final report

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Robotic Hindquarter Vac San Project Implementation Report

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1 Introduction

This document covers the implementation of a Robotic Vac San System for the sterilisation of the hindquarter and anus area of a sheep/lamb. The robot system was installed at Country Fresh/Peel Valley Exporters plant located in Tamworth NSW by Machinery Automation and Robotics. The robot went into production on 7th April 2008.

The system replaces the manual operation of using a handheld vac san wand and delivers a consistent vac san path on each carcass passing through the system. The system is located in the quality inspection area of the production line. It consists of safety guarding, safety equipment, operator controls, sensors and a standard Kentmaster vac san wand fitted to a standard ABB IRB140 Robot.

This is a turn key solution which is started stopped at the operator panel. Upon start-up the robot autonomously tracks and vac sans every carcass that passes through the cell.
Swab testing before and after the installation has been conducted and an AQIS inspection to prove the system.
The first system that has been installed meets the solution requirements of the project with room for improvements.

2 About the system

The system aims at replicating the actions of a manual operator. Manual operators were studied and it was noted that they look for impurities to vac san, others do a consistent path and some of the carcasses are not covered at all. The objective of this system is to consistently vac san an area with a fixed path that will vary with the length and thickness of the hind legs.
The vac san path consists of 5 strokes where each stoke starts at the top and moves down as shown below in Figure 1. The strokes have been arranged to maximise effective use of cycle time. The sheep is presented with its hind legs hooked into a rotating gambrel. The path is more effective if the sheep entering the cell are stable and in the correct orientation which is with the anus facing the robot. A stabilisation bar has been added to guide the gambrel through the cell as shown in Figure 2.

Where to next

The second Robotic Hindquarter Vac San system will be installed at Burrangong Meat Processors, NSW within the coming months as part of the initial development project with a further two systems being installed late 2008/9 completing the development prior to commercialisation.

Figure 1 Robotic vac san path

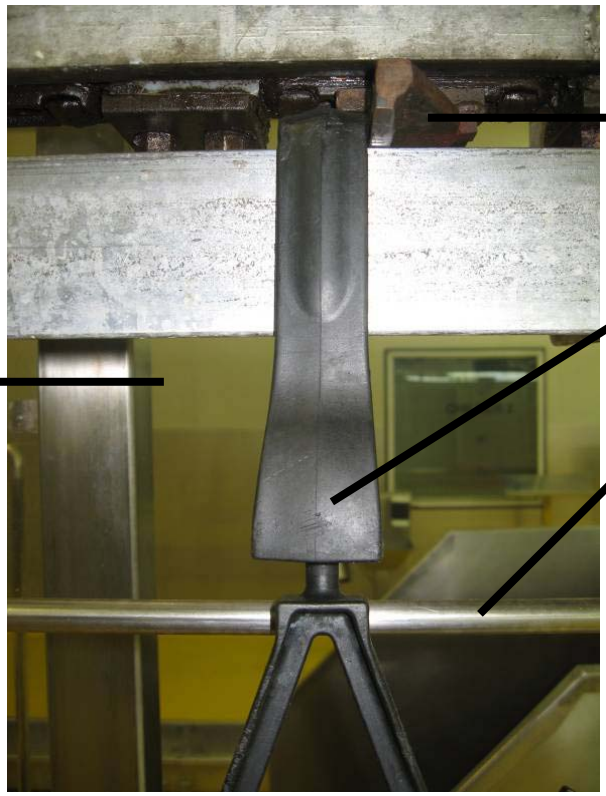

Figure 2 Gambrel and stabilisation bar

3 System Design

The robot cell is located in the same position as the original manual operator which is in the quality and inspection section of the production line. Figure 1 below shows the safety guarding, safety mats, robot position, operator panel, vac san control panel and the main line which passes through the cell.

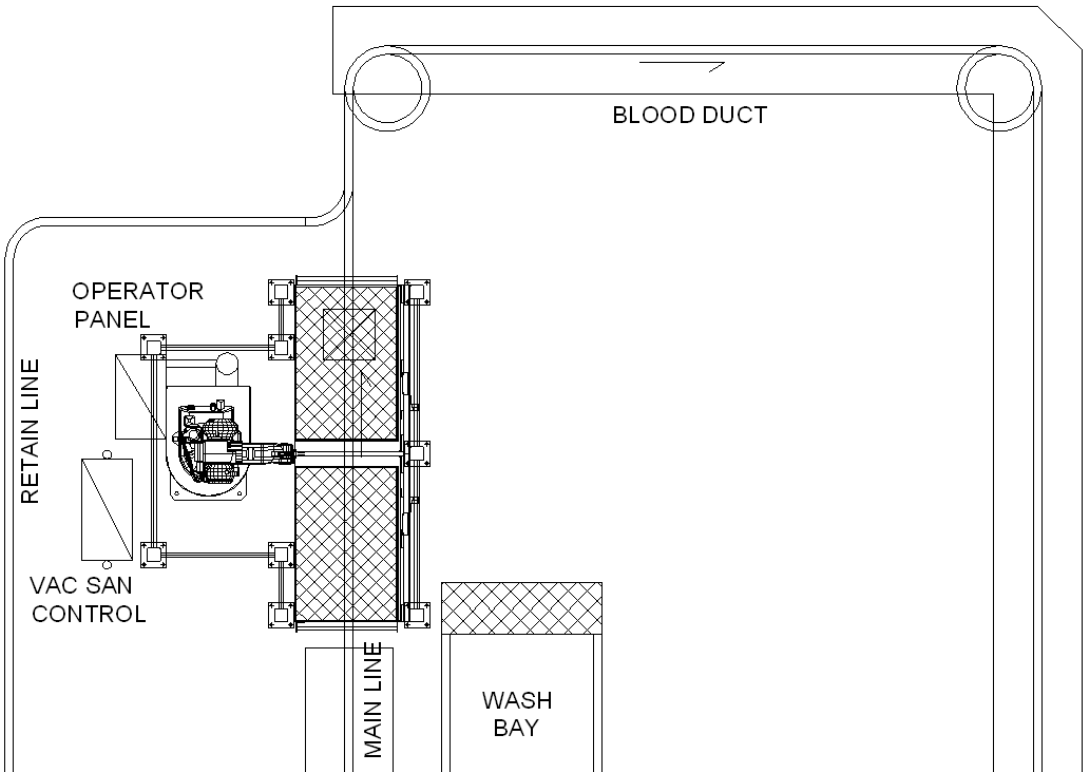

Figure 3 Robotic vac san layout

3.1 Safety Guarding

The safety guarding is made with stainless steel posts and 6mm clear scratch resistant polycarbonate sheets. The safety guarding is designed to prevent personnel from coming in contact with the robot.

Figure 4 Robot cell with protective guarding

3.2 Safety Mats

The safety mats have been installed to protect personnel around the robot cell from coming in contact with the robot. There are two safety mats installed. The safety mats trigger when a person or a weight is on them. The floors may be lifted up and held back with a chain and hook for cleaning purposes as shown below.

3.3 Robot & Vac San Wand

The robot is an ABB IRB140 with a standard Kentmaster vac san nozzle mounted to it with a white protective cover.
The vac san wand has been fitted with an air cylinder. The cylinder is designed to apply an even amount of pressure as the vac san nozzle passes over bumps and variations on the sheep during the vac san.
The protective cover is made from PVC taught-liner material and is custom designed to fit the robot and protect the robot from water entering into the motors. The bag is inflated to allow free movement of the robot within the bag and create Positive pressure to also stop ingress of water into bag.

3.4 Panel

The robot system is started, stopped and reset from the operator panel. There is also a digital temperature gauge on the panel showing the temperature of the hot water at the vac san nozzle. The operator panel may be used to stop the robot immediately using the emergency stop. The fortress key shown on the panel allows maintenance staff to isolate the system and attend to robot issue via the inspection gate located on one side of the robot cell.

Figure 5 Vac San Gripper

3.5 Operator Panel

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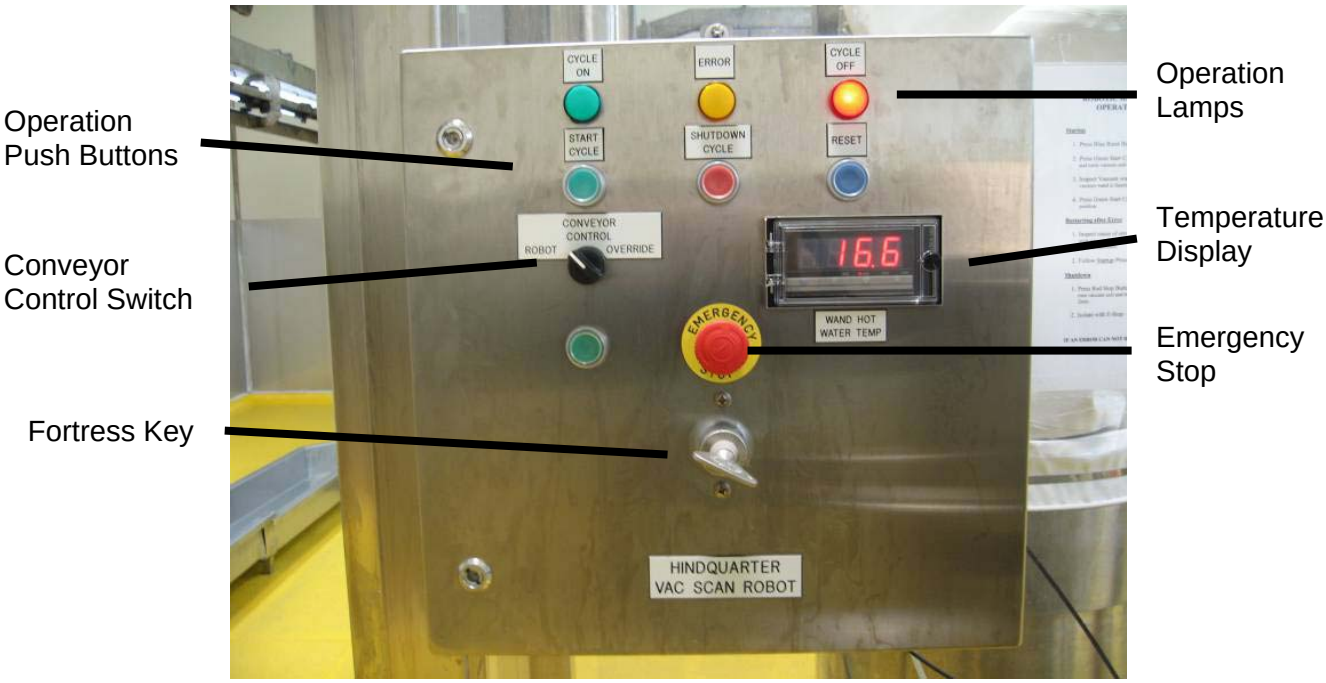


Figure 6 Operator panel

3.6 Sensors

The main sensors include the following:

1. Crutch distance laser
2. Leg depth laser
3. Trigger switch
4. Hot water temperature sensor

1. Crutch distance laser
This laser is located above the chain conveyor. When the carcass passes into the robot cell, the laser records the depth of the crutch area between the legs. The robot program then selects the maximum distance reading which is the lowest point on the crutch. The program uses the distance to position the vac san nozzle accordingly.

2. Leg depth laser
This laser is located on a robot cell guard post. The laser is aimed at left most hind quarter shank. The laser takes measurements as the carcasses pass into the cell. The program selects the minimum distance reading which is the highest point on the shank. The program uses the distance to position the vac san nozzle accordingly.

3. Trigger Switch
The trigger switch is mounted on the chain conveyor frame and is located at the entry to the robot cell. The trigger switch is used to monitor the knuckles attached the chain conveyor pushing the plastic gambrels. *Note: The trigger switch does not switch on plastic gambrels.* Every time the trigger switch is activated, it starts the read cycle for the laser sensors and signals the robot to start tracking the conveyor speed.

4. Hot water temperature Sensor
There is a temperature sensor located on the vac san wand. The temperature is displayed on the digital display on the operator panel. Once the temperature reaches the minimum operating

temperature of 82.5°C an output from the display allows the robot system to run. If the temperature falls below 82.5°C the error lamp will be lit and a warning message will be displayed on the teach pendant and allow the system to continue. If the temperature falls below 70°C during autonomous operation the system will automatically shut the cycle down.

3.7 Kentmaster Vac San System

The original manual vac san is a Kentmaster system. The Robot System basically switches the vac san on and off like an operator. The Kentmaster vac san system is self contained and operates independently from the robot system. The vac san has gauges to measure vacuum, hot water and steam pressure and temperature.

4 Functional Operation

The system is started at the operator panel by the press of the start push button. Upon cold start the system performs a warm-up routine which allows the steam and hot water to reach temperature. Once the system has reached temperature, the operator presses the start button again to resume cycle. The robot moves to a waiting-position ready for a carcass.

A vac san cycle is started when a chian knuckle (pushing a gambrel) passes the trigger sensor. Once this occurs, the 2 laser sensors read the height of the crutch and depth of the shank. The robot then positions the path to suit the measurements taken. If one and/or none of the measurements taken are within a certain threshold the system will do nothing. The common circumstances the system does nothing is when there is no carcass present or the carcass has rotated to an unknown position.

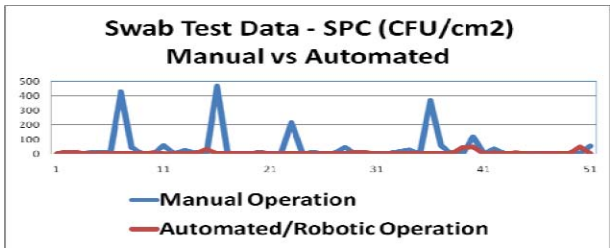
Upon each cycle the robot performs 5 fixed stokes on the hind quarter and then returns to the waiting-position ready for the next carcass.

In the unexpected event the gripper on the robot collides with the carcass the robot stops immediately. The error may be reset by restarting the cycle at the operator panel. This will occur if the carcass is swaying or has entered in the wrong orientation.

The system is shutdown by pressing the shutdown push button. The robot will go to the shutdown position and run a purge routine for 2mins to remove fat from the vacuum lines before shutting down. The shutdown position has been selected to remove the gripper and robot away from the carcass and provide a position for cleaning.

5 AQIS inspection and Swab Testing

Before and after swab testing was carried out by the Peel Valley Quality Assurance Team.
The robotic system did not increase the bacteria counts and matches the manual method used before the system was implemented. Typical Manual Operation vs Automated System swab test results shown below



6 Customer Feedback

Brain Ghangurgh the QA manager at Peel Valley Exporters, is very happy with the Robotic Hindquarter Vac San system and looks forward to seeing the completion of the next robotic systems being installed by MAR at Peel Valley Forequarter Vac San and Brisket Saw in operation.

John McClusky the Plant manager at Peel Valley Exporters, is keen to see a continuation of further robotic developments and innovation at Peel Valley in the near future based upon the success of this system.

7 Project Outcomes

7.1 Carcass Variation

The major challenge of this project is the ability to adapt to the variations in carcass shape and obtain a sufficient level of coverage. The variation in shape was mostly over come by implementing compliance in the vac san nozzle by applying a small amount of pressure with a single air cylinder. This compliance removes sophisticated measurement techniques such as vision, 3D laser scanning and thermal imaging simplifying the measurement down to a total of 2 single point lasers. This method has considerably improved the durability and simplified fault tracing for the maintenance crew.

7.2 Carcass Tracking

An ABB robotic conveyor tracking module was used on the system and has proven to meet the requirements by being able to track carcasses at various speeds and even stoppages with an acceptable level of accuracy.

7.3 Product Integrity

The system performs the same path over each carcass and varies the height and the depth depending on the laser readings. This provides a consistent coverage of every carcass.

7.4 System Design

Originally the system layout did not incorporate an inspection gate for maintenance personnel. After a piece of meat was stuck in the nozzle it was evident an inspection gate was needed to remove the meat without stopping the production line. An inspection gate has been installed and works effectively.

Clear polycarbonate offer a clear view of the robot in operation. Although the system is autonomous, it's still necessary to check the robot periodically in the case meat is jammed in the nozzle or it's malfunctioning in some way. Installing clear polycarbonate sheets is a good initiative.
The operator panel provides the simplest task of starting, resetting and stopping the machine. The panel is robust and suitable for the food industry.

7.5 Operation

The system is simple to start, reset and stop. During autonomous operation the robot will vac san every carcass provided they are within threshold.

7.6 Rates of Operation

The system is currently operating at a line speed of 8-9 carcasses/min and capable of higher line speeds for future developments.

8 Future Improvements

The vac san wand currently moved in one direction which is down. This allows the cycle enough time to perform a vac san of 5 strokes before the cycle time is up and moves to the next sheep. Coverage of the sheep may increase if the vac san wand is further developed to increase flexibility and allow bidirectional paths.

The white bag protecting the robot from wash down is a must for a robot system however the bag suffers from constant rubbing with the robot movements which are some what avoidable. Further research of materials or a water proof stainless robot will improve this aspect.

Upon completion of future development of automated and robotic systems to be installed at Peel Valley, the potential exists to provide a centralised SCADA package that will enable product integrity, down time, faults, and maintenance information to be displayed and recorded for production and maintenance staff.

Further investigation and development is required to improve support system for cables and hoses attached to the manipulator. This will increase longevity of possible wear items such as bags and hoses.