# final report

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## Red Meat Water Jet Cutting and Fat Trimming

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# Abstract

This project introduced new water jet trimming technology to the Australian red meat industry. Waterjet cutting involves the use of high pressure water directed through specialised nozzles which allow a highly accurate trimming of fat from the red meat.

Advantages of waterjet cutting include a reduction of manual handling. The end product is a more "natural looking" steak with curved trim lines instead of typically straight lines as a result of manual trimming. More consistent portion sizes and a more "natural look" offer a higher visual appeal for consumers, leading to increased sales. The accuracy of the cutting system also leads to higher yield and lower wastage, and produces a product with a more consistent shelf life. A waterjet trimming system also offers a cost reduction via automation of manual tasks, allowing increase in production speeds, and reduction in labour costs. Cost per kg is reduced therefore costs are driven down for customers. Other benefits include reduced cleaning time and costs.

A DSI Waterjet Portioning System was commissioned on a red meat production line at RROA in 2017. This system is the first of its type in the red meat industry in Australia, and revolutionises the current manual fat trimming process. KPIs have been monitored throughout the course of, and for a 30-month period following its commissioning, and indicate the technology to be beneficial in all the above areas.

Some further research and the addition of sensor technology may allow for further improvements on the KPIs mentioned above.

# Executive summary

This project was implemented in 2017 with the objective to introduce, install and optimise waterjet cutting technology to the Australian red meat industry which enables the broader introduction of waterjet trimming technology. This technology allows for a higher quality and consistency in meat cuts which has resulted in a higher level of customer satisfaction and driven increased sales.

By automation of tasks previously done manually the result has been reduction in labour costs and a higher efficiency of the line. The product resulting from the waterjet machine has much more of a "natural look" compared with the typically straight lines of manual cutting, which gives it an increased visual appeal. With manual cutting there is a wide variance of cutting depending on operator which results in inconsistent product and variability on wastage. The DSI machine offers the advantage of a high level of consistency and high cutting result, with reduced product waste.

The DSI has also delivered an increased customer satisfaction and offers improved shelf life of the meat due to reduction of manual handling. There has been a marked reduction in consumer complaints post implementation of this new technology.

Post installation, this project conducted a Measurement and Evaluation stage, where the technology is in operation and its performance monitored and measured on an ongoing basis. Data was recorded since the commissioning of the DSI Waterjet Portioning System in 2017.

Throughout the course of introduction of this project and for the period post implementation a number of Coles Key Performance Indicators (KPIs) have been monitored to measure the ongoing performance and success of this new technology. KPIs include the impact on sales, labour costs, yield and line productivity, and quality and customer satisfaction, measured against the manual baseline prior to introduction of the DSI. This report measures the success of the introduction of this technology post implementation by presenting actual results. Data has been captured on each of these areas which provide a valuable insight to the red meat industry on the success of the waterjet trimming technology.

There are a number of positive benefits to this technology which are demonstrated in this report. There has been a consistent rise in sales figures from implementation of the DSI, from offering a more consistent and accurately cut product which is much more appealing and attractive to the consumer Yields have had a strong increase across all products running through the DSI, due to a more precise fat trimming and reduction in head count. The reduction in manual labour due to an automated process has not only decreased the $/kg for production but has added benefits in increasing the line speed, efficiency, reduced wastage and allowed RROA to offer a higher quality product and keep pricing competitive for the consumer. The success of this project has opened up the potential for the waterjet trimming technology to be introduced throughout the Australian Red Meat industry.

In addition to analysis of the KPIs, this report summarises a cost benefit analysis of this project which measures the impact and success of this project against the baseline of the manual trimming process.

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# 1 Measurement, evaluation & reporting of Coles key performance indicators

## 1.1 Criteria: System Performance Testing

### 1.1.1 Key Performance Indicators

Following is an overview of the Coles Key Performance Indicators (KPIs) which have been monitored throughout the course of, and for a 24 month period following, the implementation of this new technology. These KPIs are a direct measure of the success and benefits of the DSI Waterjet Portioning System against a baseline of manual trimming.

#### 1.1.1.1 Sales & Demand

General sales figures for Coles throughout the implementation of this project have been collected.

#### 1.1.1.2 Labour Cost, Line Efficiency and Cleanability

The head count and cost of labour have been recorded and compared for the DSI versus those prior to the project implementation. A comparison with line productivity and line speed has also been made.

#### 1.1.1.3 Yield & Wastage

The overall yield impacts, which is a powerful parameter demonstrating the impact of the DSI, was compared for each SKU which runs through the DSI with comparison to manual cutting. The savings made due to the improved yield have also been calculated and verified.

#### 1.1.1.4 Product Consistency and Quality and Impact on Customer Complaints

Results of customer complaints data and feedback of product consistency were also examined, comparing manually trimmed meat versus waterjet trimmed portions.

A summary of the average shelf life (indicating product quality) for waterjet trimming versus manual trimmed meat is presented. A comparison of the consumer complaints before and after the technology was implemented will be also detailed.

# 2 Overall Project Objectives

## 2.1 Key Project Deliverables

This project has introduced new waterjet trimming technology to the Australian Red Meat industry. The first system of its kind for red meat trimming in Australia, it revolutionises the current manual fat trimming process, improves product quality and yield as well as driving a better customer quality proposition.

The Key Project deliverables include the following:

- Appropriate controlled changes to equipment to ensure clean cuts of meat are achieved without leaving residue.
- Optimisation of system pressure & algorithms to maximise yield and trimming to achieve these required specifications.
- Delivery of head count reductions and associated costs.

# 3 Methodology

## 3.1 Summary of Key Performance Indicators (KPIs)

### 3.1.1 Impact on Sales and Demand

The DSI allows a highly accurate and controlled trim to be performed on cuts of meat which has the benefit of producing an improved presentation and consistency of fat levels. Overall, retail sales figures for meat have increased steadily since the implementation of the technology.

### 3.1.2 Labour Cost and Cleanability

The installation and optimisation of the DSI waterjet cutting machine enabled a head count reduction of 4 head count per shift, reducing the labour cost per kilogram across all SKUs.

An increase in line speed is another benefit which has come from introduction of this new technology.

Line throughput utilising the waterjet cutting technology increased rates compared to manual trimming by almost five fold.

Prior to DSI installation, lamb loin primals were being hand pre-trimmed manually at the primary procesor prior to being sent to RROA in order to meet raw material specifications. It was decided to cease this pre-trimming operation at processor boning rooms and allow the DSI to complete the full trimming operations (i.e. no pre- trimming of primals required). This resulted in a significant saving in labour estimated at around 4 head-count/year at the boning rooms.

#### 3.1.2.1 Cleanability

Cleaning of the line after installation of the DSI has also been reduced by 4 hours per day, as it no longer required removal of the conveyor and machine parts as cleaning can be done in place .

### 3.1.3 Yield and Line Performance

#### *3.1.3.1 Line Performance*

Line performance data indicates that following the initial increase in Line Performance of approximately 20% following its installation in 2017, the DSI has maintained stable performance levels from 2018 to 2021. The initial improvement is attributed to the move from a manual process to a highly automated one, with higher lines speeds, driving the overall improvement in line performance.

#### *3.1.3.2 Yield*

Yield measures the direct proportion between the final manufactured product (output) compared with the raw materials into the line (input). This gives a direct measure of the effectiveness of the manufacturing process. The weekly yield has been monitored over the past 12 month period to monitor the impact of this technology.

The DSI has had a very positive impact on the yield with a consistent increase across all SKUs which run through this unit. Yield inceases between 4.8% and 6.5 % were realised across lamb and beef products.

#### *3.1.3.3 Product Wastage*

With the yield improvements across all SKUs running through the DSI, there is an additional benefit of reduced wastage. The DSI uses accurate automated trimming technology which delivers meat portions trimmed to a higher accuracy of +/- 1% of target measurements and wastage is decreased as a result of over trimming which is typical with manual cutting.

### 3.1.4 Consistency and Product Appeal

#### *3.1.4.1 Consistency and Product Appeal*

The advantage of the automated waterjet cutting is that meat portions are trimmed in a clean continuous curved manner, versus the typical straight cuts with manual cutting. The DSI trimmed cuts look more consistent and "natural looking" increasing the consumer appeal of the product.

Fig 1. DSI Trimmed lamb loins

The cut lines are smooth and rounded. A high level of precision is the result from the calibration of the vision system which individually scans and programs the nozzle for each portion. The more natural lines provide consumers a better presentation of packs.

### 3.1.5 Impact on Quality and Customer Satisfaction

The implementation of the DSI waterjet has had a strong positive impact on both product quality and customer satisfaction. Customer complaints have reduced, and shelf life has been consistent with hand cut meat.

Prior to the DSI installation product complaints were regularly received (2-4 times/month) regarding excessive or inconsistent fat levels on lamb loin chops. After the installation and optimisation of the DSI these complaints have virtually ceased.

The shelf life of DSI trimmed steaks is consistent with hand trimmed steaks.

Adhoc customer reviews in store have confirmed the more consistent and visually appealing improvements of the water jet timed products.

### 3.1.7 Maintenance

The DSI experienced 28 breakdowns in 2019 resulting in 15 hours of downtime. Maintenance costs, which include replacement pump, parts, nozzles and other ancillary items as well as labour, totalled approximately $300,000 for the 2018 financial year.

The numbers for FY2019 were similar at 31 breakdowns, 19 hours of downtime and approximately $300,000 of maintenance costs.

The numbers for the first half of FY2020 were higher than the previous years given wear over the previous years requiring some extra maintenance and over reliance on JBT's maintenance without equivalent RROA maintenance being performed resulting in 253 breakdowns with 120 hours of downtime and approximately $200,000 of maintenance costs. The majority of the costs are attributed to the fact that the system needs to operate at very high operating pressures requiring the use of specialised wearing parts such as heavy-duty diamond nozzles.

The last half of FY2020 experienced $245K of maintenance costs. The system suffered 117 breakdowns with 52 hours of downtime.

Installation of a reverse osmosis (RO) system to feed pure water to the water cutter is currently being evaluated. It is expected such an upgrade would cost approximately $40K and considerably increase the lifespan of the diamond nozzles by eliminating all particles and dissolved salts and minerals from the water. The engineering team is evaluating the potential reduction in downtime and nozzle replacement costs, these will need to be compared with the maintenance requirements associated with the intended RO water purifying system.

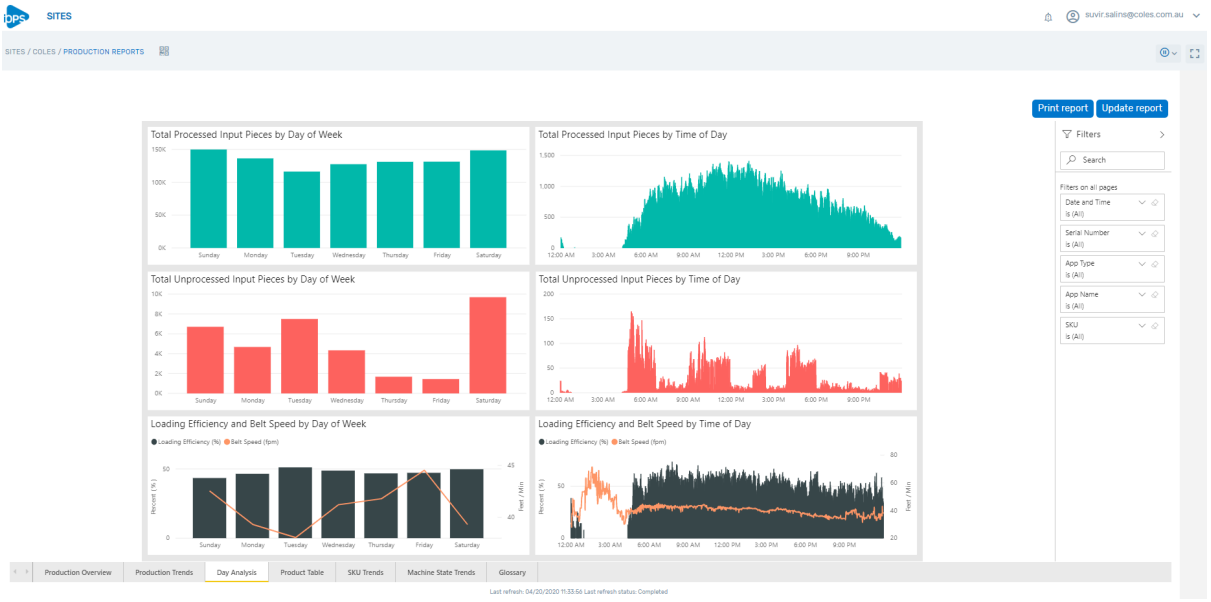
### 3.1.7 Cloud Portal

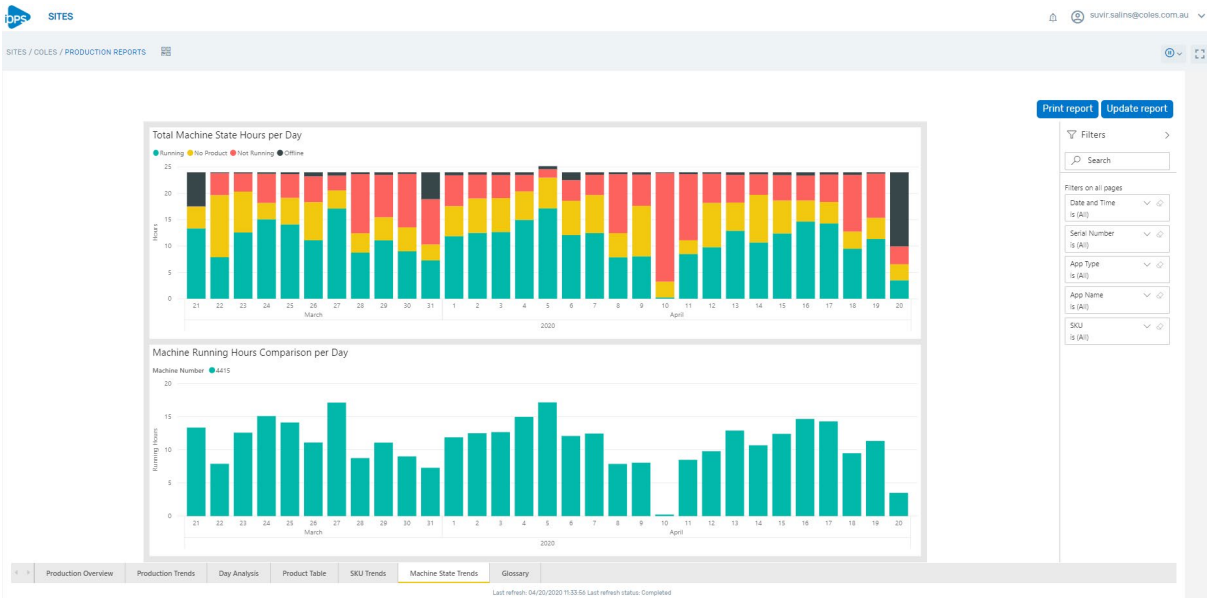
Using a unique combination of the vendor's data visualisation product, JBT iOPS Cloud Portal and their iDSS application which provided access to their cloud database, we have created a data approach which will allow full interrogation and visualisation of datasets to capture information such as yield, unprocessed portions, availability and other critical metrics. Example reports follow in Figure 2.

Using this portal, we were able to identify periods when operators were running the infeed belt at too high a speed which was resulting in a high number of unprocessed portions.

This issue continues to highlight the issue with the waterjet robot's overall speed being too low. Pre-orientation of pieces and lowering of the infeed belt speed would not be required with the use of a 3 axis, high speed robot. This robotic upgrade is being evaluated for future development of the system.

Fig 2. Examples of data visualisation



# 4 Success in Meeting Milestones

All key deliverables were met during this project. This report summarises a number of KPIs which confirmed continued success of the DSI waterjet technology.

Data has been captured over a 36-month period on a number of KPIs including plant yield, sales figures, consumer feedback, cleanability, labour costs and quality. Success of this project has been validated in each of these areas.

There are a number of positive benefits to the DSI waterjet trimming technology which include offering a more consistent and accurately trimmed product, improvement of yields, reduction in head count and increase in line output, enabling RROA to maintain competitive pricing to consumers.

The success of this project has opened up the potential for the waterjet trimming technology to be introduced throughout the Australian Red Meat industry.

# 5 Discussion

## 5.1 Key Learnings

The DSI unit operates at a very high water pressure of 60,000 psi, and due to this high operating pressure particular attention must be given to the ongoing maintenance requirements of the machine. The number of heavy-duty components operating at this pressure results in the need to service and replace parts regularly.

One of the key learnings is that for reliable operation, a dedicated focus is required to maintain these high wear components. Diamond tipped nozzles need to be regularly cleaned and replaced, as do the heavy-duty pump seals. The poultry industry uses ruby tipped nozzles which can be run at lower pressures while still maintaining performance. Evaluation of this technology for red meat is planned.

Another key learning is that appropriately trained technicians and engineers are required on site to support and monitor the operation and performance of the equipment. A comprehensive preventative maintenance program must be implemented in order to minimise the risk of breakdowns and keep the equipment working at optimum performance.

The cleanliness of the camera should be regularly monitored, as an unclean camera results unexpected variation in the cutting of product, or of product going undetected by the vision system.

Regular calibration of the equipment and line speed control is essential. Conveyor speed and meat positioning/orientation are also critical to ensure peak performance of the system.

There remain opportunities for RROA to further improve efficiency of this operation in the future. This could be done by automating the placement at the infeed or automating the separation of the trimmed fat from the meat on the outlet conveyor. These would further reduce the required headcount around the DSI operation.

Furthermore, the introduction of a 3 axis, high speed robot would remove the necessity of pre-orienting pieces or slowing the speed of the infeed belt and would therefore increase the overall line speed.

# 6 Conclusions/Recommendations

## 6.1 Conclusion

### 6.1.1 RROA Impacts

The clear financial benefits have been consistent over the period of continued monitoring.

By automation of a previously manual process, the DSI has reduced labour costs and gives a highly controlled and accurate trim. As a result there has been a significant increase in yield across all meat SKUs which run through the machine. The DSI delivers a consistently trimmed product which is more visually appealing for consumers. Customer satisfaction has increased, with a reduction in complaints received. Shelf life has been consistent with the manual trimming process across all products.

This project had a financial payback of less than one year post installation, which has exceeded the original project objectives.

The installation of the DSI has resulted in:

- Yield improvement through more accurate trimming ranging from 4.78% to 6.5%.
- Line speed increase.
- A reduced headcount of per shift.
- Significant reduction in trimming variability.

No direct correlation can be readily be made between demonstrated sales growth and the installation of the DSI, however, significant improvement in portion consistency and appearance has been noted.

Maintenance costs must be taken into consideration due to the high pressure operation of waterjet system. Replacement of wear components and regular maintenance schedules are essential to ensure optimal performance of the system.

### 6.1.2 Primary and Secondary Processing Partner Benefits

The following impacts to our primary (ALC/GMP) and secondary (ACC/SRS/RROA) processing partners are as follows:

1. $721,000/year nett benefit from lamb shortloin zero manual fat trimming at primary processing and secondary processing.
2. Head count reduction of 1-2 per primary processing partner.

## 6.2 Recommendations

Based on the positive outcomes gained from installation of the DSI, RROA may consider installation of further DSI waterjet cutting units on other red meat production lines. This would potentially create a compounded effect of the benefits outlined above.

Some research into the incorporation of additional sensors to the DSI Waterjet Cutting System may also further the benefits of the unit. Images from the vision system which scan each individual piece of meat are taken in greyscale. Incorporating x-ray technology, such as DEXA, may allow the system to further analyse the product and differentiate between fat and bone. This could expand the range

of products that can be run through the DSI to include Bone-In meat products which would allow expansion of the DSI technology to additional lines.

Currently the DSI requires two people at infeed ensuring lengthwise orientation of the meat in the direction of the conveyor to optimise cutting nozzle movements and maintain a throughput which matches line speed. These operators also push fat closer to lean meat for more efficient cutting. In future development on new units, it may be worth considering development upgrades to the DSI system to increase cutting speed and vision accuracy to make it capable of handling any position and orientation of the meat pieces without speed reduction. This would allow further headcount reduction and cost savings by avoiding the need to orient the meat at the infeed.

The addition of height sensors to allow locating gaps between lean meat and fat would provide the system additional data on the shape and position of pieces of meat. This could potentially allow further increase in trimming accuracy and increase yield.

Evaluation of an anion/cation exchanger to control water hardness would be of benefit in reducing wear on the waterjet nozzles regardless of diamond or ruby tipped selection.

In conclusion, the DSI has been a successful project which has demonstrated strong financial benefits and has delivered a multitude of benefits in terms of line efficiency, higher accuracy of cuts and increased product appeal to the consumer. This new technology offers strong benefits to the red meat industry. Development and implementation of the above improvements could allow the DSI system to provide further benefits to the business.