final report

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Robotic 6 way cutting system

Feasibility Trial at NFP

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1 Introduction

The purpose of this report covers the first feasibility trial, stage 1 of a robotic 6-way cutting system conducted on site at Norvic Food Processing, Wodonga. The main focus of the trial is to prove the cutting method is viable without bone shatter and to test cycle time requirements.
The on site trial was carried out over 4 days, 22nd — 25Th August 2006. Under sterile conditions a robot with a Freund blade and trial carcass stabiliser was used to test the blade speed, cycle time and effectiveness of the system. Cycle time and photos have been recorded to reflect the results.

Figure 1 Trial setup at NORVIC

2 Background

2.1 Industry Consultation

The project has been developed as apart of MLA's plan to increase the Meat industry's workplace safety which helps reduce OH&S claims that cost the industry hundreds of thousands of dollars annually. The project was developed by Norvic Meat Company with the MLA and has the industry support to automate the 6 way cut process to reduce the injuries from processing equipment especially Bandsaws. MLA & MAR have sought industry input during the scope & design to ensure a flexible solution for the 6 way Cut at various processing sites.

2.2 How has the project "come about"?

The 6-Way Cut project was a project that Norvic Meat processing plant approached MLA for a solution to splitting the small stock carcass into 6 portions. The primary driver for Norvic to pursue this technology in an automated solution is primarily to remove operators from the

bandsaw hazard. MAR worked with Norvic to provide a solution that not only suits the purpose however is a scalable solution that suits all types of chain speeds in the industry. MAR was selected by MLA on the basis of and a solution that was optimum for the meat industry.

2.3 What currently happens and why does it need changing?

Operators working at high speeds for long hours on the bandsaw are at high risk of amputations, severe injury that will effect the operator for the rest of his life and cost the industry money in OH&S claims.

MLA has planned to make bandsaws safer by attacking the issue from two angles. The first was reducing the impact that bandsaws would have on a human through the BladeStop project. In which a device is retro fitted to the bandsaw and the operator would suffer only cuts and abrasions instead of certain amputation in the case of an accident. This device certainly increases the safety of using a bandsaw and is perfect for small processing plants who cannot afford to spend large amounts on replacing bandsaws. However the next phase is to remove bandsaws and heavy lifting where possible and replace with technology which is the concept behind this project

2.4 Trial Objectives

1. **Cutting Method -** prove it viable
2. **Cycle Time -** complete three cuts within time limitations
3. **Carcass Diversity —** cut different sizes and species
4. **Warm and Cold —** cut all temperatures with focus on warm
5. **Establish RI —** record the refrigeration index for a hot cut carcass

We have proposed to use a 780mm Freund ZKM circular saw blade. The blade diameter and tooth pitch have been chosen to minimize cutting maneuvers through the carcass. The blade design has been chosen to cut through bone, effectively cutting straight through the centre of the spine. A selected rotational speed and feed rate will reduce bone dust, bone chips and burning the meat while reaching cycle time limitations.
Benefits of these trials will determine the limitations of cutting through meat and what are the optimum tools and speeds. The research will be covering the hot and cold carcasses to span the industry in terms of hot and cold boning.

3 Trial Arrangement

3.1 Equipment

- Kuka Robot (Payload of 125kg)
- 780mm Freund Circular Saw Blade and drive
- Trial carcass stabilizer

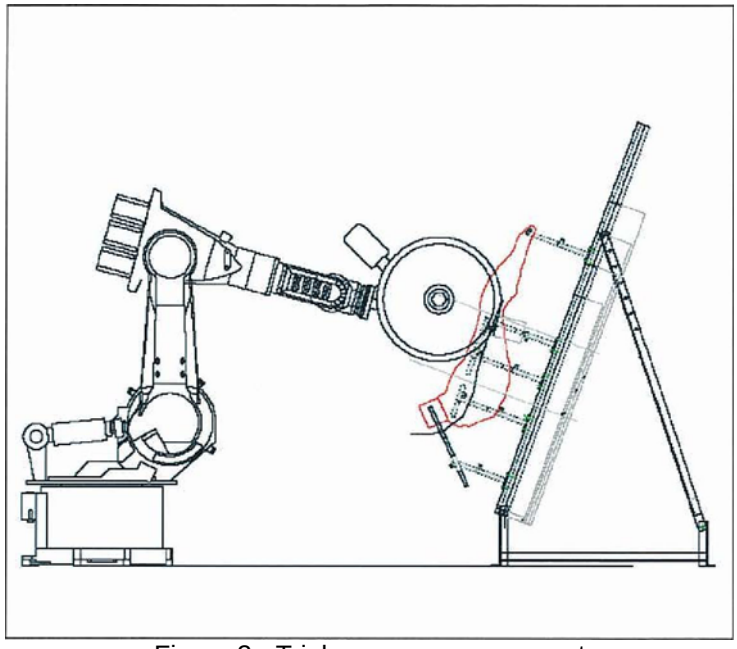


Figure 2 - Trial carcass arrangement

Figure 2 demonstrates the task of the robot with relation to the stabilizer. The actual trial stabiliser is shown in Figure 3. For trial purposes, the carcass is manually loaded into position and clamped securely before operating the robot.

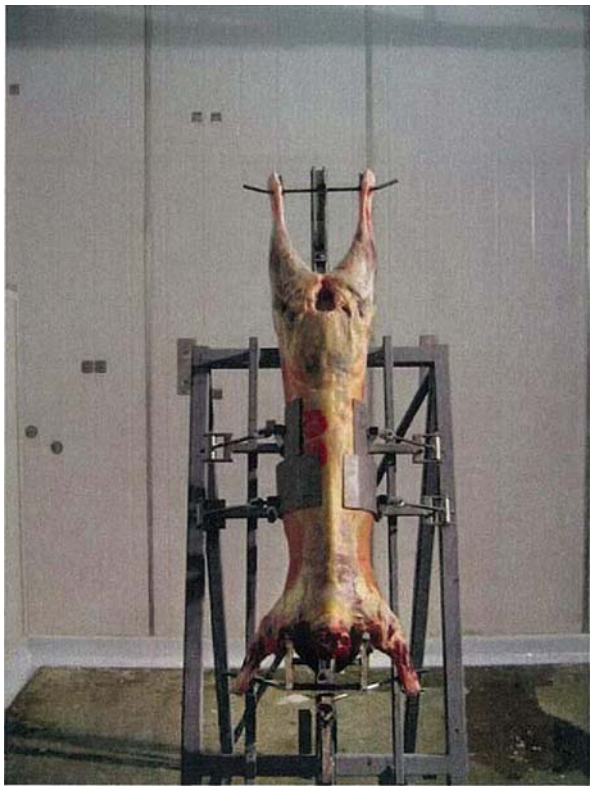
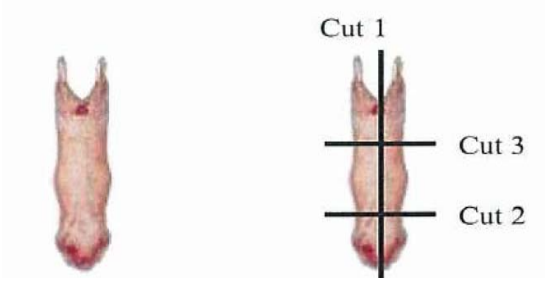


Figure 3 - Trail Carcass Stabiliser

3.2 Cutting Positions

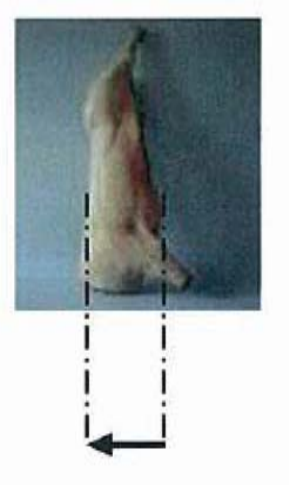
The robot has three basic tasks

1. Split the goat / mutton vertically
2. Cut through rib 5
3. Cut underneath hip



Mutton Carcass Cut lines on Mutton carcass

The depth from the brisket to the back bone varies from a minimum of 270 mm to a maximum of 370mm.



3.3 Trial Results

A recorded 29 carcasses of varying sizes, temperature and species were cut. For detailed carcass data refer to (Stage 1 Automation Six Way Cut, NFP, Oct 2006)
A summary of the carcasses are as follows:

Table 1 - Trial Results

Type	Temp	Size	Cycle (sec)	Qty
goat	cold	small	20	5
mutton	warm	small	21	4
goat	warm	med No. 4	-	5
lamb	warm	large	34	5
ram	warm	large	50	3
goat	warm	large No. 5		3
lamb	hot	small	23	2
mutton	hot	med	23	2
			Total	29

3.4 Cutting Method

Below in Figure 4 demonstrates the effectiveness of the blade. The blade has cut centrally through the spine, showing a dissection of the spinal cord. The bone dust is minimal and the cuts showed no signs of bone shatter.

Figure 4 - Demonstration of the 6 pieces after cut

3.5 Cycle Time

The cycle time achieved with trials is —20sec which has been achieved with no optimization of the robot program. Our target is 3400 carcasses in a 10 hr shift therefore one every 21seconds into each dual robotic system. By altering the blade speed, feed rate and reducing path length will reduce our cycle time considerably. With additional improvements in stabilization to occur and robotic maneuver optimisation the cycle time is achievable.

3.6 Carcass Diversity

Below is Figure 5, shows where the blade has failed to complete a cut through the meat. This is a result of not optimizing the robot program to suit the restraining device with varying sizes of carcass. Using an improved stabilizing device for the carcass size and selecting the correct robot program will solve this issue.

Figure 5: Demonstration of a miss cut in the leg and rib

Many of the trialed carcasses were unable to find centre and soft-sided through the ribs. This was a result of the stabiliser not holding warm carcasses firmly enough. An automated stabiliser with firm grip points that secure the carcass will used to eliminated shifting and achieve central cuts.

3.7 Warm and Cold

When cutting the carcasses cold they naturally hold their shape better and make cutting easier. Warm carcasses are slippery and malleable which cause a issues when cutting. The saw-blade pushes the meat aside rather than cutting through it. Restraining the carcass securely will also solve this issue. Where the carcass is held secure, the blade has no problem cutting through warm or cold meat.

3.8 Establish RI

NFP froze pieces of meat after warm cutting the carcass and logged the Refrigeration Index (RI). Refer to Stage 1 Automated Six Way Cut, NFP, Oct 2006 for data results. The RI is measured to ensure time and temperature parameters do not exceed legislative food safety requirements. The meat passed the RI test however visually the meat froze into irregular shapes as anticipated. Several measures can be taken to prevent this from accruing, for example packaging techniques or temperature regulation

4 Going Forward

This first stage of the project has proven the dustless blade can successfully cut the warm and chilled carcasses using an industrial robot in a production environment.
The next stage is to progress the full automation of the project as previously proposed, further industry consultation will be sought and additional processors may be interested in joining the project. An industry day is proposed to discuss the opportunities for this system in goat and mutton.

5 Conclusion

The results of the trial proved that using a six axis robot can effectively achieve a 6-way cut solution. The Freund circular-saw blade does not burn the meat, considerably reduces bone dust, shows no sign of bone shatter and can cut through warm or cold meat. The warm cut pieces of meat have been successful against RI requirements. The main points to address with moving forward are, 1. Firmly secure the carcass from moving while cutting; 2. Optimize maneuvers and speeds to achieve cycle time limitations.