Project Title: Cherry Shaker Bagger Concepts

Report Type: Final Project Report

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Project Duration: 1-Year

Total Project Request for Year 1 Funding: $ 40,000

Other related/associated funding sources: Davis Mechatronics investment

WTFRC Collaborative Costs:

Item	**(Type year of project start date here)**		
Salaries	$30,000.00		
Benefits			
Wages			
Benefits			
RCA Room Rental			
Shipping			
Supplies	$10,000.00		
Travel			
Plot Fees			
Miscellaneous			

Total	$40,000.00		

Footnotes:

Budget 1
Primary PI: Michael Corsetto
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Station Manager/Supervisor: Optional
Station manager/supervisor email address: Optional

Item	**(Type year of project start date here)**		
Salaries	$30,000.00		
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Shipping			
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Travel			
Plot Fees			
Miscellaneous			
Total	$40,000.00		

Footnotes:

If project duration is only 1 year, delete Year 2 and Year 3 columns.

Recap Original Objectives

The primary objective of this project is to automate the manual cherry bagging process. Currently, human operators must manually place individual bags onto shaker nozzles, creating a production bottleneck. The goal is to develop a mechanical solution to eliminate this manual effort, thereby providing substantial cost savings to cherry growers and packers.

Significant Findings

System testing achieved a success rate of nearly 90% across full operational cycles, with specific tests showing success in 94 out of 105 bags. We found that bag variance, differences in material stiffness, handle height, and dimensions, significantly impacts reliability. Doubling error rates between bag types from 7% to 14%.

Methods

Initial Research/Testing



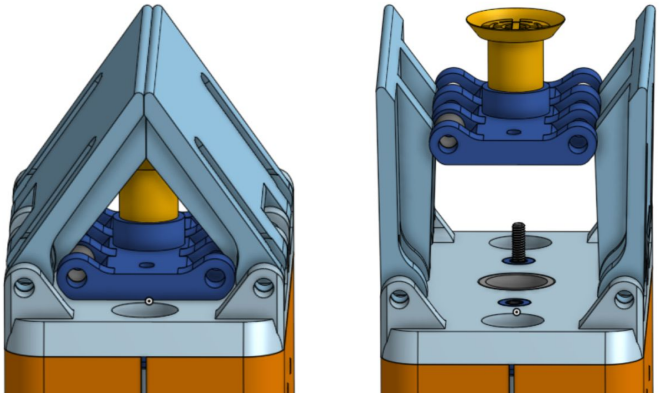
1. Outer bag grabber *2. Inner bag Pincher*

3. Inner 4 finger opener *4. Passive bag opener*

Initial Prototypes for bag grabbing concepts

These initial concepts were not pursued due to sizing and spacing constraints. For example, the outer bag grabber (idea 1) would physically hit the template after inserting the bag and would rub on neighboring bags when retracting pulling them off the template. Idea 4 (passive bag opener) couldn't exit through the template after bag placement without decreasing the final area and impacting its performance. Additionally, the initial aperture was too large to deal with zipped bags independently. The other prototype ideas were too inconsistent to move forward with.

Decided on Duckbill Concept



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First prototype with duckbill concept

Following initial prototyping for multiple concepts, the Duckbill Concept was selected for further development. This design incorporates a retractable suction cup positioned beneath the bill to facilitate bag centering and catch points when inserting into a bag. We found this configuration maintained consistent pressure while providing an acceptable margin of error during operation.

Bag opener



Initial grabber design

The finalized bag-opening strategy involves a through-template grabber mechanism. This approach necessitated a pre-opening stage and a secondary hand-off mechanism. A four-bar linkage system was engineered to maintain parallel alignment between the bag faces and the insertion tool. In accordance with industry standards for food processing, suction cups were selected as the primary bag interface. We would eventually add more suction cups to the grabber but the geometry didn't change.



The duckbill with blower attached in the template

The integrated grabber assembly utilizes the previously validated duckbill and internal suction cup. To further open the bag for template insertion, a bottom-fed blower was integrated to inflate bags during the downward stroke, thereby expanding the aperture and improving template fit.

Full System Assembly

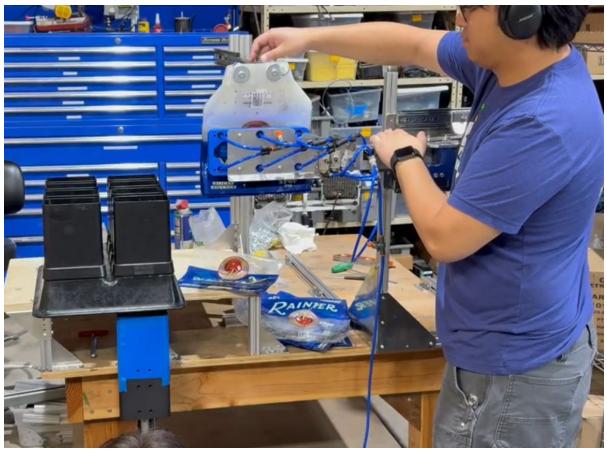


Initial Assembly of Architecture

The system architecture was formalized to isolate mechanical movements and eliminate variables associated with human handling. The test platform consists of a vertical rail for the insertion tool and horizontal rails for bag transport and grabber movement. Bags are indexed horizontally to the grabber before being positioned over the template for retrieval.

Recorded videos from initial system-wide testing is documented below:
https://drive.google.com/drive/u/0/folders/1iT3uurpS_gB6XPk9MzSeGzzQtoWmzhg_

Video of testing: "Initial system test”



Initial system wide test with human moved DOFs

To further eliminate human handling variables we fully automated the movement for each system. Pneumatic cylinders were implemented for all travel, and a motorized four-bar linkage provided multi-position control for the grabber. This configuration allowed for high-fidelity testing without human intervention, ensuring results representative of a production-ready system.



Architecture with Pneumatics

With the system fully mechanized, we could start identifying the catch points in the system. For the next month, most of our focus went into getting the bag onto the template. Here's one of the first test runs of the system, and you can see that even with the duckbill being slowly inserted, there were still many catch points that needed to be ironed out, especially when the bag first touched the template.

Video of testing:
"Pneumatic Actuated Testing"



Duckbill with expansion knobs

Our initial testing on the full system indicated that active inflation was actually unhelpful since it compromised suction force from the internal suction cup and made the bag less pliable while it was inserting on the template. To resolve this, the blower was replaced with mechanical expansion knobs integrated into the insertion tool. Additionally, the duckbill profile was reduced to improve centering across both axes. These modifications eliminated material interference during the upward stroke of the insertion tool.



Final knob placements

Final refinements involved relocating the mechanical flippers to the corners of the opening mechanism. This adjustment successfully prevented corner catching and improved system consistency to a success rate of nearly 90% across the full operational cycle. We ran a test of 105 bags from 2 variants and succeeded at 94 of them.

Results and Discussion

During the evaluation phase, we examined several cherry bag variants and observed that dimensional and material inconsistencies significantly impact grabber reliability. For the V2 iteration, we attempted to mitigate these effects by centering the grabber assembly relative to the bag aperture. Nonetheless, fluctuations in bag sizing and materials continue to present operational challenges across all parts of the operation. Differences in material stiffness can mess with the assertion step, and differences in sizing mess with every part of grabbing. Variations in bag type can double our error rate from 7% to 14%, depending on how different the bags are.

Bag Type	Success	Failure
Blue Rainer	51	4
Black Rainer	43	7
Loose Packed	10	2

Bag Type	Failue Mode	Notes
Blue Rainer	On Template	plunger didn't grab top gully
Blue Rainer	Grabber	bag extension didn't fully grab bag
Blue Rainer	On Template	plunger didn't fully grab/ bag handle caught on template
Blue Rainer	Grabber	Failed to pick up bag
Black Rainer	Bag	grabs bag right on zipper and rezips the bag
Black Rainer	Bag	Black bags hang slightly higher than blue bags have to adjust whole thing for the black bags so they don't reseal
Black Rainer	Bag	resealed again after adjustment
Black Rainer	On Template	hit top of template
Black Rainer	Grabber	grabber didn't pick up bag
Black Rainer	Grabber	opening sunction middle bottom failed
Black Rainer	Bag	Duck Bill caught on bag
Loose Packed	On Template	handle caught
Loose Packed	On Template	Handle caught

Notes from a test day with the amount of successful grabs for each bag in the top corner



Tested Bags(top) Black Rainer on top of light blue bag(left) Blue Rainier on top of light blue bag (right)

We found bag stiffness to be the main variable between bag styles. The stiffer light blue bag had more catch points when inserted into the template. Also, every bag we tested had different handle heights and bag sizes. The two Rainier bags that arrived on the wickets we tested were slightly different sizes, as were the wickets themselves and bag materials. Most importantly, you can see that the handles are at different heights. This handle area is crucial due to the nature of where the zipper is in proximity to it. The different handle sizes means that the mechanism may not grab the zipper area optimally and may have to be adjusted per bag to achieve consistent results. The light blue loose-packed bags we tested were half an inch bigger in width and height than the Rainier bags and had extra handle material on both sides of the bag instead of on one for the Rainier, increasing catchpoints when inserting into the template. While the system could be adjusted to use different bags, it was very time-consuming and had to be readjusted to the previous bag when switching back. Having a standardized bag or small selection of bags going forward would improve system reliability and significantly reduce the scope of the project.

Literature Review

Current Bagging Process

Every step in the described process is done using manual labor.



Figure 1. Shakers used to fill individual cherry bags.

Plastic liners are placed inside of the shipping box. The standard size box is 23” x 15.25” x 6”, corrugated, and packed to 20lbs.

Figure 2. Corrugated box with plastic liner.

Currently, plastic liners are placed within the bottom of the shipping box. Individual cherry bags are placed over the shaker nozzles, by hand, one at a time. Cherries are conveyed, by bulk, to the top of the shaker and hence into the individual bags.



Figure 3. Bags are placed individually over each shaker nozzle using human labor.

The shaker, complete with bags, is placed inside the shipping box to be bulk filled: https://www.youtube.com/watch?v=zxv_CzmQyQQ (2:22) shows bulk filling into the shaker trays. Not shown is how the bags are placed onto the shakers. This is the key automation step within the packaging process.



Figure 4. Shakers are placed inside the shipping box.



Figure 5. Shakers are raised and "shook" leaving cherries in their individual bags, inside the shipping box.

Executive Summary

This project addresses the manual labor bottleneck in the cherry packaging process by developing an automated bag-handling solution. We successfully prototyped and tested a mechanical system featuring a duckbill and grabber mechanism designed to position bags onto shaker nozzles. System testing validated a 90% success rate, confirming the technical feasibility of the design. While variances in bag materials and dimensions require further attention, this automated approach eliminates manual intervention, providing a pathway to substantial cost savings and increased throughput for cherry growers.

Project Title

Cherry Shaker Bagger Automation Concepts

Key words

Automation, Cherry Packaging, Grabber Design

Abstract

This report details the development and testing of automated concepts for the cherry bagging process. By replacing manual labor with a mechanized "duckbill" and "grabber" system, the project aims to increase efficiency for cherry growers. Testing achieved a 90% success rate, though significant challenges remain regarding bag material and size variance.