final report

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Cold Rib Deboning – Final Report

A terminated project

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Abstract

Based on the successful manual assist Scott Technology beef hindquarter and aitchbone device, N S Innovations (a joint venture between Scott Technology and NCMC) attempted, unsuccessfully, to apply the same enabling platform technology to the task of beef cold rib deboning.

Executive summary

NSI approached developing a manual assist solution to the 'cold rib' deboning task using the platform technology developed for both beef aitchbone and beef knuckle deboning.

When the original platform was developed there where three key areas of focus as depicted in Figure 1.

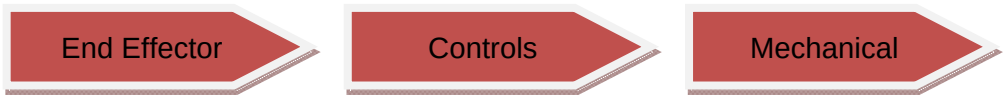


Figure 1: Puller Development Areas

The development of the cold rib solution focused on the first two areas and attempted to use the existing puller platform in an aim to fast track and reduce R&D costs. This in hindsight may now have been a limitation to ultimate success.

In addition to the approach being a potential limitation to success, various technical developers (i.e. individuals) have been involved over the past two years, in a stop / start way resulting in some lessons learnt being lost and frustration felt with NCMC operational staff and now potentially a loss of desire to develop a solution.

NSI engineering and NCMC operational team (i.e. the project team) reviewed the development history and determined that the project was not worth pursuing in its original format and as such the project was terminated.

An alternative approach has been indentified and detail in the conclusions and recommendations section, however at this point in time NSI has decided to focus on other developments in the near future and place this concept on hold for at least 12 months.

Contents

1 Background

In 2008, MLA in conjunction with Scott, NCMC, TEYS and industry partners completed the successful development of an operator aid (manual assisted device) to reduce the operator effort required to undertake two of the top three most strenuous beef hindquarter boning room tasks. The preliminary R&D projects resulted in five Australian meat processing companies working with MLA and Scott (a New Zealand Solution provider) to develop a system that has now been successfully installed, trialled and independently evaluated in two meat processing plants. In total over 25 installations have occurred globally. Of these five original meat processing companies NCMC and Teys have installed systems.

1.1 Benefits

An independent party (Greenleaf Enterprises) has completed an analysis of all developed systems and the resultant is that both the Scott and Proman approaches improve long-term yield and reduce operator fatigue and arguably OH&S issues. In some cases the Scott system has also increased chain processing speed and reduced the total labour required in the boning room. With Teys having installed a Scott and a Proman system in the one location a comparison was undertaken between the two units and the Scott developed machine yielded better results from a yield improvement and operator feedback perspective on useability. As a result MLA is now focused on ensuring the Australian industry is aware of the benefits of the Scott developed equipment. The indicative yield increase at NCMC resulted in a $4.53 head profit increase (refer Feedback magazine June/July 2009).

1.2 How has the project “come about”?

Previously MLA had worked with the industry to identify and measure the most arduous beef boning room tasks. Figure 1 summarises the findings.

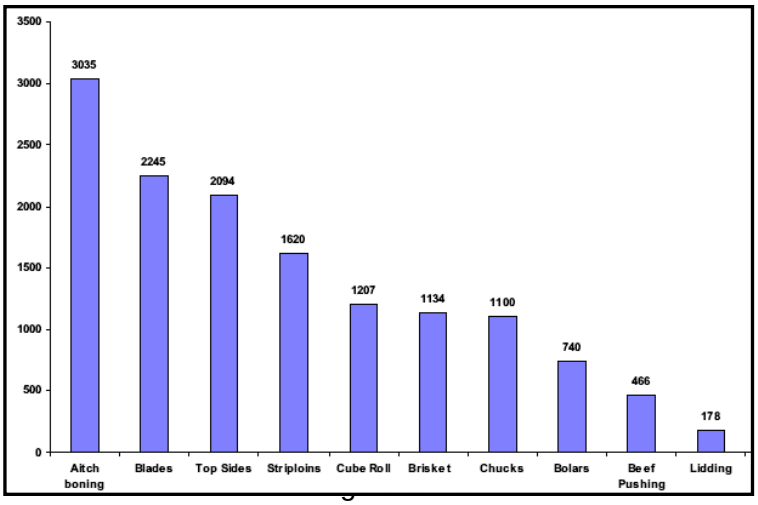


Figure 1

This data was used to identify the first manual assisted task (aitch boning) which has been successfully completed. NCMC and MLA are now considering what other hindquarter applications the developed platform could be developed to assist. With respect to the forequarter, NCMC along with Scott and MLA are wanting to commence investigating other potential applications for the developed platform. The first task that the project team has identified in the forequarter region of the carcase is cube roll removal – depicted above as the second most arduous task in forequarter boning.

As such this project aimed to take the lessons learnt and approach from the successful hindquarter developments and investigate the development of a similar system for cold rib deboning/fleecing of the cube roll.

2 Project objectives

At the completion of the Project, NSI will have completed the following to MLA's satisfaction:

- Complete design of pulling prototype for cold rib deboning,
- Manufacture & develop the prototypes, and
- Demonstrate prototypes working in the NCMC boning room.

3 Methodology

3.1 Phase 1 & 2 – Multiple paper sketches and designs with example system workings demonstrated

NSI developed multiple idea sketches to determine all the possible combinations and layouts that may work for the system

NSI operated from NCMC engineering service shed to develop agricultural examples of identified preferred system concepts and trial both in the engineering services shed and if applicable on the operations floor.

3.2 Phase 3 – Detailed design and costing of preferred solution (includes pre-project cost benefit analysis)

After the trial systems had been developed and evaluated, a preferred design was identified and NSI undertook the required detailed engineering and system costing.

Simultaneously, Greenleaf Enterprises will undertake pre-project yield analysis to enable NCMC and MLA to undertake a pre-project cost benefit analysis.

GO – NO Stage – NCMC (Gary Burridge) and MLA (Joshua Whelan) to agree, via email, to progress to phase . This will be based on the cost benefit analysis results (CBA)

3.3 Phase 4 – Design and manufacture of first unit to food grade specifications (lab prototype)

NSI to manufacture, install and commission first unit. NSI to engage MLA appointed ergonomics advisor to comment on design prior to manufacture.

NCMC production to assist NSI in the installation of system

Once the system is installed, NCMC will work with NSI to identify deficiencies and improvements required for next machine iteration.

3.4 Phase 5 – Design and manufacture of first food grade production prototypes(s)

NSI will utilise the learnings to modify the existing lab prototype and manufacture up to five production prototypes including installation and commissioning.

3.5 Phase 6 – Post project cost benefit analysis, report and video

Upon completion of the project, NSI shall work with Greenleaf Enterprises to prepare a report and video for MLA. While MLA shall own the final report, the content thereof and the video shall both form the basis of subsequent NSI marketing of the aitchbone & knuckle pulling system. Upon completion of the project, NCMC in conjunction with NSI & MLA shall host an open-day to demonstrate the benefits of the systems in production.

4 Results and discussion

4.1 Summary

NSI approached developing a manual assist solution to the 'cold rib' deboning task using the platform technology developed for both aitchbone and knuckle deboning.

When the original platform was developed there where three key areas of focus as shown in Figure 1.

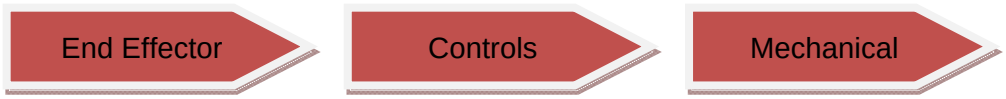


Figure 2: Puller Development Areas

The development of the cold rib solution has to date focused on the first two areas and attempted to use the existing puller platform in an aim to fast track and reduce R&D costs. This in hindsight may have been a limitation.

In addition to the approach being a potential limitation to success, various technical developers (i.e. individuals) have been involved over the past two years, in a stop / start way resulting in some lessons learnt being lost and frustration felt with NCMC operational staff and now potentially a loss of desire to develop a solution.

NSI engineering and NCMC operational team (i.e. the project team) reviewed the development history and determine if any aspects of the development had merit and if they should be included (or at the very least not lost) in any future developments. Consideration of the concept on the final page, and finally a decision on whether to proceed and if yes under what conditions, was reached. Although an alternative was identified, it was decided not to proceed with in the short term interim.

4.2 The Manual Process

Before altering a process it is vital that the manual process is understood. The following depicts the relevant steps in the manual process.

Figure 3: Rib brisket end is knifed.

Figure 4: Cut between 5th and 6th ribs.

Figure 5: Grasp rib 1 and commence knifing.

Figure 6: Change hand position to get closer to knife hand.

Figure 7: Change grip hand position and use knife hand to push down on chine.

Figure 8: Change grip hand position.

Figure 9: First five ribs free from quarter

Figure 10: Grasp second rib set at rib 6.

Figure 11: Reposition grip hand and push down on rib set.

Figure 12: Move grip hand towards back end of rib set.

4.3 Key points from Manual Process

- Process commences with two knife cuts and the operator holding onto the carcase not the rib set.
- For rib set 1 – 5 removal, grip hand changes location multiple times as the fleecing operation is executed.
- Grip and knife hand are never further apart than 400 mm.
- Removed rib set has to be carried to a drop location.
- Pull action changes between pulling towards the operator and pushing towards the ground.

4.4 Development Summary Video

A video has been compiled of ten of the multiple iterations of the end effector and control system developments and subsequent carcase trials. Table 1 summarises each trial and the lessons and purpose of each trial. Please refer to video titled "NSI Cold Rib Development History as of 2012-06-23"

Time	Purpose	Knowledge Gained
00:00 - 01:02	Manual process – understand what the technology is integrating into.	See above.
01:02 – 02:18	Use existing hook end effector and control system to gauge suitability to the task.	Hook pulls through intercostal and/or slips of the rib bone. A 'clamp' type arrangement is required. Joystick control for up and down works well on this task.
02:18 – 02:53	C-shaped clamp without and active piston for clamping, hence known as a passive clamp.	Worked well on ribs 1-5 but continually slipped on second rib set. Needs active clamping mechanism. Control system worked well (joystick).
02:53 – 03:34	Determine clamping force required.	Not difficult to clamp, however ideally clamp more than one rib. Hands start to get too far apart and operator needs to relocate 'control' hands closer to the cutting hand.
03:34 – 05:57	Trial active clamping concept, still using original joystick control.	Additional prep work required to separate ribs to allow this particular clamp design to clamp a rib (i.e. side support not sustainable approach). Clamp infrastructure/pivot points made the system hard to engage. An additional control button for the passive clamp is now required.
05:57 – 06:21	Trial a passive fork lever action locking clamp	A passive clamp, via lever action, did not appear to be a successful approach. Significant additional work up would

		be required to ensure a rib was 'free' to clamp upon.
06:21 – 07:06	Passive clamp with no side support.	Clamp effective, however very heavy. Controls are too far away from the cutting hand and does not feel natural to people experienced in performing this task.
07:06 – 07:36	Can the ribs be 'just pulled away' with force and remove the issue of the knife and 'control' hand not being close enough together when using the puller.	Pulling alone results in poor yield. This was the expected outcome but for completeness was proven and documented.
Change of developer		
07:36 – 08:40	Operator explains the important of the control/gripping hand being in close proximity to the knife hands	Controls of the device need to be close to the gripper to ensure minimum distance between control and knife hand. Operator suggests putting controls on the gripper.
08:40 – 11:05	Controls located closer to the gripper.	Button on the end of a 'motor bike throttle' concept. Button for active clamp. Throttle concept for up and down. Control seemed less intuitive than the original puller joystick. This could be due to the 'bulkiness' and poor centre of gravity/balance of the gripper rather than the control system.
11:05 – 12:20	Controls relocated directly over the gripper to determine if better control of the vertical stroke would occur.	Mounting/Gripper linkages with pulling arm still not ideal. However there appeared to be better control of the gripper and 'hitting the target'. However a lot of rib is required to be freed from the quarter to enable easy engagement. Control and knife hands still exceed what is experiences in non-assisted operations.
Change of developer		
12:20 -	Clamp and controls as an integral design.	Controls do not appear as natural to use as a joystick. Is this just experience or an typical human historical learning as to what is more natural?

4.5 Video Analysis Lessons

The following are key lessons from the author's perspective and can be challenged:

- **HANDS →** Knife and control/gripping hands need to be close together to ensure any integrated technology does not feel strangely different from the current non-assist task.
- **KNIFE CUT →** The manual process requires the 'along the rib brisket end' cut. It is hard to see how a clamp could be developed such that this process is not required, unless it either had a sharp edge of a separation technology included on insertion (i.e. 'air').
    - This poses a problem if the assist device is not resting near the quarter after this cut is performed as the operator is required to 'go looking for' the assist device having already commenced the de-boning process.
    - Alternatively the process could be changed such that the 'along the brisket rib end' cut is performed upstream.
- **FLEECING →** Knifing is required to fleece the ribs from the carcase, i.e. a clamp that just pulls will result in yield loss.
- **STROKE →** Using the existing puller has always resulted in a limited stroke required for the task and hence in many of the videos full rib cage removal was not possible due to the limited stroke, and or the installation height of the

current pullers for their installed task of aitchbone and knuckle removal. This has led to some trialling frustration from all involved.

- **CLAMP →** An active clamp is required, that cannot have any side support due to interference with ribs. Note the use of an active clamp introduces an additional control button(s).
- **CLAMP →** Balance and centre of gravity and the linkage system of the clamp are vital, and as of date, still not refined.
- **CONTROL →** Anecdotally the joystick option seems more natural as a control interface. How to integrate to a clamp controls to the clamp is still a challenge.

5 Conclusions and recommendations

5.1 Ideal Solution

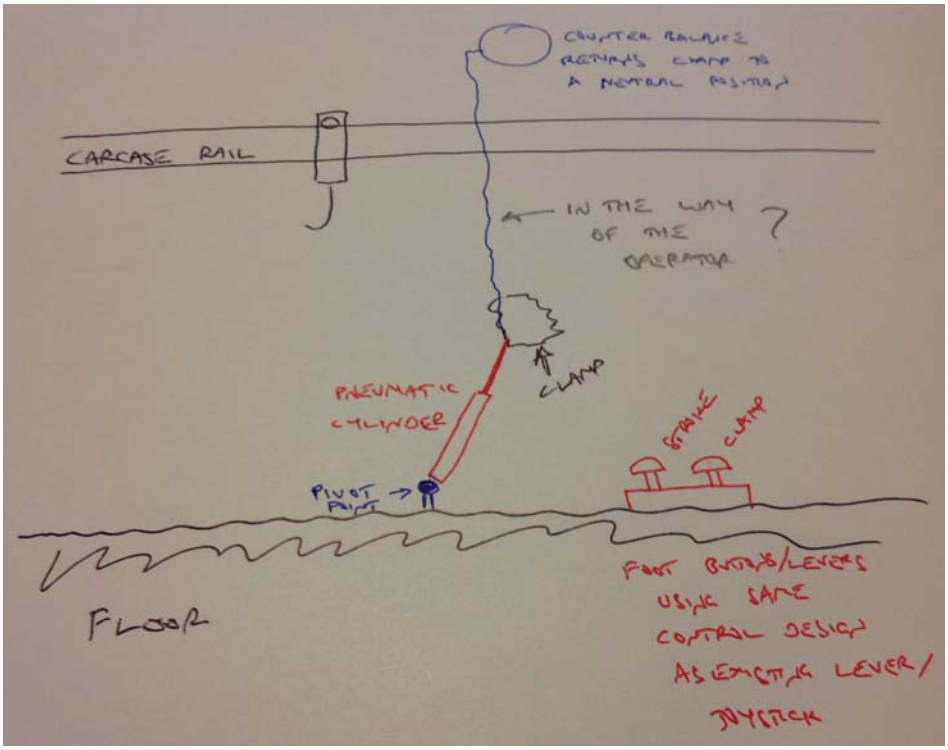
From the analysis in the results section an ideal solution would accommodate all or some of the following and not ignore any knowledge gained as noted above:

1. Not feel any different to the operator than the unassisted process.
2. Not require the 'brisket rib end' cut to be executed by the 'pulling' operator, or
    a. If performed by the 'pulling operator' reaching for the assisted device feels natural and is seamless.
3. Have the gripper always close to the quarter, i.e. no need to 'go looking for it'.
4. Probably not need a hand on the gripped once engaged, i.e. foot control the active clamp and stroke direction.

5.2 Question

Would a counterbalancing 'wire' from above the carcase be a hindrance?

If not the operator could place the clamp onto the rib set and activate the clamp, either by a button on the clamp or on the floor. Then take their hand off the clamp and position their 'gripping' hand as close to their knife hand as they chose and activate the vertical stroke with buttons/levers at their feet.



The above question could be answered as a new R&D project in this area.

6 Reference list

None

7 Appendices

Video: NSI Cold Rib Development History as of 2012-06-23 (PC)