Final Report

Frenching Scribe

Lamb Frenching Scribe (PoC)

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1.0 Executive Summary

After lamb racks (cap on) are discharged from the Scott Automated Middle system the racks are often required to be Frenched (cap on or cap off). This process is undertaken by operational staff, using a knife, with no real guide/measure of the Frenching distance (e.g. 50mm). This results in frenched length variation.

Frenching too much (results in lost revenue and potential customer complaints), Frenching too little (results in customer complaints). There is an opportunity to evaluate if the Scott automated middle machine can use its x-ray and vision modules to place a Frenching scribe line on the cap side of the rack.

This project was a PoC evaluation of using the Scott machine to scribe. It was always anticipated that if a successful concept was identified a second project would be required to implement the solution permanently.

As an aside, in parallel to this project devices and jigs that enabled staff to manually scribe a Frenching line were also evaluated at Brooklyn and Bordertown, and although these are also effective, ensuring staff use these manual devices regularly, consistently is proving to be a significant change management process.

During the further development of the Scott Middle machine an additional unit operation was developed for the middle machine – known as the “Sticky Rib” unit operation (Station 2).The unit operation was installed directly after the rack and loin flap cutting unit operation (Station 1). The purpose of this Unit Operation (Station 2) was to remove a short/stick rib from the rib (not the loin) for certain customers. This module (Station 2) is functional however not used every day. This Sticky Rib module will be used to evaluate the Frenching scribing concept, and may become a permanent scribe station.

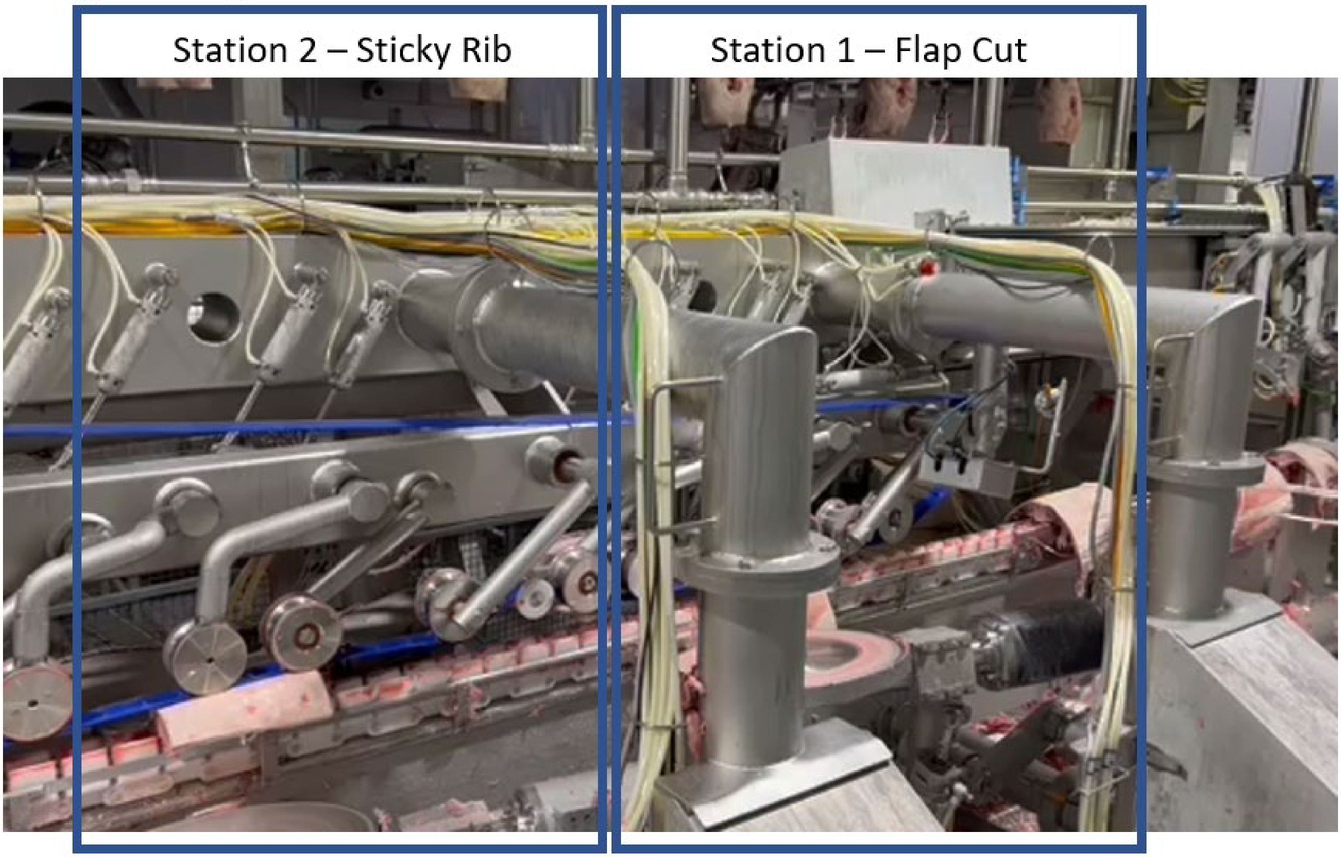


Figure 1: Current Scott middle machine station orientation

A video of both the current manual and automated trial proof of concept are provided as an addendum to this report. The manual process is depicted in Appendix 1.

The following depicts the initial concept at the time of project inception….

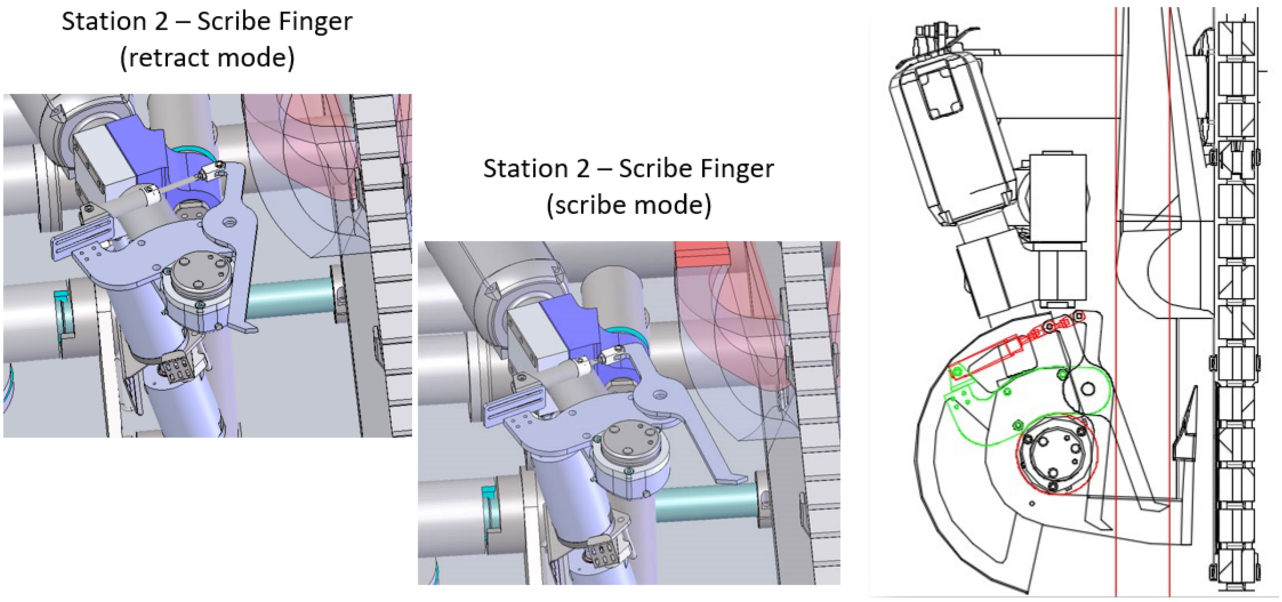


Figure 2: Concept at time of original funding application

Six methods for marking/scribing the Frenching line were assessed in relation to the existing manual process. The most notable constraints and trade-offs for the methods considered include:

- Bone deep vs shallow scribe and visibility to the Frenching operator
- High force vs lightly sprung and damage to product and hardware (incl reliability)
- Consumable vs knifed line in terms of ease of maintaining, use and cost of ownership
- Visual deterioration of rack when scribe line remains visible on the frenched rack product
- Complexity and robustness of solution in relation to parts that can go wrong and upkeep

A brief assessment of the suitability each method has to full range of frenched specifications and full range of rack saddle inputs is made as well as perceived effect on benefits such as knife work for Frenching operator and accuracy of Frenching line. Appendix 2 contains an analysis of the desk-top evaluation of the various methods.

From the results of the above process the project team agreed on a mechanical knife wheel with a set pressure as the method to pursue. This decision was based on:

- The solution has low complexity and is reasonably versatile for range of rack sizes
- The pressure required is less than a knife
- There are no continuous use consumables (only wear items as part of a PM schedule)
- The resulting mark has minimal effect on the final product if some of the scribe line remains
- With lower pressure we are expecting a reduced negative effect on product stability/location within the middle machine

A hand evaluation prototype was evaluated using a pizza cutter (refer Appendix 3). For these trials the project team built, implemented and evaluated a pizza cutter style evaluation prototype onto the stick rib module as depicted below.

2.0 Introduction

Within the lamb carcase the rack area is one of the more (and at times the most) expensive meat cut removed from the carcase. It also requires considerable additional labour to French the rack when a frenched rack is the required specification.

Although the industry is constantly evaluating how to automate Frenching, which will not only enable labour to be freed up and deployed elsewhere in the business, it will also optimise the yield of the process. In parallel to the longer term automated, or semi-automated process, our business is constantly evaluating ways to improve the manual process both from an operator welfare (physical and mental) and yield/accuracy perspective.

An example of the possible yield, through consistency of operations are pictured below…..

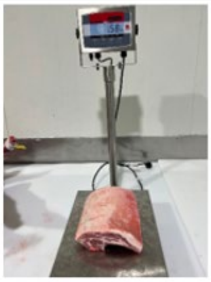
		
Rack from the Scott Machine	15.8 kg	Making two scribe lines @ 60mm and 50mm
		
Rack was frechned at the 60mm scribe mark with the intercostals and fat cap removed. 13.2kg	The rack was then Frenched at the 50mm mark	10mm Frenched product cap on weight (46g)
		
10mm Frenched product red meat weight (10g)	10mm Frenched product fat weight (38g)	

Figure 3: Evaluating the possible benefits of improve Frenching accuracy

The financial analysis of this consistent approach results in a per head benefit ranges from $0.27/carcase to $0.72 per carcase, depending on cut specifications.

3.0 Project Objectives

The project objectives were to evaluate if:

1. The Scott middle machine can place a Frenching scribe onto the lamb rack
2. If the resulting Frenching scribe improves processing specification compliance (and improves operators work environment, by removing the guess work).

The project outcome and deliverables are to provide a demonstration of how a scribe mark might be placed onto a lamb rack for Frenching and the benefits to operators and the business of providing a scribe mark.

The value proposition of the project and expected benefits are:

- Consistent customer French rack specification compliance
- Improved rack yield (and revenue)
- Improved operator operating environment (taking the 'guess' work out)

4.0 Methodology

With the benefit of an existing machine in operation, the methodology at a high level was quite straight forward as identified below.

- Part 1 – Undertake a brainstorming and desktop analysis of possible solutions/approaches (refer Appendix 2)
- Part 2 – Evaluate the preferred approach away from operations (review and revise as appropriate) (refer Appendix 3)
- Part 3 – Deploy concept and evaluation on system within a production environment. (refer Appendix 4)

4.1 Scott Middle Machine Modifications

Removal of the blade from Station 2 and replace with a scribe module and associated pneumatics as depicted below. Evaluate the system operating and tweak as required. Develop a permanent installation solution/plan if applicable. Remove system if not a sustainable solution.

4.2 Trial Method and Setup

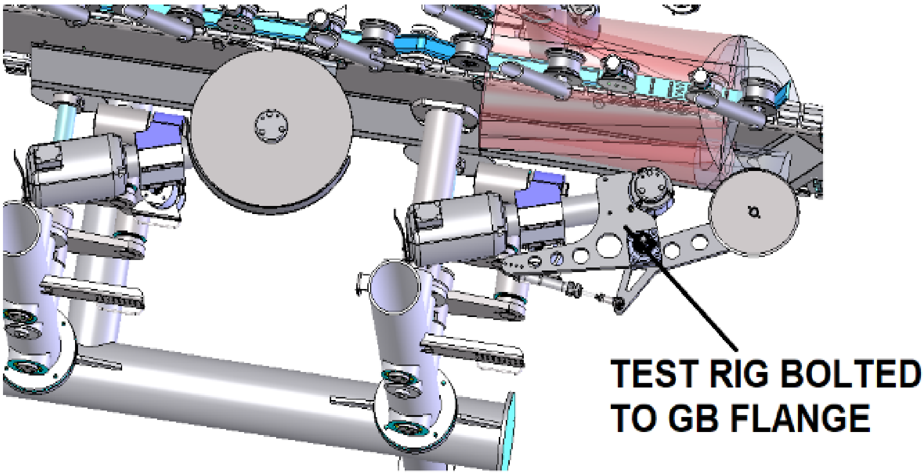


Figure 4: In situ trial concept

- A test rig was built and installed on the sticky rib gearbox flange for trials.
- Symmetry with same rig installed both sides of the Middle machine.
- Blade pivot controlled by a Ø25 air spring and precision regulator.
- Pneumatics were plumbed into Middle machine supply air with a maximum of 0.5MPa available.
- Free spinning idle shaft to attach blades.
- Test rig blades set to same height as sticky rib blades.

5.0 Project Outcomes

The proof of concept has been a success overall.

The first in situ trials were based on application of a Ø250 x 3mm Stainless blade (shown further down the page) installed on the middle machine and used to process approximately 30 rack saddles. During the trials various pressures were applied to adjust the normal force of the blade against the rack cap surface.

Learnings were as follows:

- ➢ Test rig geometry works well with varying shapes and sizes. Trialling pivot blade moved and conformed to unique rack shape.
- ➢ Test rig was reliable and did not de-rail product off chain.
- ➢ Precision regulator provided quick response and constant scribing force throughout stroke.
- ➢ The blades lowered too early to get into its bypass position. The blades would lower while the blade still had 10mm left to scribe. This can be solved in the next stage with PLC code.
- ➢ Loin De-boner blades were not sharp enough to penetrate the fat cap at max available machine pressure (0.5MPa). It left a 'bruised' mark but after a few minutes (by the time the rack reached the Frenching tables) this bruise line had recovered and was difficult to see.

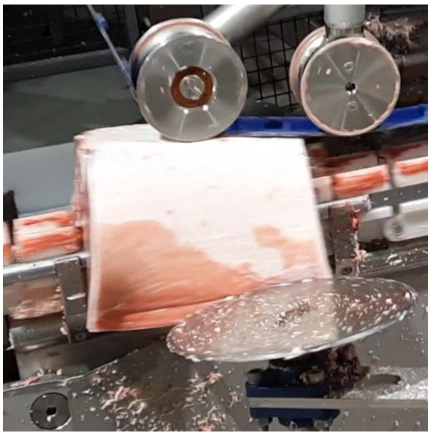


Figure 5 - Loin De-boner blade scribing a 'bruised' mark on fat cap @0.5 MPa.

Figure 6 - 'Bruised' mark less visible after 1 minute. Line becomes more difficult to see as fat cap ‘springs’ back

The second in situ trials were based on application of a Ø100 x 1mm (Pizza cutter) Stainless blade (shown further down the page) installed on the middle machine and used to process approximately 30 rack saddles. During the trials various pressures were applied to adjust the normal force of the blade against the rack cap surface.

From the second round of trials the project team found the following:

- The product being run at the time was well set with a thick layer of fat cap and full cover of red skin.
- Pizza blades were able to penetrate fat cap and leave clean clearly visible scribe marks.
- The thin thickness and steep angle of the knife edge allowed the blade to slice into the fat cap.
- A few repetitive tests at varying pressures indicated that 0.4MPa with the Ø25 air spring, geometry and blade used was likely optimal for penetrating the fat cap and carving a permanent shallow inscription.
- It appeared from the limited number of product trialled that the thin blade was not overly strained.
- It was supposed that an ultimate solution based on a thin circular blade could be optimised through a design that allows pressure to be adjusted to an optimal level to suite a full range of product. This would likely involve upsizing the available force that can be attained with the Middle system supply.
- A more robust blade that mimics the edge profile of the pizza cutter is recommended.

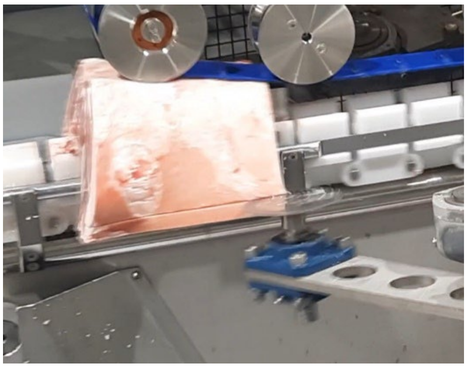


Figure 7 - Pizza cutter blades scribing rack @ max pressure (0.5MPa)

Figure 8 - Scribe line from pizza blade from trial

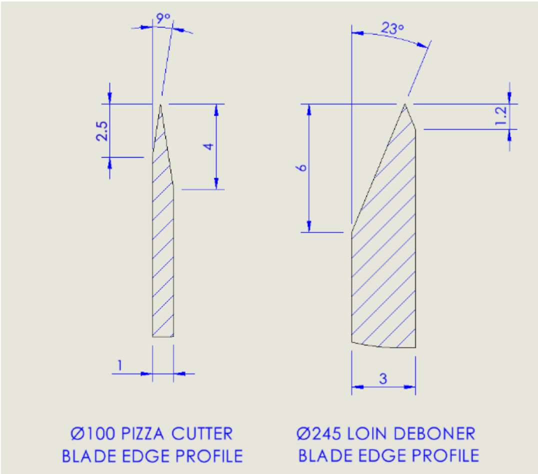


Figure 9 - Different blade edge profiles

6.0 Discussion

Trials with two blade variants and around 60 rack saddle products have provided insight into a concept that shows significant promise of achieving the overall objectives of Rack scribing as well as important learnings that will guide the development of a prototype scribe module.

It was shown that a thin circular knife blade with the correct normal force against the surface of the rack fat cap produces a shallow visible scribe mark with relatively low complexity and with minimal risk of introducing instability to the existing machine process.

Whilst the small number of product tested means there are still residual risks such as force vs full range of product sizes, performance over time, performance under full range of process variables and any stability issues that may result on the outlier product variants, the results show that these risks are likely minimal and it is recommended that a prototype stage 1 should be considered that will enable any residual risks to be fully tested and mitigated.

The next step will be Stage 1 - design and build the first production fixture for Brooklyn Middle machine based on the learnings from these initial trials. Below is a rough concept of the production prototype and the key features and improvements this fixture has.

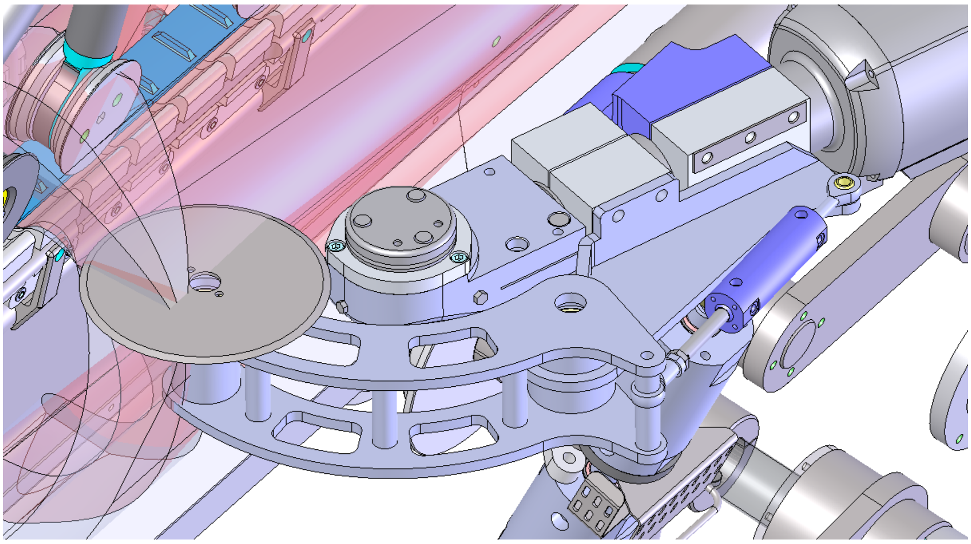


Figure 10 - Concept production prototype for JBS Brooklyn

Prototype design critical features

- Custom 3mm blades with the same edge profile as the pizza blades. This increase in thickness will increase the blades operation life and robustness to crashes.
- Stainless steel fabrication with washdown seals for bearing protection.
- Standard SMC washdown cylinders

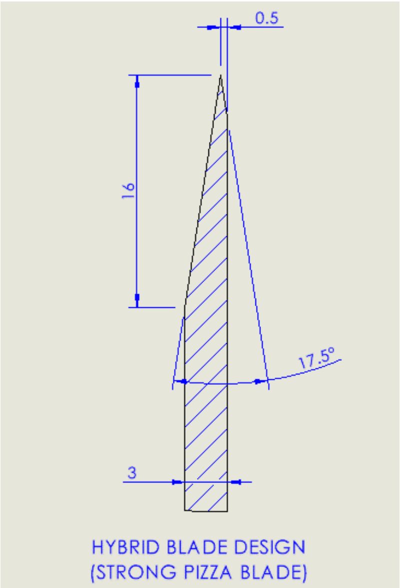


Figure 11 - Blade profile

Considerations for new design

- Ability to leave the rack scribe fixture attached when using the sticky rib flap cut.
  - Does the fixture need to be attached permanently? (Only swap blades to change between scribe and sticky rib cut)
  - Or can it be a separate fixture that needs to be attached or removed to use either device?
- Ability to control the scribe depth using a sandwich plate blade design.

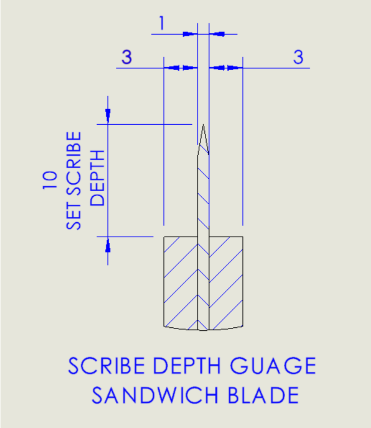


Figure 12 - Concept idea to control the scribe depth.

7.0 Conclusions / Recommendations

This proof of concept stage project was successful. JBS and Scott are currently developing a Stage 2 deployment submission for AMPC consideration

8.0 Appendices

8.1 Appendix 1 – Manual Process

Below shows the process used for boning the French rack:

<u>Cap On</u>

1. Manually slice Along French rack position and remove
2. Remove intercostal meat

<u>Cap Off</u>

1. Remove Fat Cap
2. Manually slice along French rack position and remove
3. Remove intercostal meat

<u>Denuded</u>

1. Remove Fat Cap
2. Fleece muscle along ribs??
3. Manually slice along French rack position and remove
4. Remove intercostal meat

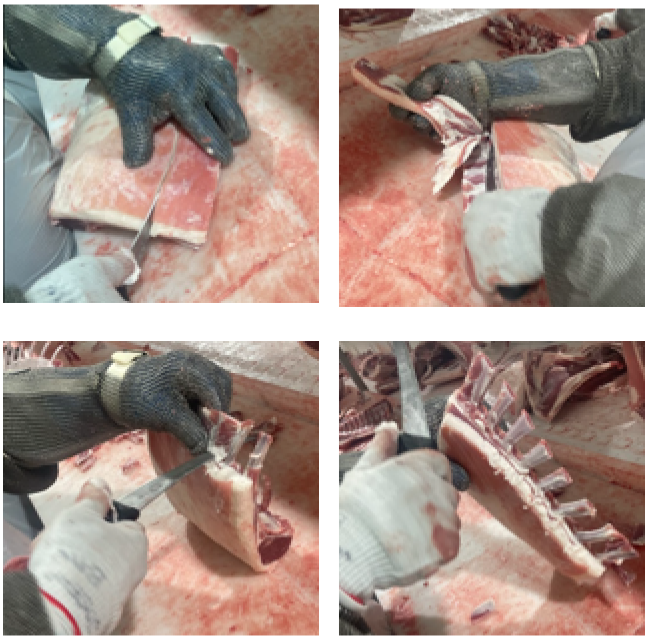
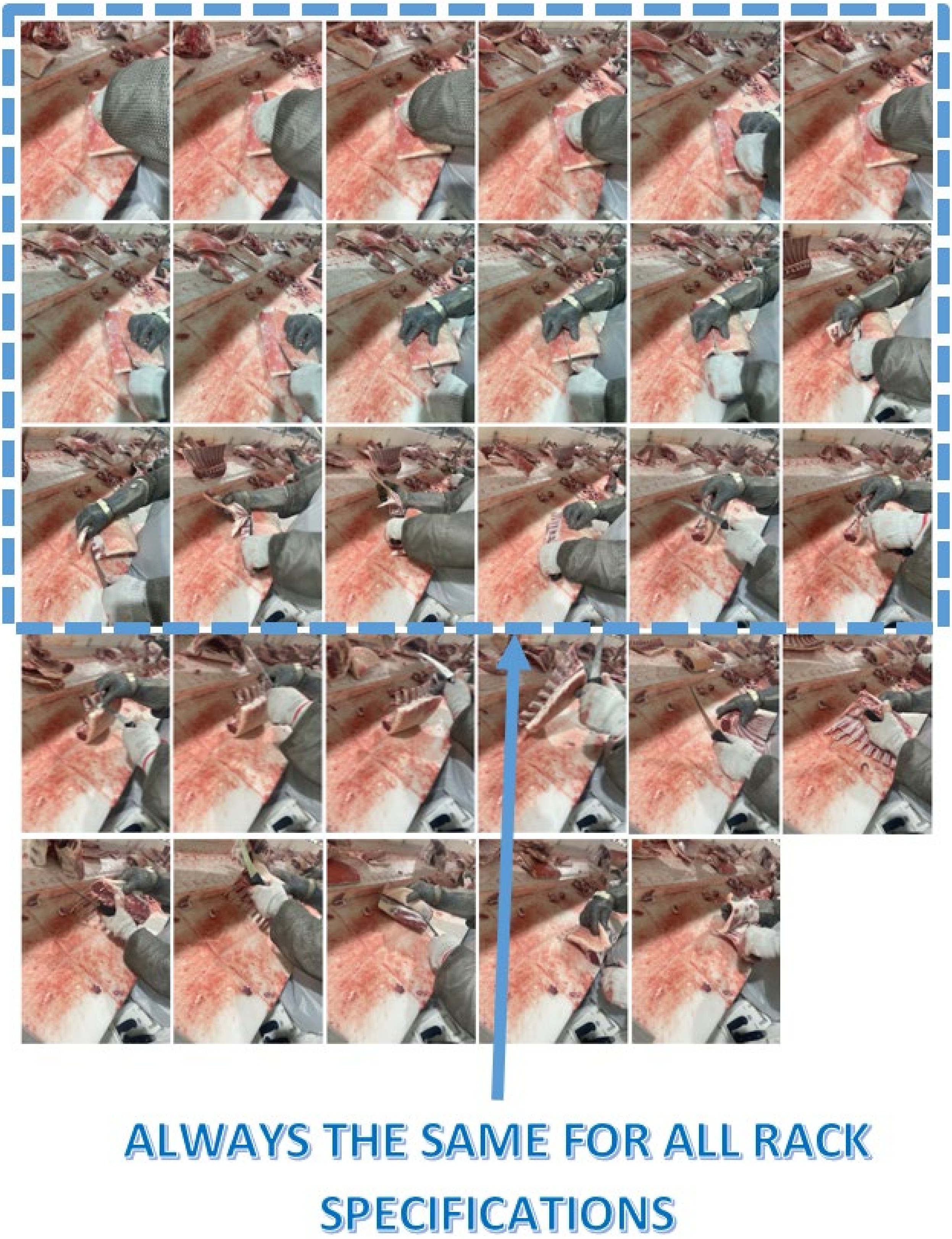


Figure 1 – Method to French the rack. The initial cut will need to be made before removing the fat cap

If implementing the rack scribing mark on the fat cap, the French cut will need to be done first before fat cap removal. Otherwise, the French scribing mark will be removed before it can be used.


ALWAYS THE SAME FOR ALL RACK
SPECIFICATIONS

8.2 Appendix 2 – Approach evaluation (desk top)

Trial Process/Device	Complexity	Consumable	Mark Visibility	Pressure	Product Stability
Pizza Cutter	**LOW** -Spring force used to contact product. No laser scan or servo axis required	**NO**	**MED** -A mark is visible but small in thickness due to thin blade	**Est 5-10 kg**	**LOW** **-**Medium force is required to mark. May cause product instability on chain
Pizza Cutter + Ink	**MED** -Spring force used to contact product. No laser scan or servo axis required. Ink will need to drip onto cutting edge which may be difficult an unreliable	**YES** **-**Ink line may have negative impact when selling	**HIGH** -Ink mark is very visible	**Est 1-2kg**	**LOW** **-**Medium force is required to mark. May cause product instability on chain
Circular Knife (drill powered)	**LOW/MED** -Spring force used to contact product. No laser scan or servo axis required. Powered motor used to rotate blade to help mark	**NO**	**MED/HIGH** -Thick steep angle of blade created a deep groove that was visible	**Est ~5kg**	**MED** **-**Low force is required to mark. Less likely to cause product instability on chain
Sharpened Steel Bar	**LOW** -Spring force used to contact product. No laser scan or servo axis required.	**NO**	**MED** **-**	**Est ~10-15kg**	**LOW** -High force is required to mark. Less likely to cause product instability on chain
Sharpened Steel Bar + Ink	**MED** -Spring force used to contact product. No laser scan or servo axis required. Ink will need to drip onto cutting edge which may be difficult an unreliable	**YES** -Ink line may have negative impact when selling	**HIGH** -Ink mark is very visible	**Est 1-2kg**	**LOW** -High force is required to mark. Less likely to cause product instability on chain
Spray Mark Device	**High** -Spray marking requires a very precise distance from the nozzle to the fat cap. A laser scanner and an external servo axis will be required.	**YES** -Ink line is thick and will be visible to the customer	**High**	**0kg**	**HIGH** -There is no external force on product

8.3 Appendix 3 – Manual off-machine evaluation

Below shows the equipment and trial results from scribe marking using manual tools.

Figure 1 - Scribe Mark from Pizza Cutter. Line is visible but a medium force is required.

Figure 2 – Scribe Mark from Pizza Cutter with Ink in cutting edge

Figure 3 -Scribe Mark from Sharped Steel Bar. Line is visible but a high force is required due to friction forces

Figure 4 -Scribe Mark from Sharped Steel Bar with Ink on tip

Figure 5 -Scribe Mark from Rotary Cutter attached to Drill. An extremely low force is required due to the rotating blade

Figure 5 -Spray marking device like the one used for carcass marking trials and Gundagai. ***This was not used for our initial tests***

8.3 Appendix 4 – In situ machine trial configuration