# final report

Project Code: P.PSH.0726
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Date published: June 2015

PUBLISHED BY
Meat and Livestock Australia Limited
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NORTH SYDNEY NSW 2059

# Beef cube roll bandsaw attachment Mk2

This is an MLA Donor Company funded project.
Meat & Livestock Australia and the MLA Donor Company acknowledge the matching funds provided by the Australian Government to support the research and development detailed in this publication.

# Final report


## Abstract

The Mark 2 Beef Cube Roll Bandsaw Attachment (BCR2) was developed in partnership with JBS and MLA to protect the operator from dangerous interaction with the bandsaw while simultaneously aiding the operator to achieve maximum yield when removing the chine and ribs from a cube roll. During production trials, site management were satisfied that the BCR2 was a significant improvement over the BCR1, the machine is easier and faster to operate and all of the modifications added value and functionality. However, site management expressed their growing interest in BladeStop technology which is detracting from safety advantages provided by the BCR2. For the BCR concept to remain viable, it must evolve to operate in conjunction with BladeStop and provide value by improving yield over and above baseline BladeStop operations.


## Project objectives

The anticipated outcome from this project is a refabricated BCR1 platform into a BCR2. The redevelopment project should:

- Identify a new clamp sliding mechanism that reduces the various friction concerns (thereby making the BCR2 easier and faster to operate) while simultaneously improving the out of plane rigidity of the machine, which will help produce a more consistent cut line.
- Integrate a low friction mechanism or surface into the base of the BCR2 to allow for easier, faster and more accurate locating of the BCR2 and product relative to the bandsaw blade.
- Modify the product cradle so that it provides increased product rigidity for particularly large products, without negatively impacting the ability to clamp onto particularly small products.
- Identify and modify areas of “overdesign” from which weight reductions could be derived.
- Introduce practical carriage points.

The BCR2 will retain all of the safety benefits of the original machine, while further improving the opportunity for increased yield and making the machine easier and faster to operate and maintain.

## Project Milestones

### Research and Development

Having taken into consideration lessons learned from operating the original Beef Cube Roll Bandsaw Attachment (BCR1) at JBS, a number of improvement options were compared and the most viable solutions identified. Milestone 1 detailed the proposed upgrades to be introduced into the second generation Beef Cube Roll Bandsaw Attachment (BCR2).

The lessons learned from operating the BCR1 at JBS have informed the upgrades being designed into the BCR2. These upgrades included:

- The original linear round shaft and plastic bushings were replaced with a new linear motion rail guide and two independent linear rail bearing blocks. Despite being a more costly alternative, these linear rail bearing blocks have been used to great effect in other machines and have proven themselves to be reliable in harsh food processing environments and should not suffer from the same performance degradation over time, as the original plastic bushings did. This will reduce the various friction concerns, thereby making the BCR2 easier and faster to operate, while also improving rigidity of the machine and so assist with the consistency of the cut line.

- The underside of the original acetal board had no integrated friction reduction mechanisms and so would tend to stick to the bandsaw table. The introduction of a network of small stainless steel roller bearings elevated the acetal board up off of the bandsaw table and prevented this sticking, thereby making it easier to rapidly and accurately align the product relative to the bandsaw blade.

- The product cradles had an extended section installed onto them so that particularly large products would be supported along their entire (or as much as possible) length, preventing sagging and therefore reduced cut accuracy. This extended backing was configured in such a way that it will not interfere with the clamp's ability to shorten onto particularly small products.

- Wherever practical, any unnecessary material that had little or no benefit to performance or robustness was removed.

**Design and Detail Modifications.**

Having addressed identified deficiencies in the original BCR1, a fully developed design of the second generation BCR2 was generated.

Fig 1 and Fig 2 below depict the models of the original BCR1 and improved BCR2. The linear round shaft, plastic bushings, retaining wall and stabilizing wheels found on the BCR1 were replaced with a new linear motion rail guide and two independent linear rail bearing blocks.

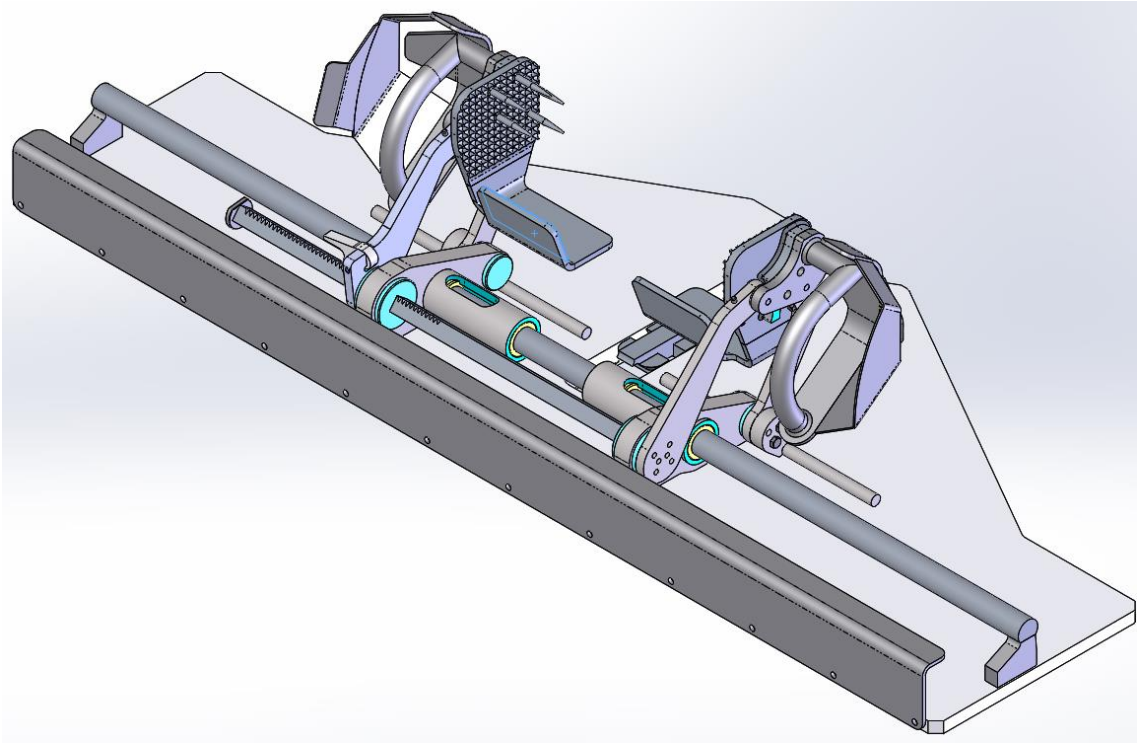

*Figure 1: BCR1 CAD model viewed from above*

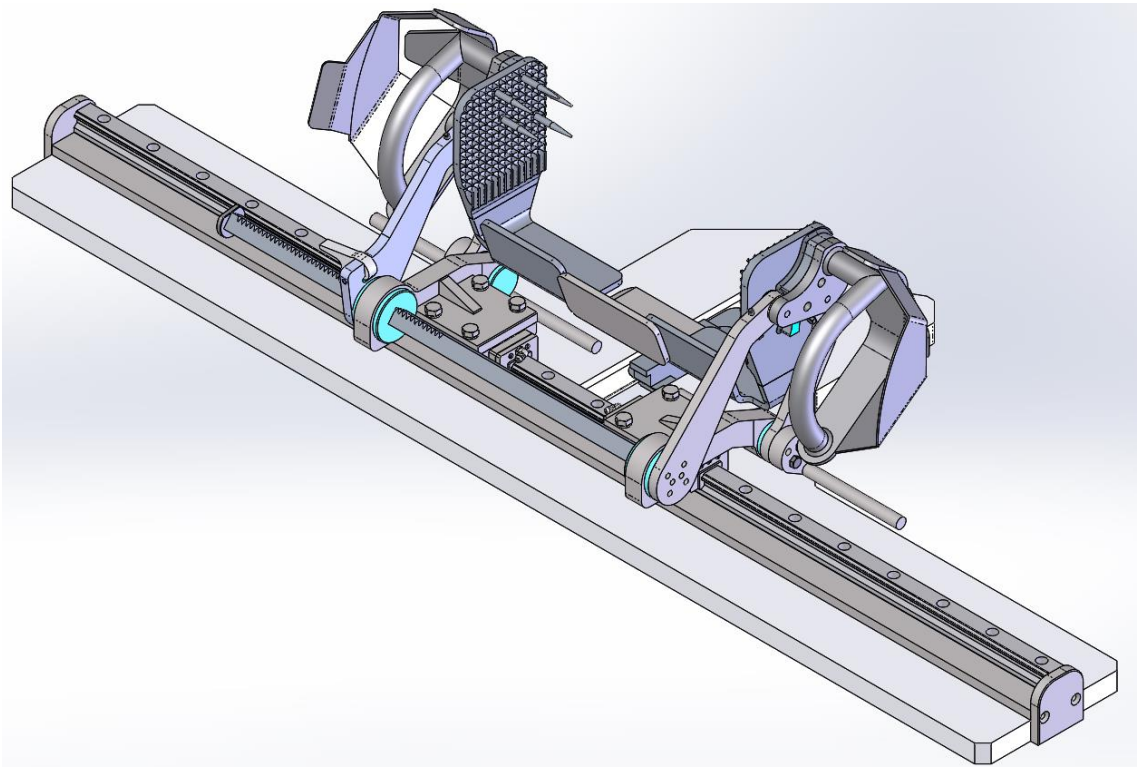

*Figure 2: BCR2 CAD model viewed from above*

Fig 3 shows the underside of the original acetal board which had no integrated friction reduction mechanisms. The introduction of a network of small stainless steel roller bearings, is shown in Fig 4.

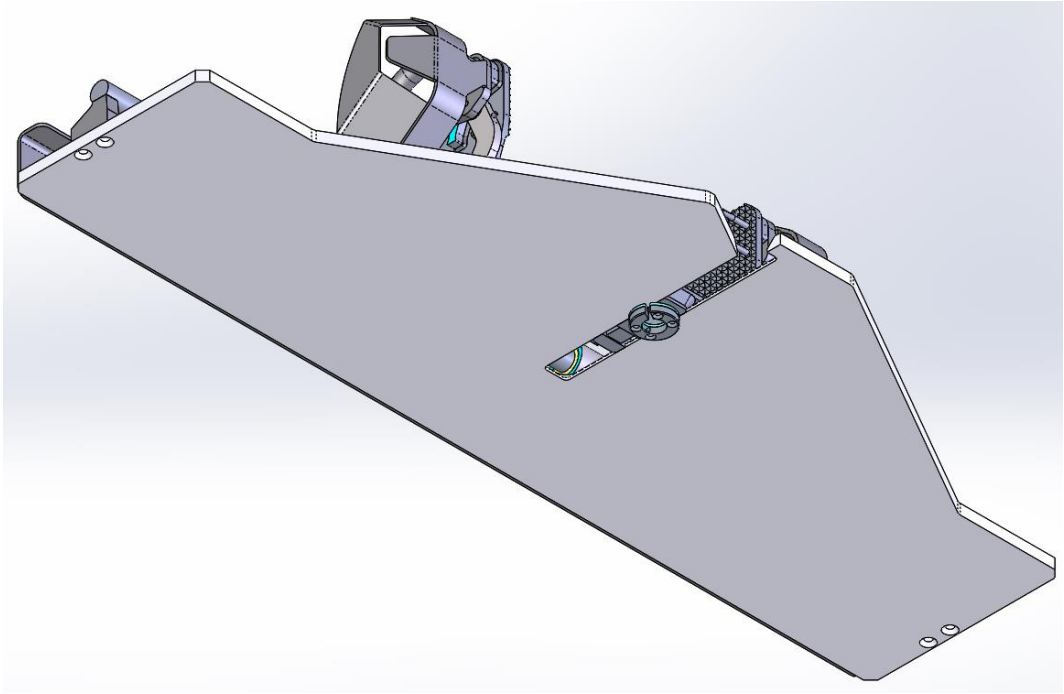

*Figure 3: BCR1 CAD model viewed from below*

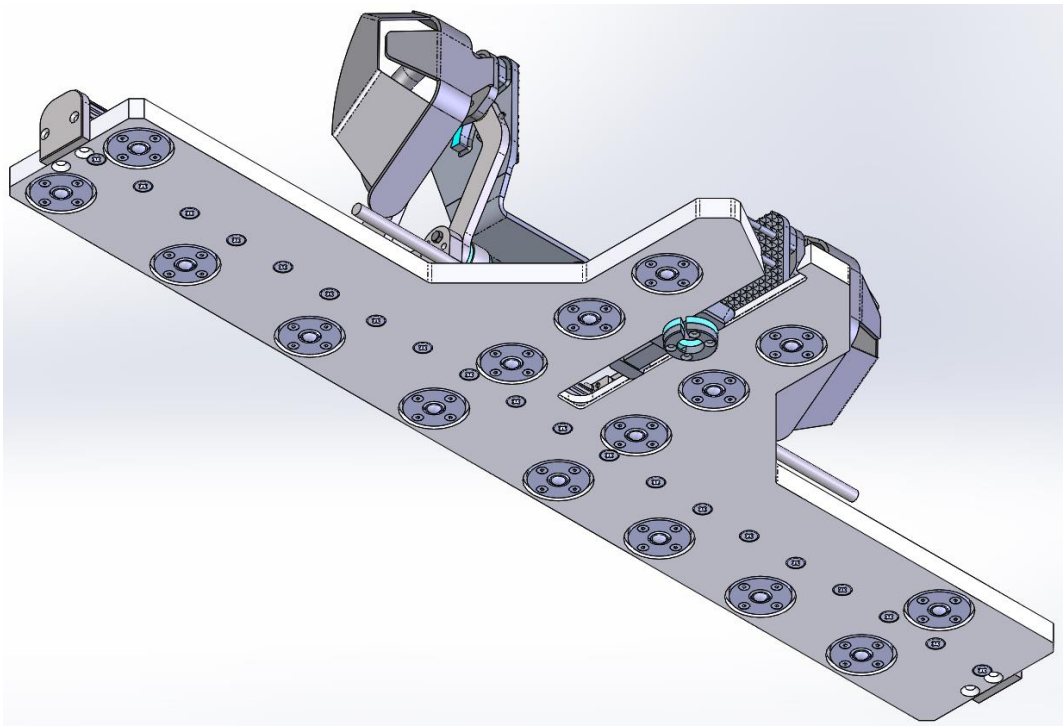

*Figure 4: BCR2 CAD model viewed from below*

The product cradles had an extended section designed into them so that particularly large products will be supported along an extended length to prevent sagging and therefore reduced cut accuracy. This extended backing was designed in such a way so that it will not interfere with the clamp's ability to shorten onto particularly small products. Additionally, the vertical height of the clamps was also be increased to accommodate larger products.

A significant amount of weight was designed out of the BCR2.

**Manufacture, Assembly and Factory Acceptance Testing**

The manufacture and assembly of the BCR2 was successfully conducted in line with the new design.

In house FATs were conducted to gauge the effectiveness of upgrades incorporated into the newly designed and built BCR2. Milestone 4 also included work that was required to fine tune the machine ahead of sending the unit to site.

Factory acceptance testing demonstrated (to a point) that the BCR2 is a significantly improved machine, over the BCR1.

The linear rail and bearings performed as well as expected, in line with similar earlier applications. The sliding resistance experienced was greatly reduced and would not suffer from degradation over time as was the case with the BCR1. Furthermore, the additional rigidity in the out of plane axes provided by the new sliding mechanism was expected to improve cut line and handling of the product as it passed through the saw.

The low friction roller balls installed into the base of the BCR2 acetal board also performed well. However, there was concern that they may in fact reduce the friction between the BCR2 and the bandsaw table so much that issues with keeping the BCR2 stationary during a production pass could arise.

The product clamps were successfully modified to allow for additional support of larger products. Increasing the size of the clamps made for very tight geometry around the BCR2's distinctive swinging cradle/clamp mechanism, it was decided that some fine-tuning of these parts may be required on-site and that the effectiveness of this upgrade will become apparent during the SATs.

The shipped weight of the unit was reduced by approximately 10kg.

**Installation, Commissioning and Production Trials**

The installation proceeded without incident or complication as the BCR2 has been designed to be a simple plug and play solution for a range of bandsaws. A single operator can carry and install the BCR2 without any assistance from others.

Once installed, the unit successfully met all site mandated OH&S requirements.

Operator and maintenance training was relatively simple for anyone who has already operated or maintained a regular bandsaw. None of the operators of the original BCR1 were available to test the improved BCR2. The first time operator and the attending engineer had the following feedback, observations and recommendations.

1. The roller bearings and lightweight design make the BCR2 (and product) relatively easy to position on the bandsaw table. Although this was a significant improvement over the BCR1, it remains slower than manual handling.

2. The new sliding mechanism makes it very easy to push the product through the bandsaw, the product clamps remained stable in orientation and smooth in operation even when loaded with product and when covered in saw dust during the production trial. This was another drastic improvement over the BCR1 which suffered from ever degrading sliding performance as it spent more time in a production environment.

3. The intra clamp locking mechanism (which was retained from the original machine) quickly began to seize up once reintroduced into a production environment. The intra clamp locking mechanism was therefore removed from the unit to allow the operator to more easily clamp onto the product. The negative impact of this was that the 2 clamps could rotate independently (with input from the operator), and there was no ability to lock the clamps together onto the product. These compromises were deemed acceptable and so the intra clamp locking mechanism was not reinstalled onto the BCR2 for the remainder of the trial.

4. The product clamps (even with the intra clamp locking mechanism) were not securing the product rigidly enough, which impacted on the accuracy and consistency of the cut line. This lack of product rigidity was due to the product being clamped by its soft tissue. Instructing the operator to mount hard flat surfaces (such as the spinal bones) of the product up against the flat surfaces of the clamps did improve rigidity slightly. This issue could be remedied by adding guides that lock the ribs in place on the product clamps.

5. The operator had problems developing sufficient grip on the product clamp handles. The handles could be improved by introducing ergonomic contouring and applying a high friction surface.

6. The operator noted that the cut line was difficult to sight as it passed through the bandsaw during chine removal. When the operator was asked to demonstrate a chine removal without the BCR2, the same orientation was used but the product was not as high above the table. The height of the product clamps seemed to be contributing to the operator’s sighting difficulty. This issue did not impact a taller operator, but the issue can be avoided altogether if the product clamps were designed to sit lower off the table.

7. The bandsaw used during the trial did not have the table extensions installed, as can be seen in Figure 5. However, this did not result in significant degradation in performance of the BCR2.

*Figure 5: BCR2 Installed onto a small bandsaw table*

8. As the operator had never used a BCR before, loading the clamps correctly required multiple attempts and as such this was initially a drawn out process. Loading time reduced as the operator's technique improved. The loading time was further reduced when the intra clamp locking mechanism was removed. Figure 6 below shows the operator loading the BCR2.

*Figure 6: BCR2 being loaded with product*

9. Issues arose during processing of “tomahawk” cuts. These cuts retain much of the rib section (220mm), which often did not fit in the bandsaw correctly without additional handling. Figure 7 through to Figure 10 show such a product that was cut to the desired rib length using the BCR2, but was subsequently too large to conduct the chine removal. Note that it was the blade guard and blade guide that were causing the interference on this saw.

*Figure 7: Product with large ribs loaded onto BCR2*

*Figure 8: Product with large ribs loaded onto BCR2 (Into Blade View)*

*Figure 9: Product with large ribs loaded onto BCR2 (Operator View)*

*Figure 10: Product with large ribs loaded onto BCR2 (Bandsaw View)*

This problem could be alleviated by redesigning the clamps to sit lower off of the table. Additionally, it was determined that with very simple modifications, the saw blade guide could be installed onto the inside of the bandsaw cabinet, and the saw blade guard could be completely removed, as can be seen from Figure 11. This would allow “tomahawk” cuts to be successfully processed with the BCR2 on this type of bandsaw.

*Figure 11: Proposed saw blade guide location*

## Production Trial Videos

There are 3 videos of the BCR2 during production trials:

1. Video 1 shows the removal of the ribs, which is quick and easy. Removal of the chine is interrupted when the operator repositions the sagging product in the clamps. This sagging was the result of camping onto the soft muscle tissue. The operator makes a number of exaggerated direction changes as he passed the product through the saw during the chine removal, this is due to operator inexperience. That being said, subtle mid-cut direction changes will ensure that the optimal cut location is achieved along the entire length of the cube roll, and so should be encouraged. This is a technique that operators will developed with practice.

2. Video 2 demonstrates the loading process, due to inexperience, the operator took 2 attempts to load the product clamps. Once again the product sagged as it was rotated. By this stage the chine removal pass had already improved significantly.

3. Video 3 shows the processing of a “tomahawk” cut. By this stage the pace of loading had improved, but the product was still sagging. The “tomahawk” length ribs can be seen contacting the blade guide as the chine removal process begins.

## Conclusions

It was immediately evident to the operator, floor supervisors and site management that the BCR2 provides important safety advantages over traditional manual cube roll processing.

Those who had observed the original BCR1 in operation were satisfied that the BCR2 is a significantly improved machine that is easier and faster to operate and that all of the upgrades add value and functionality.

The site has recently introduced a BladeStop onto their floor which is helping to reduce some of the serious injury concerns associated with bandsaw operations. Site management is planning on eventually replacing all of their bandsaws with BladeStops. The introduction of BladeStops encroaches on the safety advantages provided by the BCR2.

Site management noted that with the eventual introduction of additional BladeStops they don’t envisage a need for any additional BCR2s on their floor.

## Next Steps and Recommendations

The BCR2 has been handed over to the client and it will remain on site so that they have the opportunity to continue to use the machine on their non-BladeStop bandsaw.

Given the rapid uptake of BladeStop across the meat processing industry, it would seem prudent to ensure that any future BCRs are designed to be BladeStop compatible. For many operators, BladeStop provides an acceptable level of serious injury reduction for bandsaw operations. Therefore, to be of any value to industry, the focus of any future BCR development work should be on throughput and yield improvement, rather than the traditional safety focus.

There is an opportunity to apply learnings from this project to develop a semi-automated beef cube roll processing system.