final report

Project Code: P.PIP.0292
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Date published: October 2012

PUBLISHED BY
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Hardwicks Robotic Brisket Cutter

This is an MLA Donor Company funded project.
Meat & Livestock Australia acknowledges the matching funds provided by the Australian Government and contributions from the Australian Meat Processor Corporation to support the research and development detailed in this publication.

Abstract

The Robotic Brisket Cutting System was installed and commissioned in conjunction with MAR's first commercial Sani Vac system at Hardwicks Meat Works in Kyneton in Victoria. The Brisket cutter is the fourth in a four stage approach to finalising the development of a fully functional automated system in preparation for commercialisation of the development.

The benefits to the industry that will be achieved by utilization of the Robotic Brisket Cutting System include:

- Improvements in OH&S;
- Improvments in consistency;
- Reduction in labour cost:
    - The ability to process lamb, sheep and goat processing

Reliability and accuracy, along with processing speed which are critical to the success and acceptance of this technology have been achieved throughout this project.

Executive Summary

The Robotic Brisket Cutting System was installed and commissioned in conjunction with MAR's first commercial Sani Vac system at Hardwicks Meat Works in Kyneton in Victoria during January/February 2012. The Brisket cutter is the fourth in a four stage approach to finalising the development of a fully functional automated system in preparation for commercialisation of the development.
The Hardwick's system was designed in a modular format that will allow the system to be reproduced and installed in a cost and time effective manner and MAR are confident that the system is commercially viable and recommend its adoption by further producers.

Contents

1 Background

The first Automated Brisket Cutter system was developed and installed by MAR at Peel Valley Exporters in June 2008, a second system was installed at Burrangong Meat Processors and a third installed at Gundagai Meat Processors. This project involved the de-commissioning of the fourth Robotic Brisket Cutter system that was installed Castricum Bros, who have recently exited from the development project, and reinstallation at Hardwick's Meat Works in Kyneton Victoria.

The Automated Brisket Cutter systems being built are part of a four stage approach to finalising the development of a fully functional automated system in preparation for commercialisation of the development.

As the development of the system has progressed changes in design and concept with continuous improvements to accommodate for plant variations, equipment, technology and learning's influencing each stage of the development have taken place. This brisket cutter development project aims at completing development of the system as a whole with a new spreader bar system to be accommodated at Hardwick plus the continued development and trials of a new sterilisation system suitable for +10/min productions speeds.

This Brisket cutting system will be completed in conjunction with the first commercial Sani Vac System and will form one cell when installed on site. With a view to making these systems more commercially attractive and easier and quicker to assemble and install they will be developed as modular cells that will have bases plates and guarding that will become the standard for future Brisket Cutting and Sani Vac Systems.

2 Project Objectives

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

- Further develop the robotic brisket cutter solution for the industry and process criteria's specified by the client.
- MAR will provide a documented Project risk assessment for review as part of the initial design of the system
- Test and prove the solution at MAR in controlled environment via FAT prior to installation
- Implement into the processing facility a fully functional robotic brisket cutting system
- Commission and trial robot to achieve client specifications
- Train operations and maintenance staff to competency in maintaining and operating equipment.
- Provide to MLA for industry dissemination and promotional purposes full documented reports of the systems success and challenges.

3 Methodology

The project will be progressed sequentially through set milestones:

Each milestone must be completed to the satisfaction of MAR, Hardwick and MLA prior to continuation of the project with some milestones having a GO / NO GO decision process attached to them.

Milestone 1 - Initial Design & Project R&D

MAR will conduct and review with MLA a full project Risk assessment document that includes a detailed analysis covering technical, process, schedule, financial, resource, design and commercial risks including action plans to deal with each identified risk throughout the life of the project:

- Project risk assessment
- Submit proposed draft system design for approval.

Milestone 2 - System Components

System Components for this installation will be recovered from the Castricum installation and held in storage during development stages and prior to system build. Robot and Saw components will be re-conditioned. Variants in the designs to suit plant specifics does not allow for use of all components:

- Removal from Initial Site & Storage
- Robot, Robot Base, Protective Bag
- Recondition Brisket Cutter Saw & Sterilisation system
- Control Systems and PLC and sensing
- Cell Guarding and Safety System
- Extended Warranty Coverage for Hardware

Milestone 3 - Carcass Stabilisation

Stabilisation component design, manufacture & trials to suit plant variants, processed species, gambrel types and line design with continuous Improvements and system enhancement:

- Design & Review Stabilisation System
- Manufacture & Installation of Stabilisation System
- Functional Test of Carcass Conveyor and Stabilisation systems

Milestone 4 - Sensing Trials On-Site

Test & trials of sensing technologies to suit plant specifications and enhance the system functionality working on learning's to date through production and implementation of other systems:

- Setup sensing systems on-site at proposed location and completion of test & trials.

Milestone 5 - System Build Integration and Setup at MAR

System build test and enhancements suit plant specifications with continuous improvements working on learning's to reduce complexity, cost and manufacturing techniques. Component Integration to suit plant specifications, plant design variants, robot cleaning, protection and maintenance technologies working on learning's to reduce complexity, cost and ongoing system maintenance:

- System Build & Installation at MAR
- Initial Programming, Robot and control system interfacing
- Mechanical & Electrical Setup & Test of System

- Setup & Test safety systems
- Integrate sensing, control and safety systems
- Test simulated robot operations and trial programming of robotic movements
- Customise manufacture of robot protective bag

Milestone 6 - System FAT at MAR

Factory Acceptance Testing of system at MAR prior to shipment to site for installation Test functional operations to ensure system meets client needs, processing requirements and to minimise possible integration faults ensuring minimal plant disruption during installation and commissioning of the system;

- System operation and design review
- Trial simulated operations
- Trial and troubleshoot programming scenarios
- Trial of cycle time

Milestone 7 - Onsite Installation of System

Onsite installation and integration of robot system, safety guarding and peripherals including electrical and other services (water, air, drainage):

- System packing and equipment transport to site
- Installation of robot system, safety guarding and peripherals
- Installation of electrical and other services

Milestone 8 - Commissioning and Trial

Full test and commissioning of the system to ensure system meets client needs and processing requirements. Includes process improvements, operational enhancements and reliability testing to ensure improvements to the system provide measurable results:

- Integration and Test of system components
- Test & trial of system operations
- Trial and troubleshoot programming scenarios
- Production and cycle time trials
- Site support & Operator Training

Milestone 9 - Presentation Video, Documentation

- Two sets of documentation including Electrical Drawings, System operation procedures, Safety Audit and Risk Assessments and Operation manuals will be provided upon commissioning.
- System Videos, reports and documentation detailing the system, its components and operational procedure to be provided by MAR to MLA for industry dissemination and promotional purposes

4 Results and Discussion

The discussion below the progress through the project in line with the steps in the MLA contract:

4.1 Initial Design and Project R&D

The project Risk Assessment has been submitted to Hardwick's and reviewed. Some modifications and additions were requested and these were implemented. This Risk Assessment was used as a live document throughout the project and was reviewed and monitored regularly.
The draft system layout, shown below, was presented at this point, the general layout and clearances were agreed upon and approved by Hardwick's.

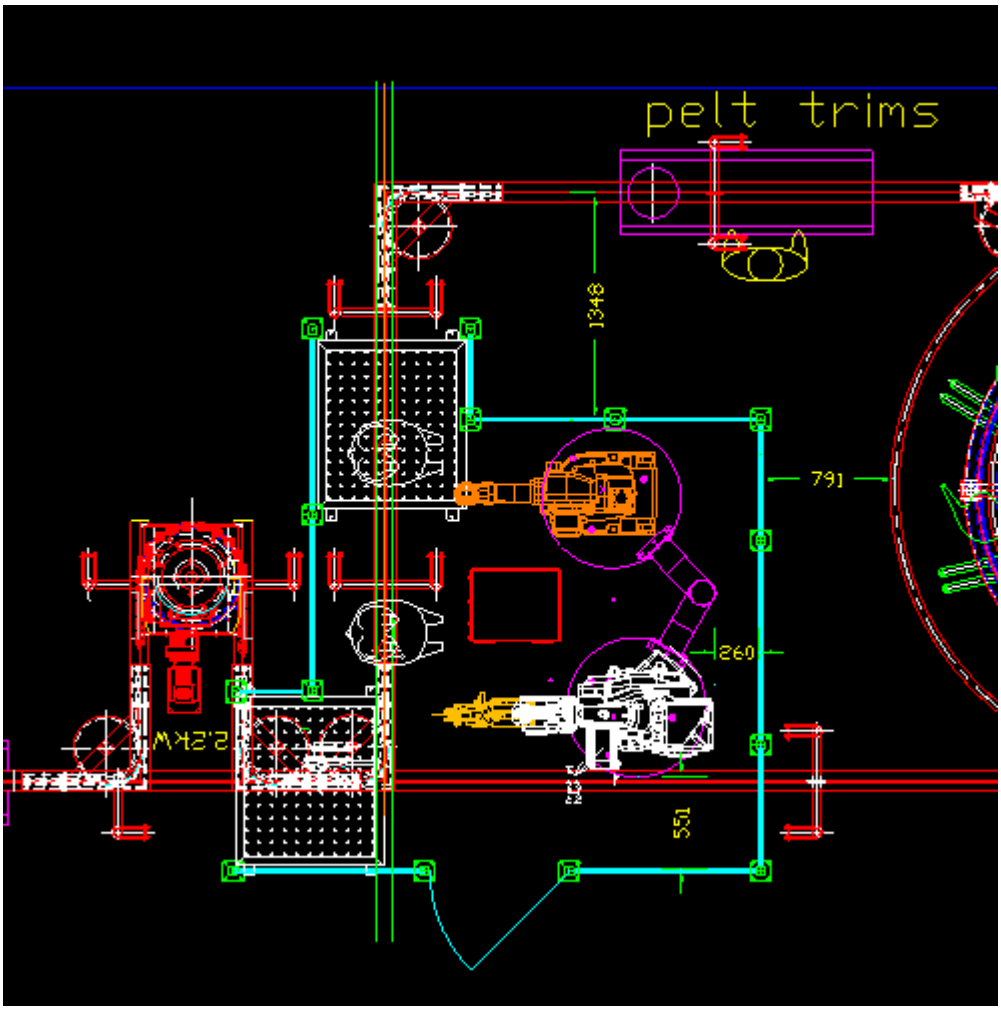

Fig.1 Initial layout approved for completion of Step 1

4.2 System Components

The robot system was removed from Castricum Bros stored at MAR's Victorian office for a period and then transported to MAR's Sydney office when contracts with Hardwick's were finalised. The robot base from Castricum could not be reused due to differences in site set up and the preference to move to a modular form of base/guarding setup for the robot cells. The image below shows final layout and the modular setup of the cells (Brisket Cutting cell along with the Sani Vac cell were built as a combined cell). Note the majority of the cell (robots, guarding and wash tank) is mounted on two bases which could easily be separated and with the addition of two pieces of guarding make two separate cells where a brisket cutter or sani vac are required in isolation.

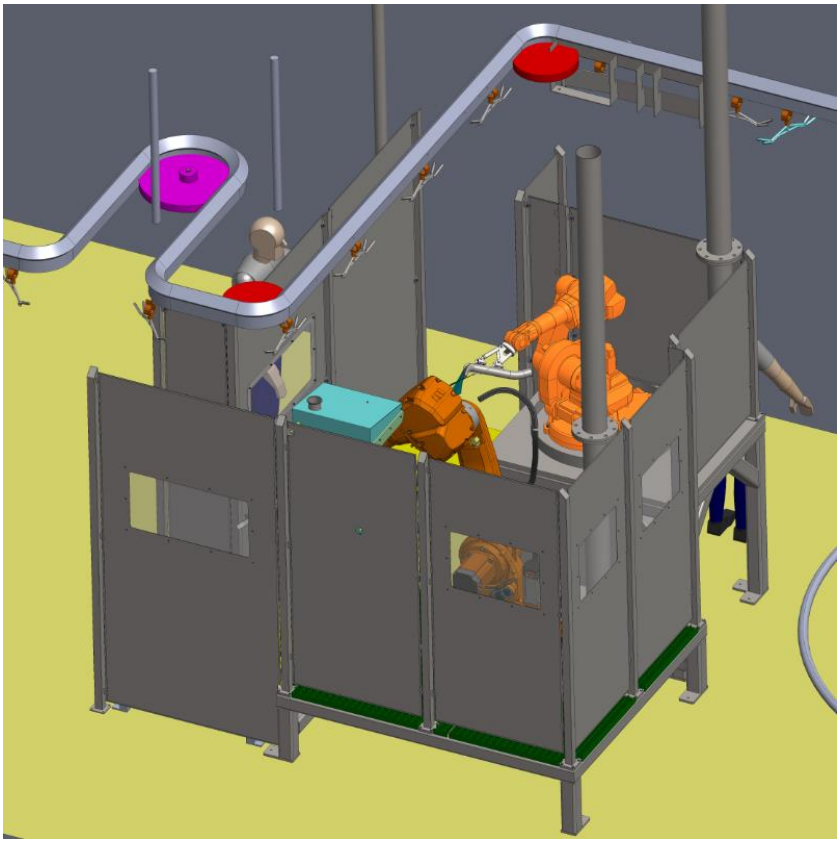

Fig.2 Modular Cell layout

The robot bag from Castricum Bros also could not be used due to the different moves required from the robots between the different sites. A new bag was fabricated and fitted to the robot during the FAT phase of the project.
The brisket cutting tool has been refurbished (shown below) and was fitted to the robot during the System build phase of the project.
The wash tank from Castricum Bros could not be reused as the tool entered it from the opposite direction and a new tank was fabricated.

Fig.3 Refurbished brisket saw

4.3 Carcass Stabilisation/Orientation

As well as stabilising the carcass within the combined cell MAR were required to orientate the carcass as it left the de pelting machine. In conjunction with the maintenance department at Hardwick's several iterations of design for this were trialled with varying success. The final design can be seen in operation in the attached videos. The design is simple and involves no moving parts, which eliminates issues with maintenance and component failure.

4.4 Sensing trials

Sensing from the Castricum Brisket Cutting System is being utilised including the use of carcass height sensors to detect carcass length. This eliminates the need for a selector switch for carcass length selection. These sensing systems have been proven to function correctly in past Brisket Saw and Sanivac installations. An additional sensor has been added to detect carcass rotation. If the carcass is rotated incorrectly with the neck facing the brisket saw, this sensor detects the neck and inhibits operation of the Sani Vac and Brisket Saw on that carcass. This sensor has not been required in past installations where the carcasses have been hung from fixed gambrels. At Hardwicks the gambrels are free to rotate and this sensor has been added to check that the gambrel

orientation system has oriented the carcass correctly and eliminate any potential damage to the tooling or carcass.

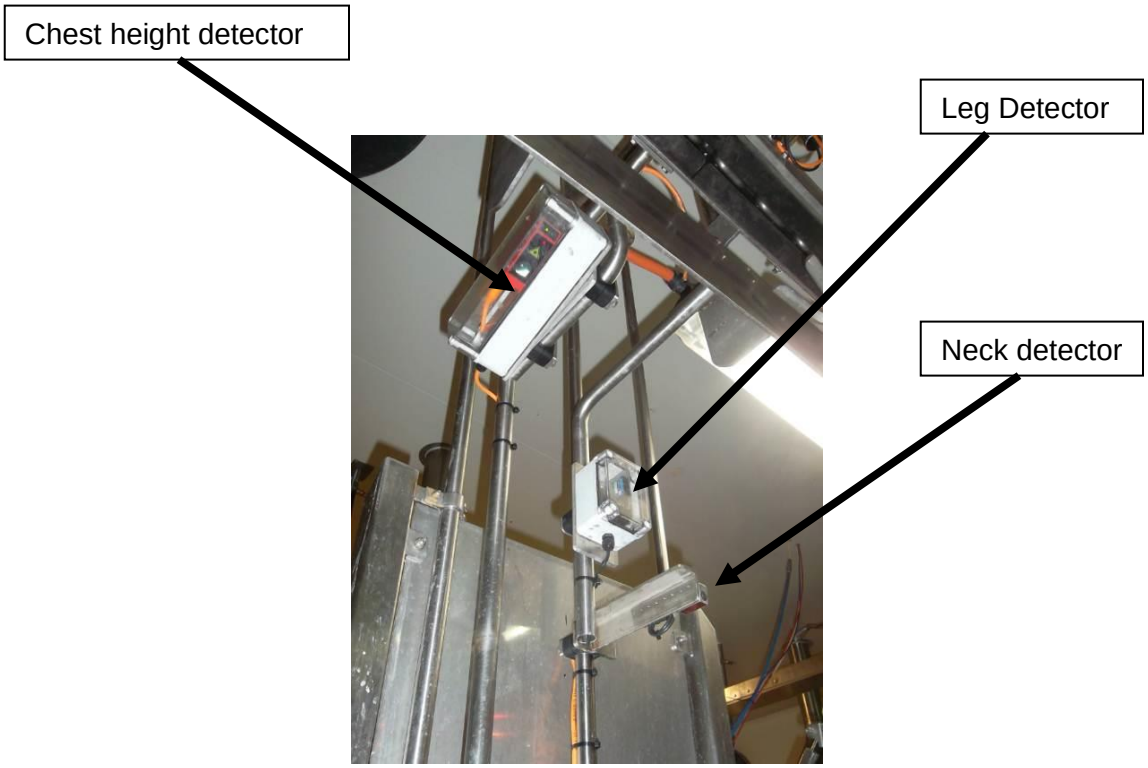

Fig.4 Sensor Locations

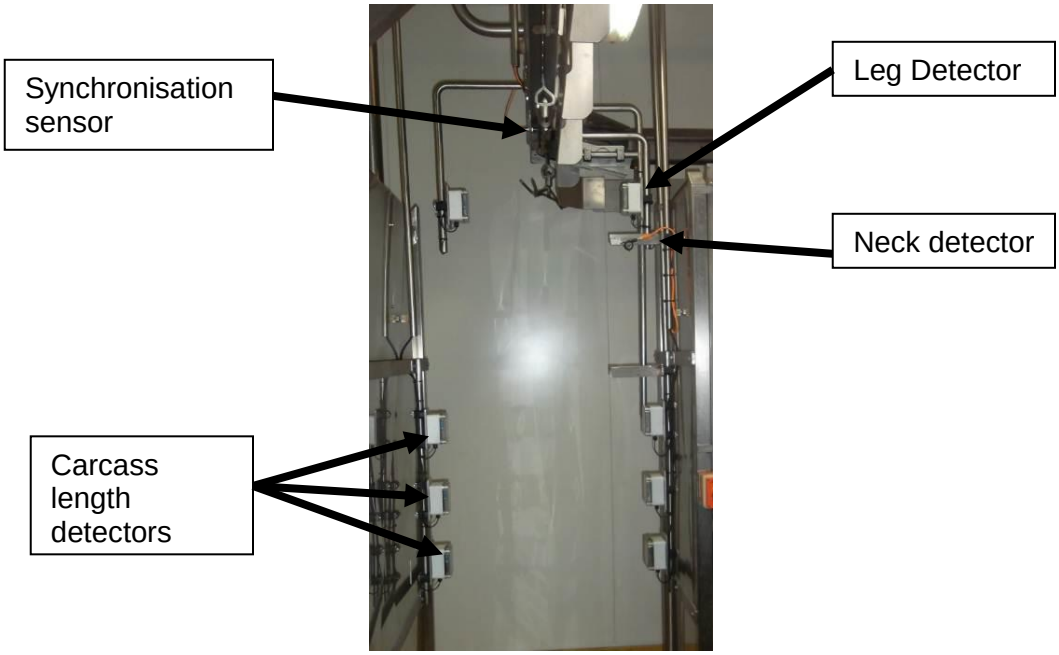

Fig.5 Sensor Locations

4.5 System Build Integration and Setup at MAR

The images below show the system setup up in MAR. The construction phase saw the system mechanically and electrically assembled in full in MAR's workshop in Silverwater. All safety, sensing and operator controls are wired in and tested and the robot protective bags were fitted. The robots were programmed and integrated with the sensing and safety systems and then operations trialled and tested.

Fig.6 Cell Setup at MAR

Fig.7 Cell Setup at MAR

Fig.8 Internal view of cell setup at MAR

4.6 System FAT at MAR

The accompanying videos show the system being tested at MAR for FAT. Hardwicks did not attend the FAT however the following was achieved:

- System operation and design was reviewed internally at MAR.
- System operations were simulated, including recovery from fault scenarios
- Cycle time was tested and shown to be capable of handling 10 carcasses per minute.

4.7 Onsite installation of System

The initial plan was to install the system and have it commissioned and running in production by the end of November 2011 so that it did not interfere with the busy time of the year in terms of production during December. Due to some delays in equipment supply however it was realised that this was going to be difficult to achieve. With agreement from Hardwicks the installation was postponed until the middle of January.
The images below show the progress of the installation along with some of the challenges that were experienced along the way;

- Additional packing of base legs was required to account for the large slope in the floor
- A dog leg had to be added to one of the robot conduits to avoid over head conveyors

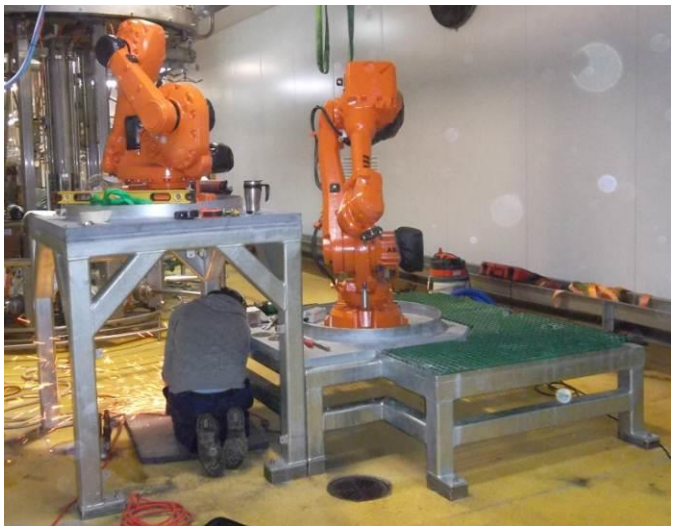

Fig.9 Installation progress images

Fig.10 Dog leg required in robot conduit to avoid overhead conveyor

Fig.11 Packers required under robot base feet

Fig.12 Robots controllers, MCC and cabling in control room

4.8 Commissioning and trial

The accompanying videos show the system in operation and formal SAT was signed off by Hardwicks on 9/2/12 with an accompanying list items for action. A subsequent visit to site was made and these outstanding items were finalised with Hardwicks on the 20/3/12.

4.9 Presentation, Video and Documentation

The documentation supplied to Hardwick's along with this report and the accompanying video satisfy the requirements for this section.

5 Success in Achieving Objectives

As can be seen from the discussion and images above the objectives of the project have been met:

- A Project Risk assessment was provided at the beginning of the project as part of Milestone 1 as was used as a live document and monitored throughout the life of the project.
- The Brisket cutter solution was further developed by making the design modular and hence easier and more cost effective to reproduce.
- The system was first tested in a controlled environment during FAT at MAR's work shop and then installed and commissioned at Hardwicks to client specifications, specifically these were:
    - The ability to handle a carcass rate that varies between 5.5 to 10 carcasses/min
    - The system utilised an encoder fitted the chain drive to synchronise robot operations with actual chain speed.
    - The system has been designed to process stock from 8kg goats to 45kg hoggets, utilising a sensor tree to detect carcass length and eliminating the need for the 3 position switch that has been used in the past.
    - A side mounted sterilization tank has been utilized as was in place at Castricum Bros and is now in place at GMP
    - A carcass orientation and stabilisation system has been successfully integrated
    - Full stainless steel guard panels have been utilised

6 Impact on Meat and Livestock Industry – now & in five years time

Benefits to be achieved by utilization of the Robotic Brisket Cutting System include:

- Improvements in OH&S;
    - Elimination of risk of operator strain injury from the size, weight and repetitive tasking
    - Elimination of dangerous operational practices
- Consistency;
    - Robotic mounting and control of the Brisket Cutting process improves accuracy and repeatability over manual systems
    - Improved sensing technology (laser) and software allows carcass variations to be identified providing a platform to implement variable robot positioning and paths.
- Labour cost:
    - The system will replace 1 unit of labour per shift.
- Species:
    - The Robotic Brisket Cutting System is suitable for use in lamb, sheep and goat processing

Reliability and accuracy, along with processing speed which are critical to the success and acceptance of this technology have been achieved throughout this project.
Production levels at plants such as Hardwicks justifies the investment in a robotic system and the recent inclination for Australian processing plants to participate in robotic developments shows the trend the industry is following towards further automation. This is fuelled by acute shortages in labour supply, which will likely get worse in the future.

7 Conclusions and Recommendations

It is evident from the discussion above that the Robotic Brisket Cutting System that has been installed at Hardwick's Meat works is a success. The modular design that has been implemented here allows the system the be reproduced and installed in a cost and time effective manner and MAR are confident that the system is commercially viable and recommend its adoption by further producers.