IMPACTS TO POTATO SEED TUBERS FROM HARVEST TO PLANTING

by

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Introduction

Impact characterization using the instrumented sphere (IS) is briefly described and preventing damage to tubers and cut seed is discussed using several examples. This paper contains graphics directly from the presentation. The underlying assumption and motivation is that minimizing damage to potato seed tubers and cut seed pieces is economically desirable due to the reduced performance potential of the damaged seed. There have been conflicting reports as to the effect of damage on seed performance.

Objectives

1. Discuss instrumented sphere (IS) evaluation of handling systems.
2. Illustrate and discuss potential problem areas in handling seed potatoes and cut potato seed pieces.

Observations and Discussion

Instrumented Sphere

The instrumented sphere (IS) was developed to characterize impacts in handling systems (Zapp, et al 1990). The IS is 8.9 cm (3.5 inches) in diameter and will float in water. It consists of internal electronics (accelerometers and microcomputer), bee's wax, and a plastic cover. A small connector, approximately the size of a standard telephone jack, provides the connection to a personal computer for control and data transfer. The characteristics and time of each impact above a specified threshold are recorded by the IS for analysis later.

The best results are realized when the IS is used with a video camera, portable computer, printer, and VCR. The video camera with an on-screen clock accurate to the nearest second is synchronized to the clock in the IS. This allows the impacts recorded by the IS to be found easily on the video tape by finding the impact time on the video that corresponds to the impact time on the IS. This greatly simplifies verification of the impact locations during analysis, especially if the video is played in slow motion.

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A dust resistant cameras is required for reliability when analyzing potato handling equipment. The 8 mm (or "High 8") video format has been useful because of the high resolution image and quick VCR operation. Figure 1 shows two the equipment utilized in these studies.

Figure 1. Printer, instrumented spheres, portable computer, VCR monitor, and 8 mm camera used for impact analysis

The IS characterizes every impact with two parameters to represent the severity of the impact: peak acceleration (g's) and velocity change (m/s) (velocity change can be used to approximate equivalent vertical drop height). In general, impacts from the same drop height onto different surfaces will have similar velocity changes, while the hardest and softest surfaces having the highest and lowest peak accelerations, respectively.

Figure 2 is IS output from a relatively gentle potato seed handling operation that shows few potentially damaging impacts. The two cushioning (diagonal) reference lines are for impacts onto steel and 1/4" open-cell cushioning (P15250 Poron_). The 10% probability bruise reference lines (nearly vertical) are for 8-10 oz Russet Burbank tubers at two different temperatures. Notice only two impacts were severe enough to be considered a problem. These came from the discharge end of the telescoping conveyor and was probably due to under loading of the receiving conveyor.

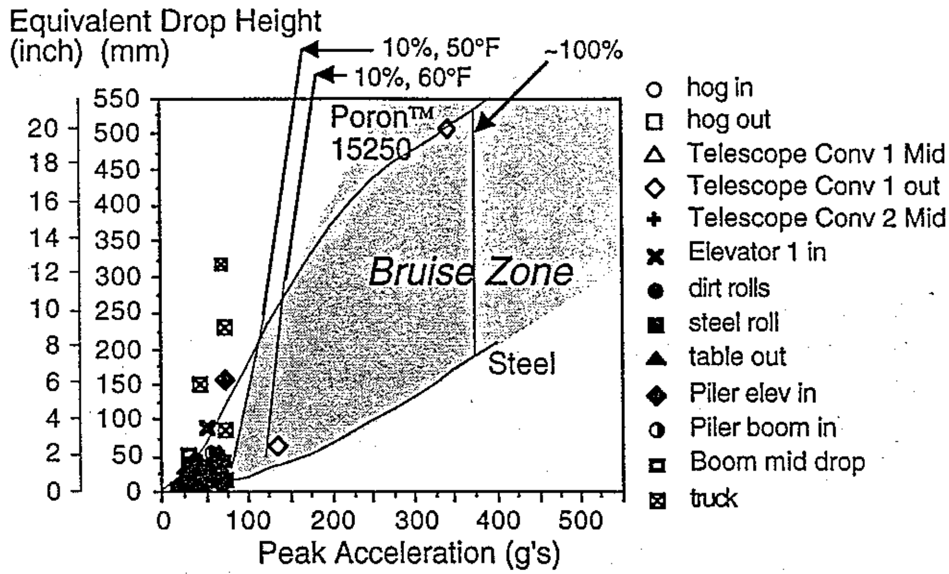

Figure 2. Instrumented sphere analysis of a low damage potato handling system

The IS is rapidly becoming a standard method for quick verification and location of high impact areas and their relative importance (probability of bruise to susceptible tubers).

Potential Problem Areas

Proper harvester operation is the first step in minimizing bruise damage. There are publications, videos, and computer programs dedicated to optimizing harvester performance (see list of references). The basic approach is that ground-to-primary and secondary chain speed ratios that keep the chains full of potatoes, and minimize the drop from one chain to the next will reduce tuber damage.

The transfer from the harvester to the truck is very challenging to optimize and requires constant communication between the harvester and truck operators. A good strategy is to start the pile in one end of the truck (cushioned for best results) and build the pile toward the opposite end of the truck. The concept is to minimize the number of tubers falling directly onto the hard surface and minimize the height of the drops onto the pile (Figure 3). Another thing to watch out for is tubers rolling fast into the sides of the truck box. Multiple small impacts (under the bruise threshold) are better than one large impact.

Figure 3. A very good transfer from the harvester to the truck. Notice the short drop into the truck box and the full conveyor

Unloading the potatoes from the truck must also be done carefully. Ideally, the receiving conveyor can be adjusted vertically to minimize the drop distance. Adjustable speed control on either the truck bed or the receiving conveyor is needed to be able to match the unloading and conveying rates so the conveyor hopper is kept full (Figure 4).

Figure 4. A good transfer from a truck to a conveyor. Notice the full conveyor and the minimal drop distance.

A very important aspect of seed potato handling is rock detection and elimination. Each area has different rock elimination requirements depending on the amount of tuber-sized rocks in the fields. A very common method of rock detection is dropping the potatoes and rocks onto steel rollers or plates enabling people to find the rocks after hearing them hit the metal surface. The obvious danger is that large drops directly onto steel can damage a large percentage of the potatoes. However, several small drops of 1 1/2" or less onto steel rollers or plates would minimize this risk and yet provide enough drop to have rocks "ring" the roller or plate. Figures 5 and 6 show rock detection schemes that are effective at both detecting rocks and often bruising potatoes. Both could be improved by drop height reduction with minimal reductions in rock detection effectiveness. Rock elimination schemes that rely on an operator to hear the rocks strike a metal surface should be operated in a quiet environment. This reduces the need for large drops onto the steel surfaces.

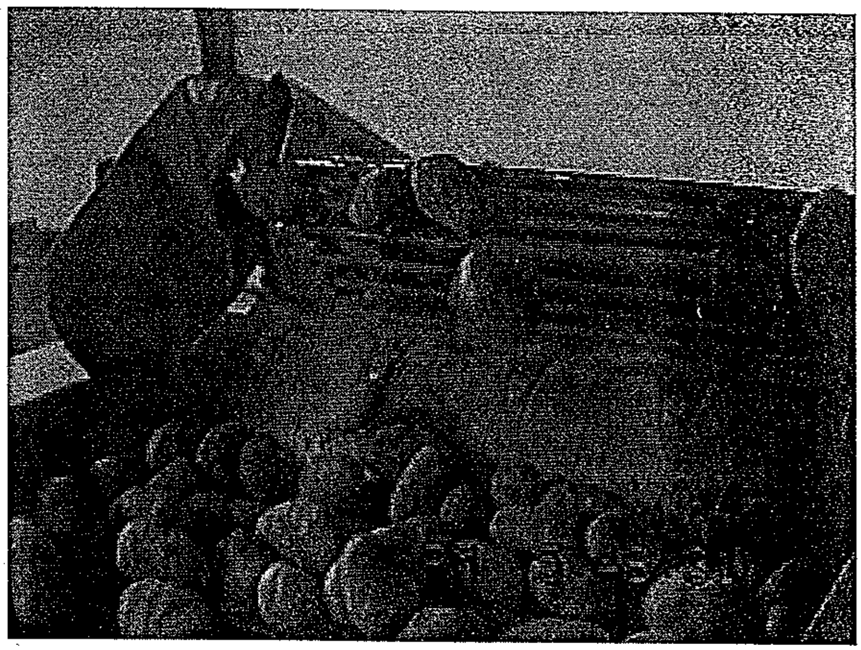

Figure 5. Rock detection with a steel plate.

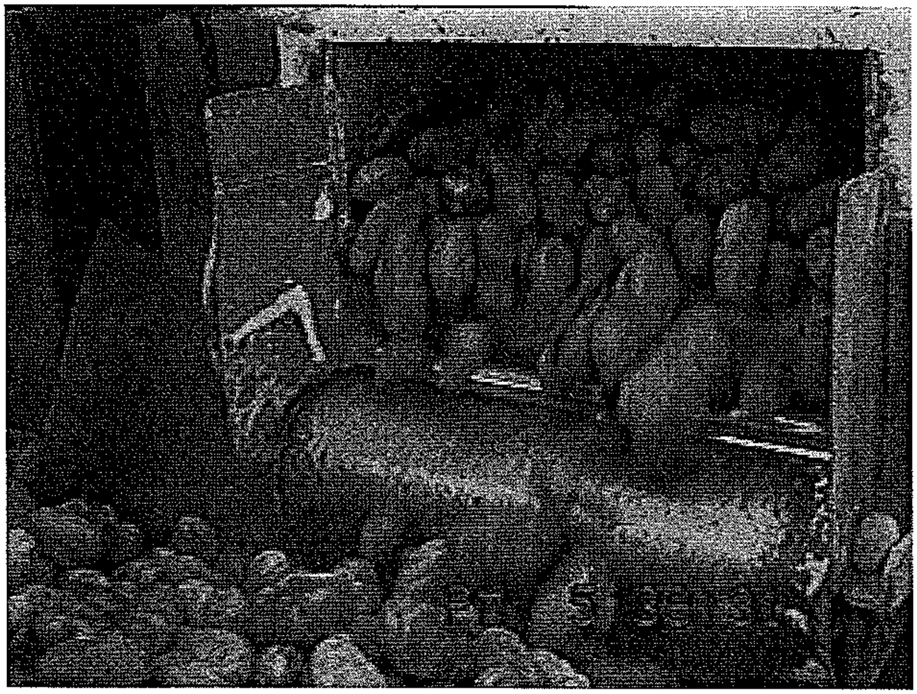

Figure 6. Rock detection with a steel roller. The high flow rate here can reduce bruise but decreases the effectiveness of the rock detection slightly.

A commercial mechanical rock eliminator that was tested showed very high potential for bruise (Figure 7). The principle of operation is that rocks and potatoes bounce different distances when dropped onto a slowly rotating steel drum. IS impacts onto this drum had peak accelerations ranging from 336 to 504 G's. Research has shown that 100% of the 10°C (50 °F) Russet Burbank (8-10 oz) tubers bruised from a drop of 400 mm (~15.75 in) (approximately 375 G's). The advantage is that the majority of the rocks are eliminated without labor costs.

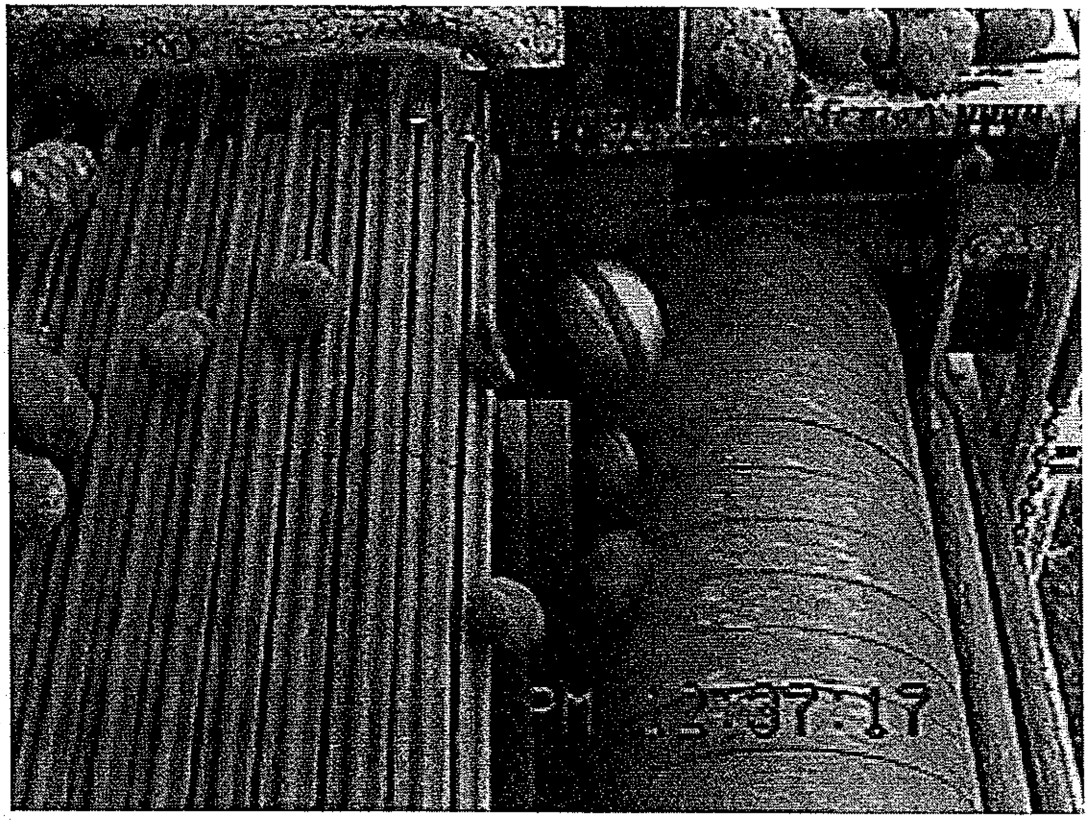

Figure 7. A commercial mechanical rock elimination scheme

Transfers between conveyors can damage both whole tubers and cut seed pieces. The best transfers have small elevation changes and the delivering and receiving conveyors are full minimizing high speed impacts. Placement of cushioning materials at locations that have been shown to have a high number of hard impacts is also helpful. Areas of polished or worn steel is a good indicator that cushioning is required. Figure 8 shows a transfer chute from a delivery conveyor to a chain. Chutes should be avoided whenever possible because the potatoes typically gain speed that must then be absorbed when they come to a stop. This is difficult to accomplish without damage. A better method when the height change is absolutely needed is a conveyor that runs downward. Flights can be used if the angle is steep enough to cause rolling.

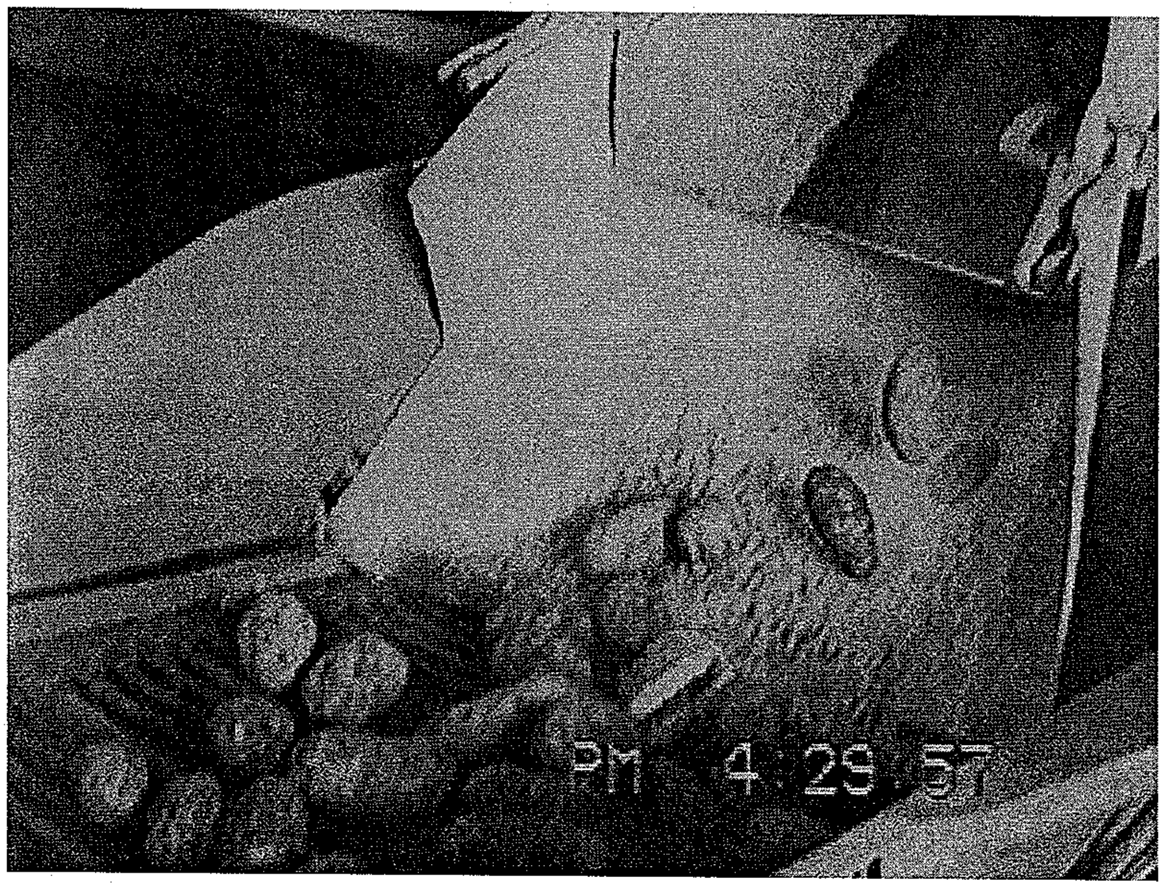

Figure 8. Transfer from a chute to a chain that could cause bruise damage.

Figure 9 shows a transfer from a sizer to a belt that discharges into a chute. It is important to note that a belt without direct support where the potatoes drop onto it provide effective cushioning. Many belts however, are supported unnecessarily by steel plates in the area onto which potatoes are falling. Another potential problem is impacts onto an uncushioned flow divider.

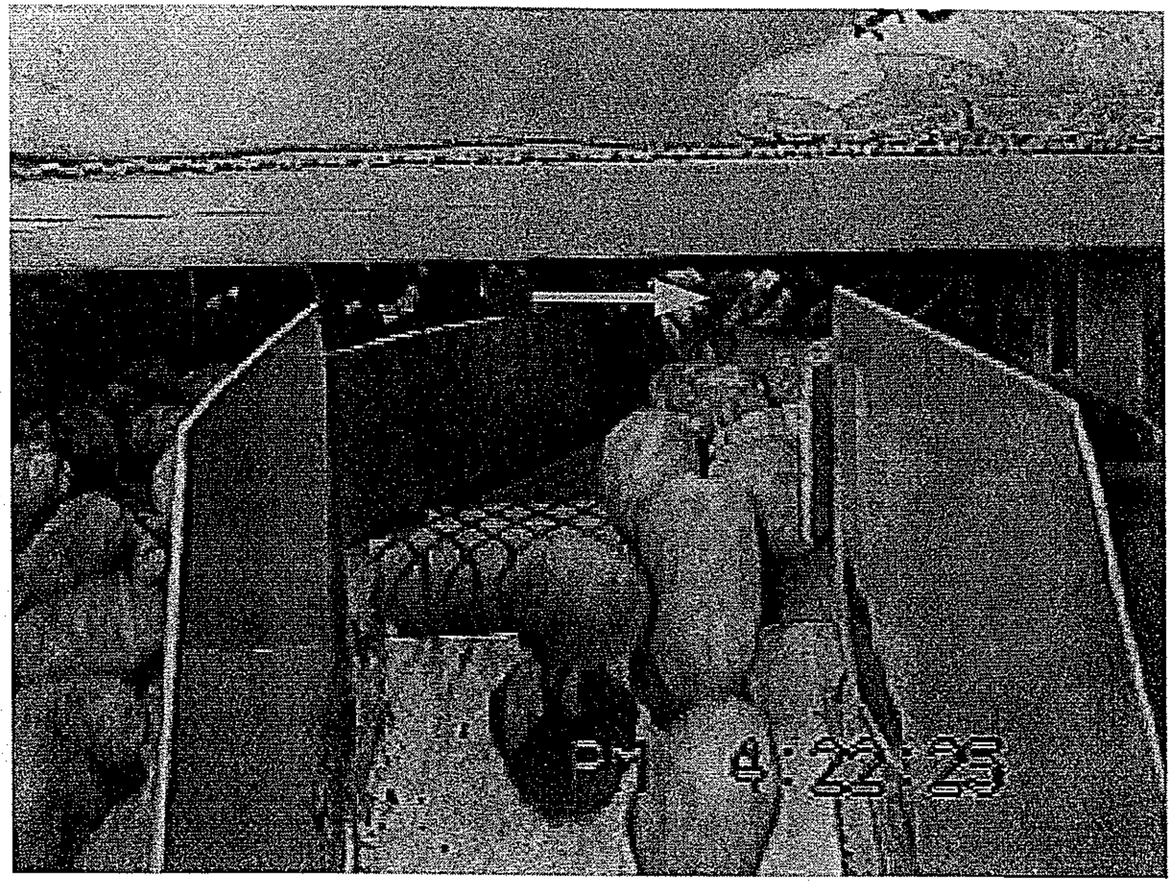

Figure 9. Transfer from a sizer to a belt that discharges into a chute

Often bulk potato tubers and cut seed pieces are handled in bins or loader buckets (Figure 10). It is critical that the operators of the equipment are consciously trying to reduce the number and severity of impacts. Sharp edges on equipment contacting the tubers and cut seed pieces should be rounded to avoid cutting. If possible, the seed tubers and cut seed should be transferred onto existing tubers to avoid hard impacts onto uncushioned surfaces. This applies to both the cutting and planting operations. Several loader designs exist for filling the planters that utilize a box with doors on the bottom to more gently fill the planter bins.

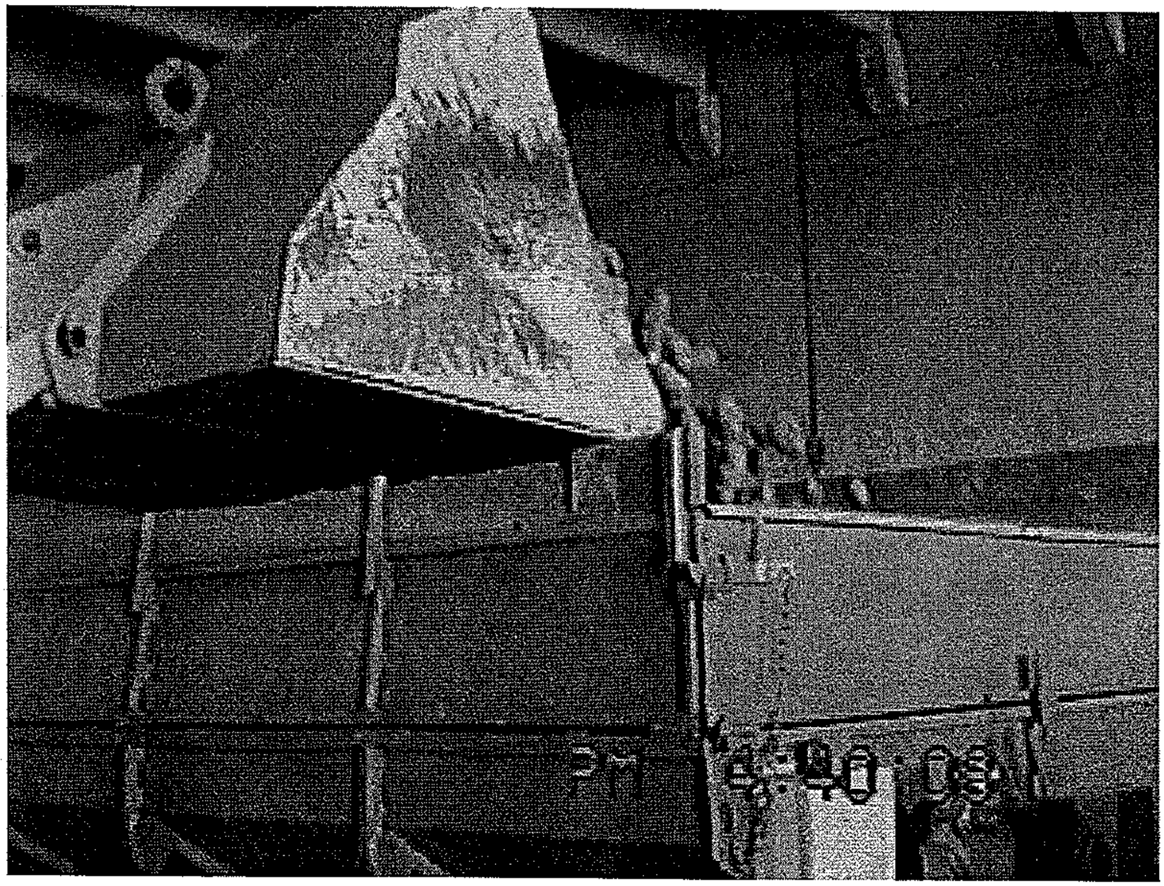

Figure 10. Loader tractor dumping potatoes into a bin. This is not the optimal filling method

Cut seed pieces require special attention to avoid damaging edges and corners. Conveyor transfers and bin loading should be done carefully. Large drops (Figure 11) are commonplace in potato seed cutting operations and should be avoided, or at least reduced, whenever practical.

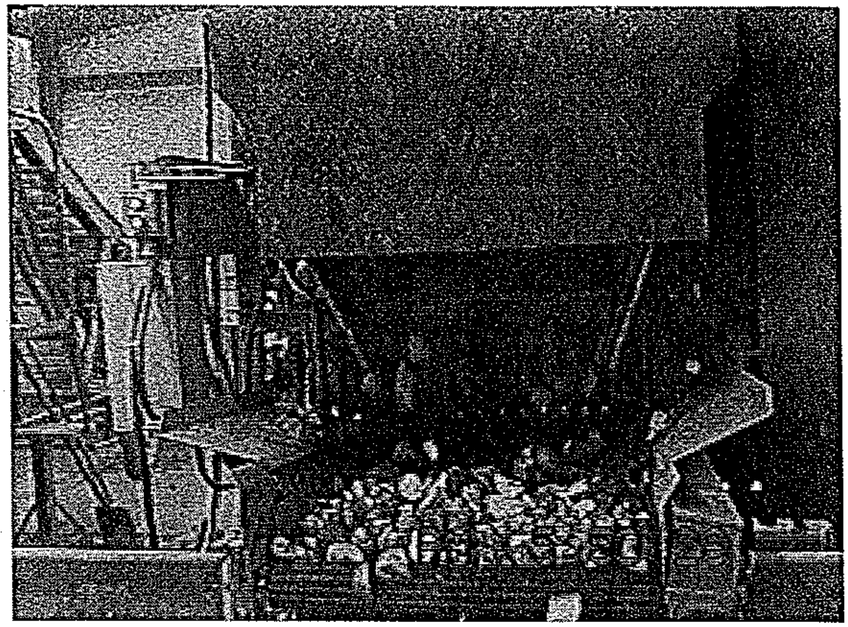

Figure 11. Seed falling out of a cutter onto a chain.

Conclusions

The instrumented sphere is a very useful tool for quantifying the probability of damage to potatoes for a given impact situation. Use of the IS has enabled the investigation of handling systems rapidly and make suggestions for improvements based on the IS measurements. The basic concepts used to minimize damage are reducing drop heights, cushioning surfaces when possible and practical, and keeping conveyors as full as possible. Until the effect of damage to seed tubers and cut seed pieces is more fully understood, the cost effectiveness of extensive modifications will not be known. There are a number of operational modifications that include drop height reduction and conveyor filling that have been shown to reduce tuber damage causing impacts that are easy and inexpensive to implement.

References

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