Final Report

AUSTRALIAN MEAT PROCESSOR CORPORATION

Mechanical Lamb Frenching

Waterless Mechanical Lamb Frenching – Stage 3 – Alpha prototype

Project code
2021-1183

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1.0 Abstract

The main objective of this project was to develop, with associated trials, a first off concept prototype machine to demonstrate Frenching racks, with intercostals removed in one piece and without the of use of water. Where the development would be suitable for a future commercial production machine.

The problem being addressed is to establish an automated Lamb rack Frenching process to ideally improve product quality and reduce labour demands and cost to the Australasian lamb industry.

The project proposed a machine concept that would give a production rate of 10 racks/min with various clamping, intercostal removal and delivery stations.

The methodology used included research of the prior art, including project 2014-1056, trials of hand tools and prototype test rigs, both in the workshop and at a processor site.

The trial results from the various project stages indicated unacceptable variability in performance and identified the intercostal strength as the key issue. The plethora of contributing factors was extensively explored in each subsequent stage without a satisfactory conclusion.

It is recommended that the next steps are two sequential projects.

1. Intercostal removal mechanism benchtop development and process strategy validation.
2. Further development of a concept prototype machine, adjusted to suit stage 1 outcomes.

It is estimated that a machine like this could cost \$1.5 - \$3M, save 6 boners and have a payback of 2.5 – 5 yrs.

2.0 Executive summary

2.1 Main research problem being addressed in this project

A significant value in the lamb meat industry is derived from the premium obtained from the lamb rack. The lamb rack market is predominantly for “Frenched rack”. Where the “Frenching length” is typically 40 or 50mm. The most desirable frenched rack is where for the Frenched portion, the bones are clean. Cleans bones are readily achieved with known water Frenching. But water Frenching introduces issues, including, the loss of value from the discarded intercostal meat and degradation of shelf life due to the water contact. The knowledge gap is, how to automate Frenching, without water contact, achieve quality equivalent or better than the current manually frenched product and with acceptable capital payback.

The main question being asked is what processing strategy is best employed and what are the key clamping, sensing, cutting and transport elements required for the prototype automated machine.

2.2 Main target audience

The main target audience is Australasian lamb meat processors. The Australasian lamb meat processors are driving for reduced cost, improved benefit and are under labour constraint challenges.

2.3 Consequence for industry stakeholders

The results of the research will be used to progress the development of a commercial lamb rack Frenching automated solution. The goal is to create a solution that enables processing Frenched racks with significantly reduced labour input and associated machine payback.

2.4 Objectives

The objectives of the project were:

- Preliminary design to address feedback from the concept prototype (previous project)
- Design a mechanism that removes the intercostals.
- Design a first off concept prototype machine to demonstrate Frenching racks without the of use of water. The concept prototype machine is to be based on the concepts developed under project 2014-1056.
- Trial the first off concept machine at the Scott factory and then at a processor site.
- Make any refinements to ensure that a commercial machine can be designed suitable to roll out to industry.

A prototype jig was developed to validate the removal of the intercostals.

This developed process and proposed concept machine does not use water. The test rig accurately represented the proposed process.

The waterless Frenching test rig was trialled at the Scott factory and relocated to a processor site and trials performed.

A significant process of trials, refinements and repeated trials was performed. The problem has repeatedly been shown to be very difficult, particularly subject to significant variation in the intercostal connection strength. After exploring many alternative solutions and fundamental research this project was unable to confidently establish the optimum process and associated tooling that would be suitable for the development of a commercial machine.

2.5 Methodology

The methodology employed included:

- Background research of prior art, notably previous Frenching projects. A quality standard was established to enable consistent evaluation of results.
- Creation and proposal of process elements, manufacture of test rigs with the created process elements and trials and results analysis.
- Literature research of the published theories regarding the intercostal connection strength and associated investigative experimentation.
- Creation and review of lamb rack Frenching processes.
- The inclusion of Australian product variation into the trials by shipping Australian product for trials on the test rigs at the Scott factory.

2.6 Results

The development through the project and associated trial results have shown an improvement in beneficial quality. Particularly the broken bones and associated loss of product is now near zero.

Significant work has been done to maximise the performance of the mechanised process and minimise the variation. Some products are processed with clean bones and result in directly packable product of exception quality. But results now indicate that the connection of the intercostal to the rack rib is highly variable. In significant number of cases the soft tissue is torn, leaving variable quantities of soft tissue on the bones necessitating rework. The rework time required varies from reducing the benefit to being a loss.

2.7 Benefit to industry

It is estimated that a waterless Frenching machine could cost $1.5 - $3M

Payback, based on estimated labour saving, would be 2.5 – 5 yrs.

2.8 Future research recommendations

It is recommended that the next steps are two sequential projects.

3. Focused benchtop development and consequential overall process strategy validation.
4. Further development of a concept prototype machine, adjusted to suit stage 1 outcomes.

3.0 Introduction

A significant value in the lamb meat industry is derived from the premium obtained from the lamb rack. The lamb rack market is predominantly for “Frenched rack”. Where the “Frenching length” is typically 40 or 50mm. The most desirable frenched rack is where for the Frenched portion, the bones are clean. Cleans bones are readily achieved with known water Frenching. But water Frenching introduces issues, including, the loss of value from the discarded intercostal meat and degradation of shelf life due to the water contact. The knowledge gap is, how to automate Frenching, without water contact, achieve quality equivalent or better than the current manually frenched product and with acceptable capital payback.

The main question being asked is, what processing strategy is best employed and what are the key clamping, sensing, cutting and transport elements required for the prototype automated machine.

The main target audience is Australasian lamb meat processors.

The results of the research will be used to progress the development of a commercial lamb rack Frenching automated solution.

4.0 Project objectives

The overarching objective of this project was to develop, construct and trial a concept prototype standalone lamb Frenching machine with a small footprint that can operate without the use of water and demonstrate Frenching at up to 10 racks per minute and retrieve the intercostal in a "dry" state that can be recovered as a saleable meat product.

The following key objective components will be undertaken:

1. Preliminary design to address feedback from the concept prototype (previous project)
2. Design a first off concept prototype machine to demonstrate Frenching racks without the of water based on the concepts developed under project 2014-1056.
3. Trial the first off concept machine at the Scott factory and then at a processor site.
4. Make any refinements to ensure that a commercial machine can be designed suitable to roll out to industry.

5.0 Methodology

5.1 Background:

There are several manual Frenching methods; knife, peel from the rib end and the string at the Frenching line that has been demonstrated online by several different chefs.((CAFEmeeetingplace, 2003), (Kitchen, 2014), (Malcolm, 2013)). The ideally the result has “clean bones”, similar to water Frenching quality.

5.1.1 Established quality standards

A quality standard and associated benefit model was established to enable the determination of overall benefit, including the contribution of variable output quality.

The standard was used throughout all project trials.

5.2 Further development work in pursuit of finding solutions to residual issues.

1. Identify residual issues, propose solution(s), develop the most likely solution(s) to enable building test apparatus and performing evaluation trials of the solution principle. Includes:
    a. Further improvement to rig
    b. Rib position vision system feasibility study
2. Publish trial performance results as per agreed quality standards.

5.3 Parallel path concept work

1. Establish and publish likely candidates for alternative waterless Frenching means
2. Select most likely candidate and develop a bench top test rig
3. Perform trials through the bench top test rig and present qualitative results

5.4 Shipping Australian product to Scott Dunedin facility for testing

1. Purchase product from Australian processor. Ideally biased towards the larger products.
2. Locally CT scan the Australian products to add to the product CAD database.
3. Perform trials through the “press” test rig, configured as per the most successful configuration.
4. Perform trials, with Australian product, through the Parallel path test rig.

6.0 Results

6.1 Further development work in pursuit of finding solutions to residual issues.

6.1.1 Further improvements to rig

Results from the “at processor trials” were largely aligned with the results established with trials performed at Scott factory. However, with the greater quantity, the variation across grades, cut specifications and conditioning, the key issues were very evident. The trial was completed as the season came to an end and the test rig relocated back in the Scott factory.

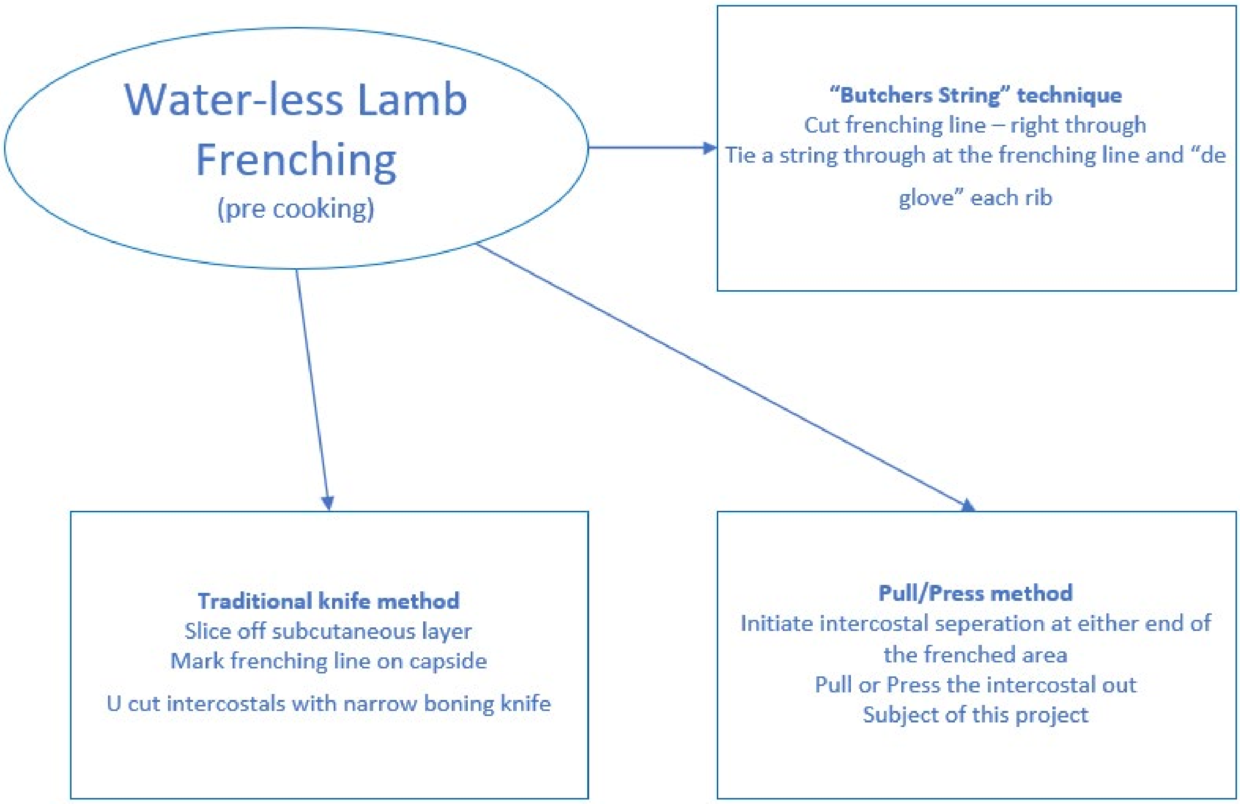
6.1.2 Rib position vision system feasibility study

6.1.2.1 Scope and solutions

The scope was to investigate possible Vision strategies for locating the required features. Including hardware choices, camera locations, software solutions and any other vision requirements.

6.2 Parallel path concept work

6.2.1 Establish and publish likely candidates for alternative waterless Frenching means



The core of the problem is to deliver a product at least as clean and accurate as the manual Frenching standard.

6.3 Shipping Australian product to Scott Dunedin facility for testing

6.3.1 Purchase product from a Australian processor. Ideally biased towards the larger products.

40 racks were purchased from an Australian processor, vacuumed packed, chilled and shipped to Scott Dunedin.

6.3.2 Locally CT scan the Australian products to add to the product CAD database.

The products were all put through the local CT scanner. This enables using accurate Australian product data for 3D CAD design.

Figure 1: Product through the CT scanner

6.3.3 Perform trials through the "press" test rig, configured as per the most successful configuration.

10 Australian products were put through the waterless Frenching test rig.

7.0 Discussion

7.1 General

The project has firmed up on the product specifications based on feedback from a New Zealand and a Australian major processor.

The Australasian requirement is to process Cap Off product

Ideally, for 10% of Australian product, cap on could be processed, but not a requirement.

The requirement is to process: 50mm & 40mm frenched from 75mm rib length racks and 50mm frenched from 100mm rib length racks.

There are other lengths produced in insignificant numbers.

There is market pull for: clean bones, correct Frenching length, straight cut at the Frenching line and tidy. Ideally no residual soft tissue, that would blacken on cooking (this would be an approvement on the current knifing process).

7.2 Further improvement to rig

The final trials with the developed waterless Frenching strategy indicated further improvement is required before the waterless Frenching process could be confidently used for the prototype automated machine development.

7.3 Rib position vision system feasibility study

A significant challenge is the camera placement to get an optimum view.

7.4 Parallel path concept work

Parallel path concept work was performed. A machine concept was formulated. Where the machine concept has potential to be very elegant and cost effective. The main knowledge gap would be removing the sub-cutaneous layer. Solutions, with some experience, have been proposed.

7.5 Trials on Australian product

Australian products were shipped to Scott Dunedin plant. There were differences noted, such as increase in variation in size and geometry (in connection with clamping). Trials through the developed test rigs weren't significantly different in the key metrics.

7.6 Processor business case

It is estimated that a waterless Frenching machine could cost $1.5 - $3M

Payback, based on estimated labour saving alone, would be 2.5 – 5 yrs.

8.0 Conclusions

The main objective of this project was to enable the implementation of automated lamb rack Frenching, without the use of water.

The project scope included the development of benchtop test rigs and the performance of the solutions establishment with trials. It was intended that the discovered solutions would be validated and suitable for the design and build of a concept prototype machine.

A significant number of benchtop and prototype test jigs were designed, developed and tested. Various problem solving and solution exploration tools were implemented. The activities included extensive theorisation, multiple solution paths explored in parallel and associated test rig development and trials.

The finding of a solution with acceptable performance was significantly more difficult than envisaged. The key characteristics of the problem included product related variability. The variability extends the scale of the solution candidates and experimentation that is required to form a robust determination.

Unfortunately, the main objective of the project has not yet been achieved. The project scope was research and development, with the associated uncertainties. The performance of the explored process candidates, in the project, was not appropriate for moving through into the development of the concept prototype machine.

The project work, with the extensive parallel path research and experimentation, has significantly contributed to the project topic learnings.

Given the project learnings, a path forward, of the most likely solution, has been established. The recommended path forward is to perform further benchtop rigs and trials for validation of the problematic portion of the process and then the development of concept prototype machine. Where the concept prototype machine as a forerunner to a commercial machine.

9.0 Recommendations

It is recommended that the next steps are two sequential projects.

1. Focused benchtop development and consequential overall process strategy validation.
2. Further development of a concept prototype machine, adjusted to suit stage 1 outcomes

10.0 Project outputs

Outputs (tangible deliverables) delivered during the project include:

- Technical reports for milestones 1 – 7, summarising options evaluated, results from trials and recommended future paths of research
- Data has been collected for the various research, alternative solution evaluation and experimental activities and analysis performed. Presented in the technical reports in various tabular and graphical formats.
- Multimedia documentation: video has been supplied with the milestone reports to document the summary of key trials and associated performance.
- Test rigs have been built throughout the project and used for physical experimentation and establishment of proposed solution performance.

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12.0 Appendices

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