

## FINAL PROJECT

4<sup>th</sup> QUARTER 20005

**WTFRC Project #:** TR-04-441  
**Project Title:** Dry Bin Filler  
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### Objectives:

The over all objective of this design project is to demonstrate the feasibility and effectiveness of utilizing wave belts to fill a storage bin with apples. This project is supported by grants from the United States Department of Agriculture Small Business Innovative Research (USDA-SBIR) and the Washington Tree Fruit Research Commission. The goal is to develop a prototype of the bin filler that can:

- ❖ Fill a storage bin 90% full of fruit.
- ❖ Operate at a minimum speed of 8 bins per hour.
- ❖ Inflict minimal to no damage to the fruit.

The goal for this work is to design, build and test the prototypes. The testing will prove the mechanical function and fruit handling characteristics of the prototypes. Three prototypes are needed: one- the elevator / delivery head system, two- the fruit accumulator/organizer method and three- the full working prototype bin filler. The specific questions that need to be answered to show technical feasibility are:

Without bruising or otherwise damaging the fruit, is it possible:

- To organize the fruit in such a fashion as to deliver a “full” width row of fruit to the storage bin?
- To maintain a level layer of fruit in the bin to minimize the fall of fruit from the head to the bin and to maximize the bin fill?
- To transfer the fruit into a padded pocket and then slide the pad from under the fruit?
- To do all of the above with the machinery tilted at up to a 4% slope?
- To accomplish the above at a rate of 8 bins per hour?

### Objectives of the WTFRC project:

The goal of the research funded by the WTFRC was to design and develop a method to deliver fruit into the storage bin, build and test a prototype of the delivery head.

### Significant findings:

- ❖ Opposing wave belt system is a practical transport method for lowering a row of fruit into a storage bin.
- ❖ Fruit is effectively delivered to the storage bin
- ❖ Wave belts are an inherently gentle technique of transporting fruit. No bruising action was found in the receiving, transport or release of fruit from the opposing wave belt system.
- ❖ The current configuration is capable of transporting a sphere 2¼” to 4½” in diameter

### Results and Discussion:

The final design of the prototype delivery head consisted of two opposing wave belts, two padded drapes and a structural mechanism. The waves on the belt cradle a row of fruit as it is in the process of being lowered to the level of the fruit already in the bin. When the waves on the belt reach the idler pulley they collapse against it, this action releases the fruit onto the padded drapes that are positioned against the fruit or bin bottom. Subsequently, the head is raised upward and forward approximately four inches. This action releases the fruit into the bin with the lowest possible state of kinetic and potential energy. In other words, the fruit is not rolling and has a minimum drop when it is released into the bin. In preparation for the next row of fruit, the delivery head is repositioned in front of the previously deposited row of fruit

The prototype delivery head was evaluated for fruit handling characteristics with the use of an impact recording device and Pink Lady apples.

Testing with the impact recording device (IRD) has not shown any impacts that exceed the bruise threshold established by Schulte-Pason, Timm, and Brown; Michigan State University.

Testing of the prototype with Pink lady apples has shown minimal fruit damage. Three different tests were carried out to evaluate the fruit handling characteristics of the delivery head prototype. Fruit that had been delivered to the warehouse was marked to identify all existing bruises. The marked fruit was subsequently run through the prototype and evaluated the next day for additional bruises caused by the bin filling process. The fruit in lots one and two were placed on the bin floor by the prototype. Lot three was placed on top of a layer of fruit with some apples in a second level to replicate a partially filled bin. The bruises that were attributed to the dry bin filling process were all small, shallow bruises with no skin punctures.

The following table contains the results of the testing;

LOT	ORCHARD	PICK DATE	TEST DATE	# OF PIECES	# & % OF EXISTING BRUISES	# & % OF ADDITIONAL BRUISES
1	West bank 1	11/04/05	11/10/05	37	23 - 62%	4 - 11%
2	Waco home	10/31/05	11/10/05	25	12 - 48%	2 - 8%
3	West bank2	11/14/05	12/12/05	63	10 - 16%	4 - 6%

**Budget 2005 :**

**Funding request; Proof of concept and Impact Recording Device**

IRD -----\$4,600  
Shipping-----\$35  
Sales tax----- \$368  
**Sub Total ----- \$5,003**

Design, build and test the fruit handling characteristics of  
a prototype elevator and delivery head -- ----- \$7,200

**Total Request 9/3/2004-----\$12,203**

**Budget Breakdown:**

Item	Year one 2005	Year two 2006
Salary	\$ 4720	
Benefits <sup>1</sup>	\$944	
Administration fee <sup>2</sup>	\$236	
Equipment <sup>3</sup>	\$1300	
Impact Recording Device	\$5003	
Total	\$12,203	\$0.00

- 1) Benefits are 20% of Salary
- 2) Administration fee is 5% of total direct costs.
- 3) This is an estimate of parts, purchased and fabricated, to assemble a prototype opposing wave belt prototype.

**Support from other sources:**

The prototype of the bin filler/ proof of concept project is also being funded by the, Phase I, USDA SBIR Grant; \$80,000. A no cost extension has been granted though October 31, 2006. This extension of the USDA SBIR grant allows me to continue the research through harvest 2006, and utilize the remaining grant funds.

**Current status**

The prototype bin filler is nearly complete. Motors, sensors and motion control are operational and functioning.

I have spent considerable time developing a working relationship with a belt fabricating shop. The belts that they provided demonstrate their ability to fabricate a usable wave belt, but they have not been able to build a wave belt with the dimensions that I have specified. This will be resolved in the next few days. As soon as the final version of the wave belts are fabricated and installed I will be ready to begin testing of the complete functioning prototype.