FINAL PROJECT REPORT

Project Title: Platform and Bin Filler Technologies

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Other funding sources

Agency Name: USDA
Amount awarded: $5,900,000
Notes: Provided salary support for one graduate student (Brian Kliethermes)

Total Project Funding:

Budget History:

Item	2009	2010	
Salaries			
Benefits			
Wages			
Benefits			
Equipment		2,000	
Supplies	3,000	6,000	
Travel	500	1,500	
Miscellaneous			
Total	3,500	9,500	

PLATFORM TECHNOLOGIES

OBJECTIVES

1) Develop core team and identify needs and priorities including economics, health and safety
2) Identify current options for meeting specific needs (light duty, hybrid)
3) Begin initial design of light duty and or hybrid equipment or begin initial procurement of light duty and hybrid equipment
4) Determine best protocol for assessing multi row, over the row platform in the field

SIGNIFICANT FINDINGS

- Core WA team identified and expanded to include Penn State and MI State. Top priorities are ROI, Integration, Ergonomics, OTR and 2 person platforms.
- Options are being identified – domestic options are not fully commercialized, international options are on the shelf
- Designed and purchased Sensible Machine Inc. /Workman Toro Hybrid Platform. Still interest in SilverBull platform – will fully evaluate during Nov 2010 Italy study tour.
- SCRI proposal for OTR is under development. PD for project is Qin Zhang and includes WSU, ARS and MI State.
- SHIP Platform Ergonomic Project was funded and year one data collection is complete.
- ETV has successfully performed in research trials

RESULTS AND DISCUSSION

The platform technology portion of this project met its stated objectives in that several tasks were accomplished, resources were secured, equipment purchased and teams identified and partnerships built. Using both formal and informal methods, the priorities for platform research and development were identified as: ROI, Orchard/ Employee Integration, OTR, Ergonomics, and 2 person platform designs. The CASC technology adoption survey reports that serviceability and reliability are critical criteria that influence adoption of new technology. This is the case with mobile orchard platforms.

The UW SHIP proposal was funded and year one activities yielded industry partnerships and identified goals and objectives to be used in protocol development.

After researching our needs for a 2 person platform, PI worked with Sensible machines to have a 2 person platform built for use on the CASC Toro Workman / APM. Fig.1. This research vehicle will arrive in WA in January 2011. We continue to explore options for a commercially available 2 person platform. Our study tour to Italy will include the viewing and evaluation of the latest versions being sold in Europe. The development of Over the Row mechanization and automation technologies and is the subject of a 2011 SCRI proposal. The proposal also includes a novel apple orchard system /architecture component.

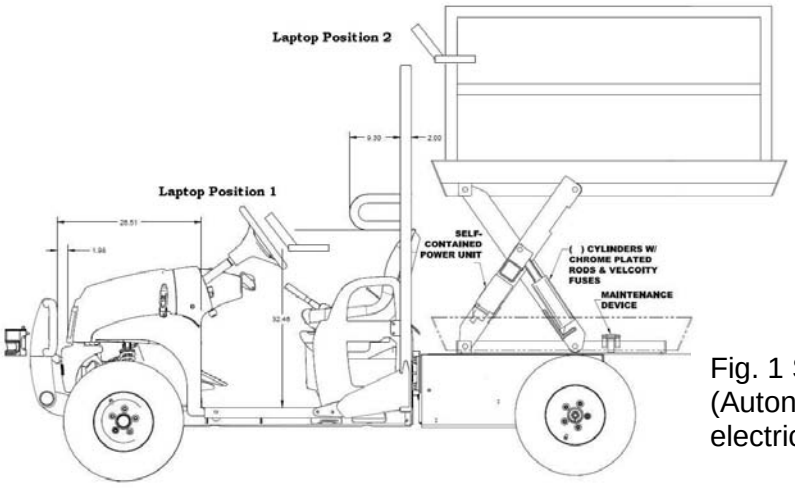

Fig. 1 Sensible Machine APM Platform (Autonomous Electric Toro Workman and electric scissor lift)

BIN FILLER TECHNOLOGIES

OBJECTIVES

1) Construct prototype of the Energy Absorbing Grate Bin Filler
2) Construct prototype of the Self Adjusting Bin Filler
3) Field test both bin fillers

SIGNIFICANT FINDINGS

Carnegie Mellon, Penn State, and ARS developed designs for two prototype bin fillers that showed promise in laboratory testing for reducing damage to fruit during the bin filling process.

- *Energy absorbing grate bin filler*—frames of energy absorbing materials strung on elastic bands. (Figures 2 and 4)
- *Pneumatically self-adjusting bin filler*—parallel inflatable soft polymer cylinders attached to a frame and of an external air supply for pneumatic inflating of the cylinders. (Figures 2 and 3)

We developed full scale prototypes to determine if they could be successfully adapted to use in the field to both reduce fruit damage and to increase the speed of harvest. We also investigated method for guiding tossed fruit to the bins.

Our major findings were the following.

- Both types of bin fillers can reduce bruising when apples are dropped into them one at a time, and they are position within 2-4 cm of the top layer of apples in a bin.
- A variety of different energy absorbing materials successfully reduced bruising, including large sheets of inexpensive industrial bubble pack.
- The pneumatically self-adjusting bin filler could not lift itself because of the compliance of the polymer cylinders.

- When apple were dropped into a chute leading to the bin fillers, the impacts between the apples in the chute and in the bin filler caused significant bruising.
- Nets for guiding apples into the bin show promise for reducing the need for picking bags.
- *Singulation of the apples during transport into and through the bin filler is essential to reduce bruising.*

RESULTS & DISCUSSION

Figures 1 and 2 show one instantiation of the energy absorbing grate bin filler. Figure 3 shows the concept for the pneumatic self-adjusting bin filler, and Figure 4 shows the test rig for the full scale prototype.

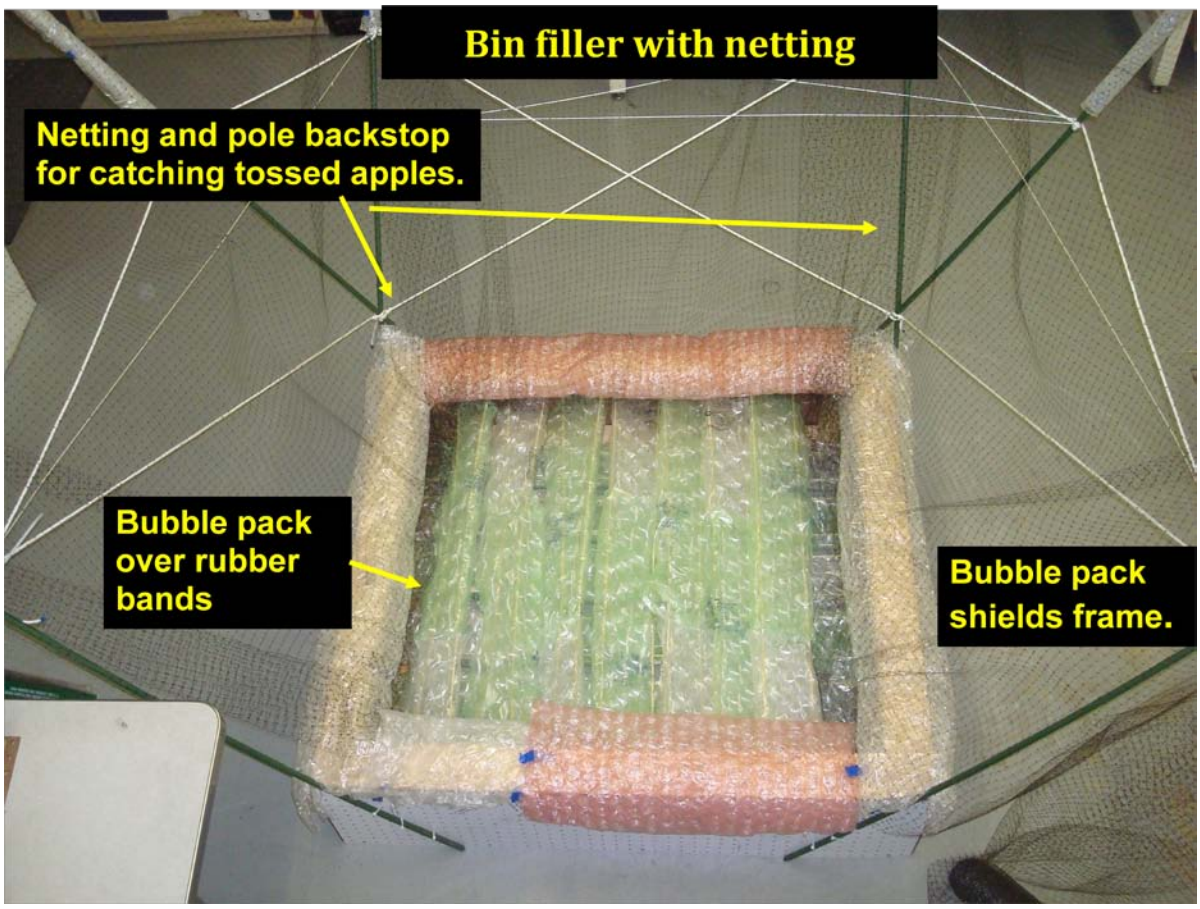

Fig. 1. Energy absorbing grate bin filler. Netting was experiment in guiding tossed apples into the bin filler.

We determined a variety of energy absorbing materials, such as foam balls strung on rubber bands, are suitable for the bin fillers themselves. Significantly, even inexpensive, easily replaceable bubble pack can work, provided the pressure in the bubbles is high enough and there is the right amount of space between the energy absorbers so that they slow down the apples without completely stopping them. (Figure 2.)

The pneumatic self-adjusting bin filler needs some modification to work as intended. The soft polymer cylinders are too compliant, and bend under the weight of the rest of the mechanism when inflated. The middle of a cylinder remains in contact with the central inflation tube, and thus cannot lift the mechanism. The solution may be as simple as tying off the cylinder into discrete, separately inflatable sections.

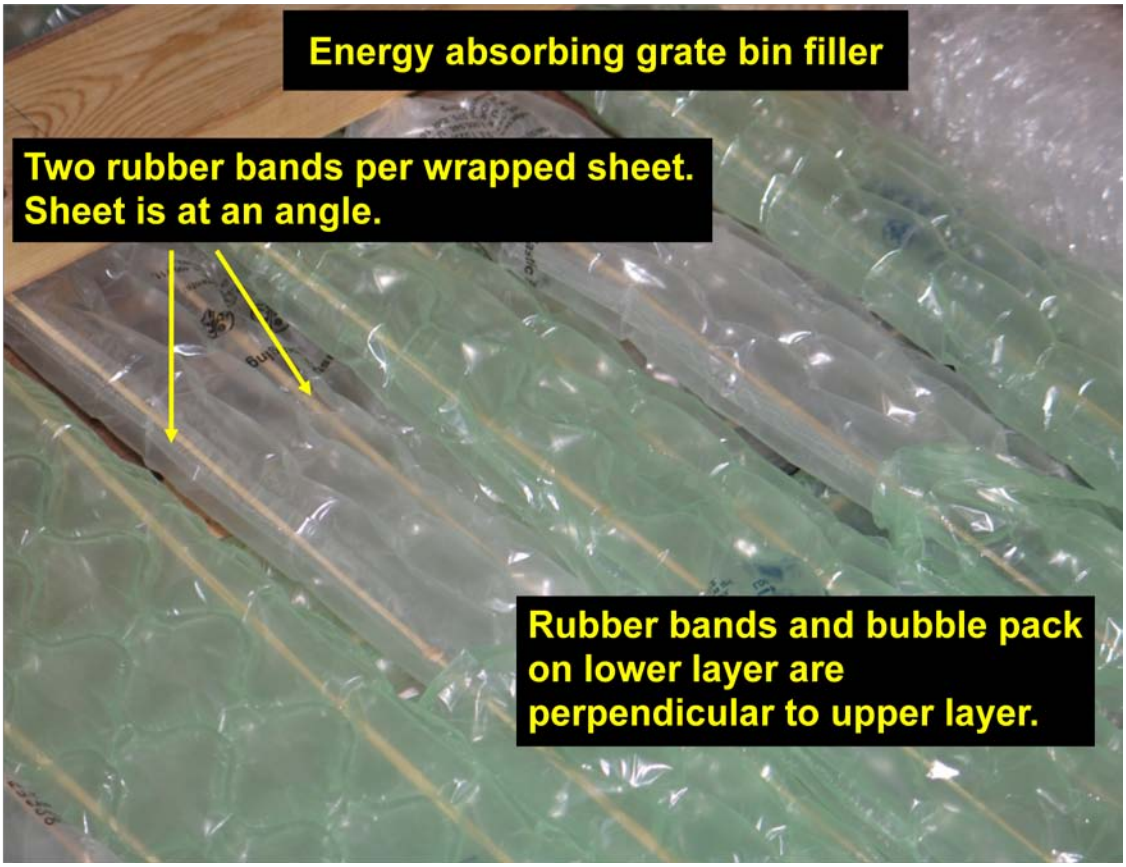

Figure 2. Energy absorbing grate bin filler with bubble pack

Both types of bin fillers were effective at reducing as intended when apples were dropped one at a time into the bin filler with enough time between successive drops to prevent apples from hitting each other. However, simply pouring a bag of apples into the bin filler from the side or into a chute leading to the bin filler resulted in excessive bruising. (Figure 4.)

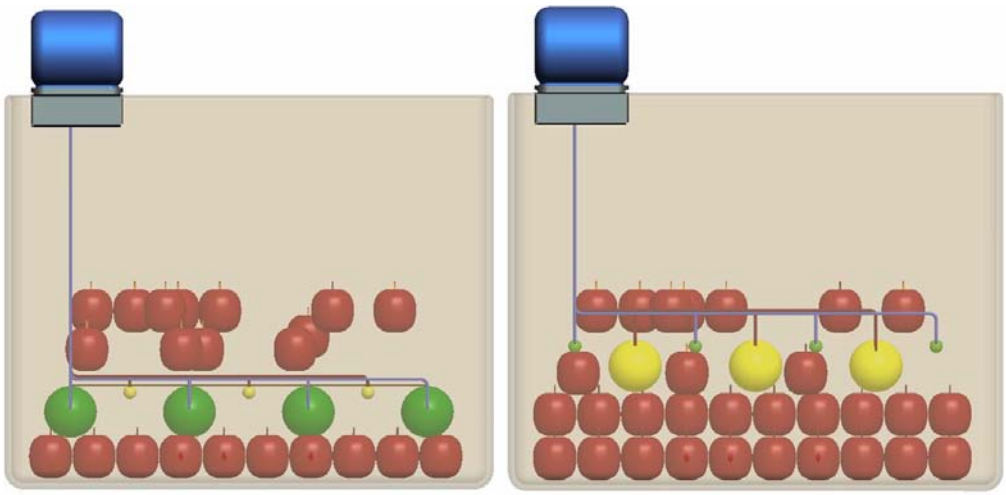

Fig. 3. Pneumatic self-adjusting apple bin filler concept

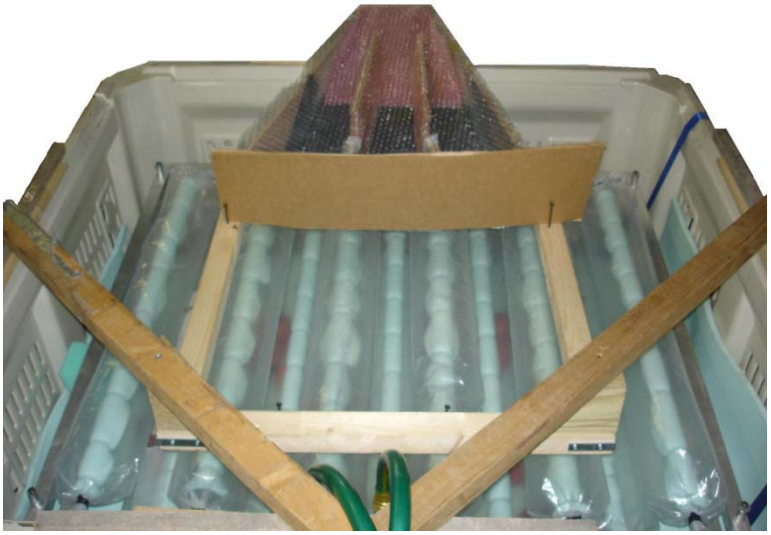

Fig. 4. Pneumatic self-adjusting bin filler with test ramp.

To address the problem of singulation, we also tried a system of netting to catch and guide apples into the passive bin filler. (Figure 1.) This method still had excessive bruising, but the problem was with impacts between the apples and the sides of the bin filler. There was insufficient padding on the edges of the bin filler and the netting did not sufficiently guide the apples to the middle of the bin filler away from the edges. Considering that apples were tossed from heights above 1.8 m (6 feet), the fact that the apples survived at all was encouraging. We believe this concept hold considerable promise for moving apples from the tree to bin without bags.

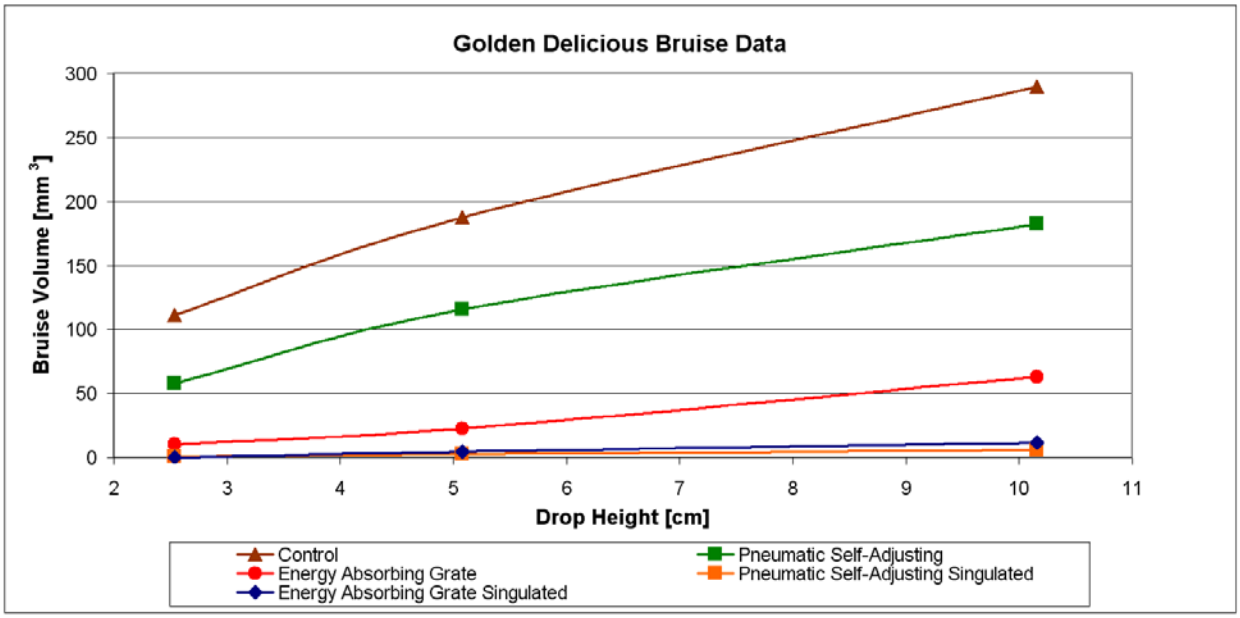

Fig. 4. Trend lines comparing the performance of two full-scale bin filling prototypes across three drop heights with and without singulation. Singulation improves performance by a factor of 10 for the energy absorbing grate and by a factor of about 100 for the pneumatic self adjusting bin filler.

EXECUTIVE SUMMARY

Platform technology is of great interest to the U.S. tree fruit industry. In Washington, we have brought new people to the table to address the many issues and challenges that influence purchase and adoption of platform technology. New WSU scientists that have taken on platform technology projects include Qin Zhang, Manov Karkee, Mykel Taylor and Karina Gallardo. Based on industry priorities we have identified a suitable 2 person platform, we have purchased a research vehicle with a 2 person platform, we have built a team to address OTR technologies and we there is a UW SHIP comprehensive platform ergonomic study funded and ongoing.

Significant activities and findings include

- Core WA team identified and expanded to include Penn State and MI State. Top priorities are ROI, Integration, Ergonomics, OTR and 2 person platforms.
- Identified platform equipment that is suitable for modern WA Orchards. Interest exists in the Italian SilverBull machines
- Designed and purchased Sensible Machine Inc. /Workman Toro Hybrid Platform.
- SCRI proposal for OTR is under development. PD for project is Qin Zhang and includes WSU, ARS and MI State.
- SHIP Platform Ergonomic Project was funded and year one data collection is complete.

Bin filler technology is the focus of several public and private studies. The process of filling bins is a bottleneck for the efficient harvest of apples. Carnegie Mellon, Penn State, and ARS developed bin filler designs and built full scale prototypes to determine if they could be successfully adapted to use in the field to both reduce fruit damage and to increase the speed of harvest. We also investigated method for guiding tossed fruit to the bins.

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