final report

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Beef aitchbone and knuckle puller

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Executive summary

A visit was made to Scott Technology Ltd (Scott) in February 2006 by MLA, AMPC and 5 Australian Beef Processors (now known as the Australian Beef Automation Committee). Following the visit, an MLA/AMPC project was instigated to develop a Pre-Production Prototype of a manual assistance device for the aitchbone & knuckle boning operations. The prototype developed by Robotic Technologies Ltd (RTL) proved to be relative successful in providing labour assistance in these arduous tasks thereby potentially reducing the number of occupational injuries, and has the added bonus of increasing yield.

In a visit to RTL in Feb 21st 2007, the system was demonstrated to members of the Committee who highlighted issues like the system being static, pulling controls and pulling angle. Although RTL tried to address those comments by including modifications to the prototype, the project was terminated by the Committee. The issues identified were the following:

- The prototype was not moving with a chain (this was intended for the next phase of the project)
- The machine was felt to be cumbersome – in particular the gripping mechanism
- The machine was felt to be over-built for the task

Although the project was terminated by the Committee due to the issues above, further work was continued by RTL under another project, P.PSH.0286.

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1 Background to Project

On the 7th February 2006, MLA brought a group of Australian Beef Processors to Scott Technology Ltd in Dunedin, New Zealand for 3 days. The purpose of the visit was to get an introduction to Scott/RTL, view the work RTL had done to-date in the lamb processing industry, and to discuss ideas for applying principles to the beef industry.

The Australian Beef Processors involved in the visit agreed to form the Australian Beef Automation Committee (“the Committee”) in conjunction with MLA and AMPC. The Committee chose the aitchbone & knuckle boning operations as RTL’s first area of beef automation. RTL put forward a proposal to develop a pre-production prototype manual assistance device to aid in the pulling of the aitchbone and the knuckle. MLA and AMPC subsequently agreed to fund the project. The prototype is described below.

2 Details of Prototype

The prototype designed and built by Scott (acting for RTL) differed little from the original proposal. It had a free-standing frame on which was a vertically moving carriage powered by two pneumatic cylinders. Connected to the carriage were a catch tray, and a gripper arm. The gripper was used to hold onto the aitchbone or knuckle while the carriage was lowered to pull the bone or meat from the butt. The operator then only needed to make cuts in strategic places in order to cleanly free the meat.

Vertical motion was controlled by a vertical rod, which was pulled down for downwards motion and pushed up for upwards motion. The speed of motion was controlled by how far down or up the rod was moved. Grip was controlled by a pushbutton on the gripper (push to open). There was a second switch available to lock the gripper in the gripped position to avoid accidental opening.

3 Findings of the Project

Scott and PPCS (note that the Puller was sited at PPCS's Belfast plant) have trialed the Puller over a number of carcases and a number of operators. In doing so, the main functional and ergonomic issues were identified. The functional issues were addressed, while the ergonomic ones were to be addressed in the production prototype. MLA separately commissioned ergonomics expert David Tappin of COHFE to assess the prototype. David's assessment helped to shape the proposed production prototype.

3.1 Issues Encountered

The main issue encountered during testing was ensuring sufficient grip on the product. The knuckle proved easy to hold onto. However, when trying to grip on the aitchbone the gripper had a tendency to slide on the bone. Existing systems utilized a hook which was hooked into the hole of the aitchbone. Use of this hole proved quite adequate with the gripper also. However, in situations where the carcass had been soft-sided, this was not possible (the bone breaks away). The gripper was extensively modified during the course of development, and now grips the aitchbone very reliably.

Operating the pulling motion with the vertical rod at the same time as boning out the butt proved to be very awkward (two hands are often required for boning – one for the knife and one for either the gripper or stabilizing the butt). However, this did not appear to be an issue in the production model as the speed variability was not needed, and a simple control such as a wireless system integrated in a hand hook or a foot pedal can be employed instead.

In general, the ergonomic review identified the controls as the greatest problem. Boning requires two hands most of the time, making it difficult to integrate any hand controls. The original proposal for the production Puller had the Puller running on a track alongside the chain. David Tappin suggested that a personnel platform be added to this so that foot pedals could be utilized to control the mechanisms.

3.2 Benefits Achieved

Based on having one Puller for the aitchbone (with rump also removed at this station) and one for the Knuckle, the device easily met the room rate of 55 to 70 carcases per hour at the plant. While it was difficult to get absolute figures of the overall machine cycle without having the Puller integrated into a boning chain, the machine operation met the manual operation for Knuckle removal. In the Aitchbone operation the machine appeared to be much faster. At least, the machine cycle time did not have any detrimental effect on the room rate.

The main driving factor behind the choice of area to mechanize was the incredible strain the two boning operations place workers under. Injuries in this sort of work were common. The Puller removed the hardest part of the task, and would thereby significantly reduce worker injuries. An added benefit was in widening the potential labour pool. Being a less physically demanding task, much more slightly-built operators could be employed without fear of rapid injury. During testing, a female trimmer (who had never before done any boning) was given the opportunity to try boning out on a small number of butts using the Puller. While there was an obvious need for training to get up to speed and quality, the task did not prove too physically demanding for her.

A further attraction for the Puller was found in the form of improved yield. As seen below, the bones were much cleaner after processing on the machine than after manual processing. (The aitchbone on the left was from the Puller, and the one on the right from the same carcass was manually processed). Early yield data (appended) showed an average yield saving benefit in the order of $0.01 per kg of side weight. For example, on a 130kg side, the expected saving was ~$1.30. Assuming a 130kg average side weight at an average 60 carcasses/hour, 7 ½ hours/shift, 2 shifts per day, and 48 weeks per year, this would equate to an annual saving of over $500k. The appearance of the cuts was also of a higher quality.

4 Summary of Committee Review 21 February 2007

In the visit to RTL last Feb 21st, it was noted that RTL had completed the aitchbone & knuckle puller to the specification given by the original project proposal. The system was demonstrated to two processors (John Hughes and Michael Nolan) who provided the following feedback:

1. The prototype was static (i.e. not moving with the chain) – the original proposal showed a commercial model that was capable of being attached to a moving chain
2. A second person is typically involved to control the pulling motion. (A foot pedal was proposed by RTL for future models, but this was seen by the Australian visitors as being overly cumbersome). The clamp/pulling mechanism on the prototype is cumbersome and awkward to operate.
3. They requested that the angle of pull be investigated to determine what gives the best results.

Although RTL analyzed and tried to address those issues, they failed to meet the expectations of the Committee and the project was terminated.

5 Proposal for Production-Prototype Aitchbone & Knuckle Puller

Although the project was terminated, there were several recommendations made for a production prototype, which were implemented eventually under P.PSH.0286.

Functional Description: While the earlier proposal had the production prototype moving on a rail adjacent to the main boning chain, in the current proposal the machine is fixed. There are a number of reasons for this, not least of which is the safety aspect of a moving frame near workers, and the fact that to ensure worker safety, three carcass boning positions would have to be dedicated to the Pullers in the old proposal, whereas the new proposal only took two.

There shall be two pullers for a chain of similar speed to the trial plant (55 to 70 carcasses per hour), one for the aitchbone and one for the knuckle. The rump shall also be removed in the aitchbone station. They shall be technically the same apart from the gripper height being optimized for the specific cut (i.e. aitchbone or knuckle). The butt shall remain on the overhead conveyor rail, but shall be indexed ahead of the conveyor trolley pusher and stopped in the pulling station by an automated transfer device. (In the case of the Belfast conveyor, the rail shall be re-shaped to allow the trolley to disengage from the pusher).

Functionally, the Pullers shall not differ from that which has been developed to-date, apart from the absence of a tray, and the mounting of the gripper arm on a pivot to allow the operator to swing it out of the way when not in use. The controls (raise/lower and grip release) shall be operated by foot pedals. The gripper shall have dual pressure pneumatic circuits to ensure operator safety. The high pressure circuit shall only be engaged when the gripper arm is lowering. (This is to ensure that if the operator should accidentally get his/her hand caught in the gripper while attaching it to the carcass, the gripper can be released before a significant injury is sustained).

Project Stages: In Stage 1, RTL shall design and build the 1st production prototype. Where sensible, components from the pre-production prototype shall be incorporated into the new prototype. This shall then be installed in an off-production processing room in a plant (probably Belfast). Stage 2 shall see the prototype tested and refined by RTL. Completion of this stage is a Go/No Go point in the project. If the Committee is satisfied with the outcome of Stage 2, RTL shall proceed to Stage 3 in which further production prototypes shall be built; one for the processing site of each interested plant. This includes design of the transfer and other relevant items to suit the site layout. It does not include freight, installation and commissioning.

Project Timeframe: Stage 1 (design, build and installation of the 1st prototype) is expected to take 4 months from project initiation. Stage 2 (testing and refinement) is expected to take a further 3 months. Following approval to proceed to Stage 3 and following supply of suitable plant information, manufacture of the additional prototypes is expected to take 3 to 5 months depending on component lead times and resources available and committed at the time. It is therefore conceivable that the later prototypes be in operation in participating plants within a year from project initiation.

6 APPENDIX – Yield Results of Aitchbone & Knuckle Puller

19-01-07		Carcass 1					
		Manual			Machine		
	$/kg	kg	%	$	kg	%	$
Shank	$3.74	4.02	3.19%	$15.03	3.876	3.00%	$14.50
Top	$5.60	6.715	5.33%	$37.60	6.925	5.37%	$38.78
Knk	$6.10	4.868	3.86%	$29.69	4.668	3.62%	$28.47
S/S	$5.20	6.71	5.33%	$34.89	6.81	5.28%	$35.41
Rump	$6.50	5.204	4.13%	$33.83	5.862	4.54%	$38.10
T Tip	$6.00	0.968	0.77%	$5.81	1.07	0.83%	$6.42
Trim (80cl)	$3.19	1.512	1.20%	$4.82	1.302	1.01%	$4.15
Fat	$1.00	1.08	0.86%	$1.08	1.534	1.19%	$1.53
Total $				$162.76			$167.37
Side Weight		126			129		
$/kg Side Weight				**$1.29**			**$1.30**

02-02-07		Carcass 2					
		Manual			Machine		
	$/kg	kg	%	$	kg	%	$
Shank	$3.74	3.744	3.15%	$14.00	3.75	3.16%	$14.03
Top	$5.60	7.785	6.54%	$43.60	7.845	6.62%	$43.93
Knk	$6.10	4.344	3.65%	$26.50	4.42	3.73%	$26.96
S/S	$5.20	7.27	6.11%	$37.80	7.075	5.97%	$36.79
Rump	$6.50	4.184	3.52%	$27.20	4.472	3.77%	$29.07
T Tip	$6.00	0.882	0.74%	$5.29	0.992	0.84%	$5.95
Trim (80cl)	$3.19	0.994	0.84%	$3.17	0.841	0.71%	$2.68
Fat	$1.00	0.74	0.62%	$0.74	0.546	0.46%	$0.55
Total $				$158.30			$159.96
Side Weight		119			118.5		
$/kg Side Weight				**$1.33**			**$1.35**

02-02-07		Carcass 3					
		Manual			Machine		
	$/kg	kg	%	$	kg	%	$
Shank	$3.74	4.424	3.16%	$16.55	4.43	3.14%	$16.57
Top	$5.60	9.142	6.53%	$51.20	9.355	6.63%	$52.39
Knk	$6.10	5.04	3.60%	$30.74	5.268	3.74%	$32.13
S/S	$5.20	8.568	6.12%	$44.55	8.491	6.02%	$44.15
Rump	$6.50	4.9	3.50%	$31.85	5.1	3.62%	$33.15
T Tip	$6.00	1.05	0.75%	$6.30	1.12	0.79%	$6.72
Trim (80cl)	$3.19	1.148	0.82%	$3.66	0.667	0.47%	$2.13
Fat	$1.00	0.84	0.60%	$0.84	0.595	0.42%	$0.60
Total $				$185.69			$187.84
Side Weight		140			141		
$/kg Side Weight				**$1.33**			**$1.33**