One is the force applied by the air cylinders, next is the torque applied to the lever arm, and lastly the force exerted by the plates that causes the squeezing pressure. Another thing that needs to be tested is how much the electronic linear actuators can lift and how much force it takes to move this device. The cycle time can also be tested using a stopwatch.

After all these tests have been completed and meet the requirements the device will be used to do a test in an actual situation at Chelan Fruit.

Calculated Parameters
These are the calculated parameters for this project.

- Max lifting load of apple boxes is 1225lbs. (A-3)
- Max squeezing pressure of 1psi can be applied to the boxes without crushing. (A-2)
- Maximum needed squeezing pressure is .72 psi. (A-5)
- Max friction force needed to hold the boxes on both sides without slipping is 613lbs. (A-3)
- The device will take less than 30lbs of force to make it move on its wheels. (A-12)

Device Shape:
The device shape was dictated by the customer’s space requirements. The device needs to be no more than 36” wide so it can fit through the aisles between pallets. The height of
the device is dependent upon the configurations of multiple pallet heights.

Device Assembly, Attachments
The device will be assembled the following way. The plates will be made from 3/8” aluminum plate. Cross members will be welded on the back side of the plates for additional support. Two attachments will then be welded to the plates so they can be attached to the lever arms via pins. The lever arms have a pivot point through the top frame, connected by pins. The top end of the lever arms will be connected to air cylinders. The air cylinders will be fixed to the top frame and lever arms via pins. The top frame will slide up and down on the leg system. The top frame will be lifted using 2 electric actuators. The structure will be made from aluminum square tubing as long as forces and stresses allow that material without failure. All the tubing will be welded together. The wheels will be attached to an aluminum plate that will be welded to the bottom of the square tubing on all four legs.

Tolerances, Kinematic, Ergonomic, etc.
Tolerance is important on this device. The holes drilled in the lever arm must be centered on both the x and y axis of the arm. They cannot be out of tolerance by more than .030in. Also the distance between the three holes needs to be within tolerance of .010in. That way when the distances are used to calculate forces and torque the values are precise. Also, when welding together the structure, all 90 degree connections cannot be out of tolerance by more than ½ a degree to insure even loading to the structure.

Operation Limits
There are some risks to evaluate with this device. The device will be top heavy so when moving one must be careful not to tip over the device. A force of 30lbs. is needed to move the device. In a situation where the device’s wheels are not free rolling the device will tip over if more than 300 lbs. is applied to the device at 5 feet above the ground. (A-13) These calculations were done for a static situation assuming the device will not be moving at high speeds. For safety the device should be moved according to the directional sign to prevent tipping. Another risk is the apple boxes will be lifted ½ to 1 inch above the pallet to allow an employee to remove a box of apples from the middle of the pallet for quality control purposes. This is dangerous and some sort of safety will need to be incorporated here.

Methods and Construction
This device will be built at Van Doren Sales in Wenatchee, Washington. All the parts will be ordered to this location and be paid for by the company. Structural welded tubing will be ordered and cut to length on a band saw. The tubing will make up the structure of the device. The plates will be made from 3/8 in aluminum plate. Ribs will be added and welded on to the back side of plates for additional support. The arms of the device will be made from aluminum flat bar. The rounded pieces will be cut with a laser machine. The rectangular pieces will be cut to size with a band saw. After all 4 intermediate pieces have been made they will be welded together to make the arms. The pins will be made from 3/4 inch round stock. Then the pins will be turned down to the appropriate diameter, cut
to length and chamfered. The brackets used to attach the wheels will be made from steel plate. These parts will be faced and drilled on the mill.

**Description**

The device is held together by structural tubing. Wheels are attached at the bottom of the two leg assemblies so the device can be mobile. The cross frame slides up and down on the steel tubing. Electronic linear actuators provide the force to do the lifting in the up and down direction. The actuators are connected to the bottom of the cross frame and the cross member holding the leg assemblies together. The arms are connected to the cross frame via pins. The arms also connected to air cylinders that are attached to the cross frame. This is where the squeezing force is generated. The arm is also attached to the plates via pins. The plates apply the squeezing force to the apple boxes. The device is powered by rechargeable batteries that power the linear actuators, portable air compressor and lights. Hoses and wires run along the device to make all the components work.

**Drawing Tree, Drawing ID’s**

The first drawing tree shows the main sub-assembly and components that will make up the Multiple Apple Box Lift. The following drawing trees are the individual drawing tree for each sub-assembly. All the part drawings and assembly drawings can be referenced by the part number in Appendix B.

**Manufacturing Issues**

One of the manufacturing issues is that the engineer who designed this project lives in Yakima, WA. The building of this device will take place in Wenatchee, Washington. With the engineer going to school full time and living in Yakima it is going to be hard for him to make frequent trips to Wenatchee to oversee the manufacturing of the device and be available to answer questions. This is why it is crucial to have well drawn up drawings with needed dimensions and descriptions. The lead engineer on this project will have to try to be readily available by phone and email to keep the building of the device progressing.

Another manufacturing problem foreseen is that the lead engineer has designed his device based on using several purchased parts. However, some parts can only be ordered from certain suppliers. Therefore, the lead engineer may have to use similar parts and make modifications.

**Discussion of assembly, sub-assemblies, parts, drawings**

This device will built from 10 sub-assemblies/categories, they consist of wheels, brackets, plates, arms, legs, pins, bushings, frame, pneumatics and electronics. The best way to approach the building process is to first build all of the sub-assemblies. Once the sub-assemblies are built, weld the brackets to the bottom of the legs. Then fasten the wheels to the brackets. Next, assemble the arms to the frame with their corresponding pins and bushing components. Next, fasten the actuators to the legs and stand them upright. Then use a forklift to slide the frame on top of the leg and fasten the other side of the actuators to the frame. Then connect the plates to the arms. Lastly, run all necessary wires and
hoses for the pneumatics and electronics.

**Introduction**
The testing of this device will take place at two locations. One of them is at Van Doren Sales in Wenatchee, Washington and the other is at Chelan Fruit. The first set of tests will take place at Van Doren sales. At this location the amount of force required to move the device will be tested as well as the amount of pressure the plates can exert. Also, the device will be tested for load lifting capabilities. At the second location Chelan Fruit, the device will be put to the true test. Can it lift and squeeze several rows of apple boxes without damaging the fruit?

**Method/Approach**
These are the methods used to test the deliverables and how they compare to the predicted values.

The weight of the device will be weighed on a scale and the actual weight will be compared to the prediction made from the solid works rendering.

The pressure on the plates will be measured by using a pressure gauge and the value will be compared to the calculated value and must be less than 1psi, so it does not crush the apples or apple boxes.

The load capacity will be tested by lifting a load that is greater than any load the customer will be lifting with a safety factor of 1.25. This number will be computed from the total weight of the apple boxes being lifted plus the portion of the device being lifted multiplied by 1.25. If the device can lift that weight without failure this test will be a success.

The lateral force to move the device will be tested by using a scale and then compared to the calculated value.

The cycle time of the device will be measured with a stopwatch.

**Test Procedure**
Weighing the Device:
Materials: Scale, multiple apple box lift
Procedure:

- Zero the scale.
- Use forklift to lift the device on the scale. (do not try to lift device manually)
- Make sure the device is stable on the scale and remove the forklift
- Record Weight
- After weight is recorded use a fork lift to lift the device off the scale
Making sure the device can lift the required load.
Materials: 2lbs of something inside of boxes, pallet, multiple apple box lift
Procedure:
• Stack boxes with weight inside them on a pallet in such a way the device can lift up the boxes.
• Apply enough squeezing force so the boxes don’t slip and then lift the boxes up.

Recording the cycle time
Materials: Stopwatch, multiple apple box lift
Procedure:
• Place the multiple apple box lift in a location close to the pallet of apple boxes.
• Start stopwatch
• Record the total cycle time. 1 cycle consists of positioning the device; squeezing and lifting the apple boxes, having an employee remove an apple box from a middle row, complete their inspection of the apples in that box, replace the apple box, and then lower the boxes back on to the stack. Then the cycle time is complete.

Measuring the lateral force
Materials: Force measuring device, multiple apple box lift
Procedure:
• Attach the force measuring device to the multiple apple box lift.
• Pull on the force measuring device and record the amount of force it took for the device to start rolling.

**Deliverables**
These are the deliverables that will be found from testing.

• Squeezing pressure
• Load capacity
• Cycle time
• Required lateral force to move the device
• Weight of the device
Proposed Budget

Estimate total project cost
There are several costs factored into the total cost of this device. One is the materials. A list of the materials and their costs are listed in appendix C. The costs of the materials for this project are around $9500. Another cost of this project is fabrication time. Van Doreen Sales pays their welders $20 an hour and this project has a predicted weld time of 25 hours. That adds up to $400 in weld time. There will be additional fabrication time added to this project, but it will be done by volunteers in order to keep the total cost of the device down as the parts list is getting rather expensive. There will also be an additional $1000 dollars available for any unforeseen costs. With all this in mind the total cost of the project is estimated to be $11,000.

Funding source(s)
The funding for this project will be from Van Doren Sales. They hope to make their money back on this investment by selling this product to Chelan Fruit.

Proposed schedule
A complete schedule with specific tasks that must be completed by the end of each month is located in appendix E. Tasks are encouraged to be completed early so in the event of any setbacks or issues there will still be plenty of time to complete the project. It is very crucial that the schedule be followed. Van Doreen Sales has many projects going on right now and if this project falls behind at any point, then the building of the project will not be completed on time. It will be the job of the engineer to make sure all tasks get done in a timely manner. The amount of time needed to complete each task will be recorded in the schedule.

Discussion
This project was a huge task to take on as a senior project. Even with the support of a well-established company with much knowledge and support this project has been difficult. The time spent on this project was far more than expected, many hours have been put into the design, analysis and proposal of this project. It was quite devastating to hear they would not be moving forward with the proposed design and would be cutting the funding to the project. However a lot was learned from this experience. Always try to be ahead of the game and make sure the right people are giving you the design requirement. Overall the 10th scale redesign of this project has been a success, after several hours of redesigning and finding parts that would work for a 10th scale model. The scale model should be able to prove the concept of how the device would have worked at full scale. This has been a huge setback because several hours had to go back into the proposal phase and planning phase.

Design Evolution / Performance Creep
The design evolution of this device is quite interesting. The basic movements of the device have been established from almost day 1. The device will squeeze and lift the boxes of apples. The part of the device that continues to be changed and redesigned is how the lift and squeeze technique will be performed. The first idea for this project was that the squeeze and lift would be driven by hydraulics. This quickly changed because the fruit company did not like the idea of hydraulic fluids being around the fruit. Also a hydraulic system was overkill for the amount of load the device needed to lift. The next idea was to move to pneumatics to drive the squeeze and lift force. This then came up for discussion because air is a compressible fluid. Before any lifting or squeezing occurs the device has to be able to be positioned so that the plates start at a certain height for that specific box configuration. Using air would make it hard to pin point certain heights for different box configurations since when adding air to a cylinder the movement is quite jerky. Also the layers of boxes have some glue between the layers so before the boxes could be lifted air would be compressing in the cylinders until the glue bond between layers was broken resulting in uncontrolled lift acceleration. This potentially could cause boxes to tip over. After all this was taken into account the company decided that pneumatics would be the best solution for the squeeze force of this device and that the lifting force would be provided by a linear electric actuator. The linear actuator provided precise, smooth movement. The only thing left to be determined on this device is it will need its own batteries and compressors to run the device. There will be a lot of help from the Van Doren Electric and pneumatic team for sizing batteries and compressors. Lastly the funding of the project was cut and now it is redesigned at a 10th scale.

Project Risk Analysis
One of the greatest risks of this project is cost. The cost of this device keeps going up and up. My main concern is will this be a marketable product? There are 3 potential things that can happen based on the cost of this project. One is the device costs too much and the customer is not willing to pay for it, therefore this device is not manufactured. Two, the company keeps the cost down enough to make a profit and potentially sell many more units. And lastly, the company breaks even on the project and it’s up for redesign. In this case the customer did not accept the proposal and the device is up for redesign at a later time by the Van Doren Company.

Success
This project will be successful if the device allows access to a mid-level box in the pallet stack. The device must meet all the customers’ requirements and must not damage any of the fruit. Lastly, the device must be safe when used appropriately.

Next Phase
The next phase for this project is the manufacturing phase. All the drawings of the parts for this device have been completed. The part drawings will be sent to the Van Doren machine shop. Once all the parts are cut to size and made at the machine shop they will
then be passed on to the welders. Once all the Sub-Assembly have been welded they will be put together to make the final assembly.

Appendix K – Resume/Vita

OBJECTIVE
Seeking a position as a full time engineer. Expected to graduate in June of 2016 with a bachelor’s degree in Mechanical Engineering Technology. Current GPA is 3.7. Job interests include: mechanical engineer, manufacturing engineer, or a similar position.

EDUCATION
9/23/14 – current  
Central Washington University  
Ellensburg WA  
CWU GPA 3.959  
Honor roll Fall of 2015, Winter of 2015 Spring of 2015

Completed courses:
- Metallurgy, Machining, Thermodynamics, Fluid dynamics, Advanced Machining, PLC’s Solid Works Level 1 Certification, Computer Aided Manufacturing and Applied Strengths and Materials.

9/16/11 – 6/10/14  
Yakima Valley Community College  
Yakima WA

Completed Associates of Arts and Science Direct Transfer Degree with honors December 2013.  
YVCC GPA 3.595

- Presidents List—Spring 2013, Spring 2014
- Dean’s List—Spring & Fall 2012, Fall 2014

Completed Related Courses:
- Calculus based Physics series, Calculus 1 and 2, Statics, Dynamics, Strengths and Materials,
- Interpersonal Relationships (team building/communications course)

EXPERIENCE
3/30/2015 TO CURRENT  
Van Doren Sales  
Yakima WA

Engineering Intern
Van Doren Sales builds and designs fruit packaging equipment. What began as an internship has turned into a part time engineering job. An engineering intern helps with the Layout CAD Drawings of a Cherry Facility.

6/21/14 TO 9/17/2014  
Yakima County Public Services  
Yakima WA
Survey Crew Member
A survey crew member learns how to acquire data for topography and upload it to AutoCAD. Also interns learn the process of laying out roads.

REFERENCES

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<tr>
<th>Name</th>
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<th>Email</th>
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<tr>
<td>Dr. Stephen Rodrigue</td>
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<td><a href="mailto:SRodrigue@yvcc.edu">SRodrigue@yvcc.edu</a></td>
<td>2 Years</td>
<td>Instructor</td>
<td>Physics/Engineering</td>
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<td>Kim &amp; Connie Eisenzimmer</td>
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<td>Jason Rinehart</td>
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<td>Summer Intern 2014</td>
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<td>John Pickens</td>
<td></td>
<td><a href="mailto:Jtpickens@triumphgroup.com">Jtpickens@triumphgroup.com</a></td>
<td>20 Years</td>
<td>Family Friend</td>
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