AMPC

FINAL REPORT

Scoping processor and change management requirements in beef cutting control, yield data traceability, robotics, automation and structured manual cutting and handling.

FINAL REPORT AND GUIDELINES (M4)

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1.0 EXECUTIVE SUMMARY

The project has considered and applied change management as a discipline for transitions in the adoption of automation that can accomplish sustainable benefits in Australian beef processing. The focus has been scoping processor requirements in beef cutting control, yield, traceability, robotics, automation and structured manual cutting and handling. Observations of major beef plants has been made and consultations held with senior leaders of beef operations. The scope of requirements for robotic cutting has been assessed and presented. The key motivations for the project are related to:

- Maximisation of overall yields, especially in high value primal products;
- Reducing reliance on labour whilst improving work conditions, including ergonomics and safety, and retaining the essential work force;
- Meeting consumer needs, while adapting to dynamic changes in demands for volume, variety, quality and consistent supply;
- Managing costs while embracing complexity, simplifying operations and maximising production performance;
- Achieving total electronic information traceability from the start of the process to the point of consumption, supporting the management of the supply chain.

The work has included consideration of the following: -

- Scope and benchmarking
- Automation and robotics
- Skills requirements
- Implementation methodology and process
- Infrastructure changes: space, training, etc.
- Mapping processor needs to supply capability
- Cutting control and yield
- IT and traceability requirements
- Space requirements
- Change process management
- Framework for adoption, current & future solutions
- Change management capacity

The overall objectives, leading to guidelines for managing change, have included:

- Review of meat processing operations and opportunities for automation.
- Review of the benefits, and quantification of the scale of opportunity and barriers.
- Identification and documentation of the scope for implementing solutions.
- Framework for adopting present technology and the scope for longer-term R&D.
- Evaluation of the scope for international co-operation.

The work has benefitted from the experiences of several Australian plants.

Automation of beef processing tasks offers benefit in quality, yield, safety, hygiene as well as efficiency. The manual tasks that have been observed include those in slaughtering, cutting and end of line operations. Automation solutions are already in use in certain plants, particularly for end-of-line palletising. Figure 1 gives a project summary of the priority opportunities in the beef cutting. Time to adoption is presented based on consultation with technology providers: short term being 1-2 years, medium term, 2-4 years, and long term 4-6 years or beyond.

Highest levels of management have been involved in the definition of priority requirements with respect to beef primal handling, manipulation, fixation and cutting. A document defining the user requirement for automatic primal cutting has been drafted.

AMPC 2019-1112		S= Scott Tech	AMPC-BMC Confidential - Australian Beef industry opportunities and management of change	Based on 60 h/h	Other
H-high	L- long	J= Jarvis			H- Hygiene
M- medium	M- Medium	F= Frontmatec		Potential staff saving	Q- Quality
L - Low	S-short	M= Marel			Y- Yield
Priority	Timeline	Supply	PRIORITIES FOR AUTOMATION		S- Safety
H	S-M	S, Other	Pre-cutting and scribing	2-3	Y, S, Q
H	L	R&D	Primal piece separation	8-10	Y, Q
H	M-L	Other, R&D	Chine cutting	4-8	Y, Q, S
H	M	Other	Rib bone separation	2-6	Y, Q, S
H	M	R&D	Button bone and flat bone separation	4-8	Y, Q, S
L	L	R&D	Shank boning	4-6	Y
L	L	R&D	Neck boning	4-6	Y
H	M	R&D	Leg boning (front and back)	4-8	Y, Q
M	M	R&D	Rib cage de-boning	2-4	Y
H	M	Other, R&D	Striploin fat trimming for uniform fat cover	4-8	Y, Q

Figure 1: Priority automation opportunities in beef processing.

Guidelines for change towards adoption with an outline example template for documentation of requirements are detailed. Supplier engagement and management process towards adoption have been considered, following a tendering process involving a leading Australian processor.

The work highlights the significance of senior management involvement in the definition and the processes of change as a first step, followed by the effort to establish infrastructure, including decision steps for the provision of space, services, staffing, training and management resources.

Implementation in all cases requires careful detailed planning with risk minimisation at every step, including in the processes of requirements definition, technology evaluation, and procurement to the point of adoption. The overview of Figure 2 shows typical steps as a guideline that may be followed, in the 'spiral of progress' for a given organisation to start and focus attention towards adoption.

Figure 2: 'spiral of progress' in the management of change from start to adoption.

The validity of automation technology, delivering workable and financially justifiable performance with sustainable functionality at low running cost, is key. Where new R&D is needed, it is important to take direct action irrespective of the time to first adoption, given that the business drivers, value proposition and the automation of identified priority tasks have remained unchanged, whilst labour cost increases and technology becomes more affordable. The recommendations point to initiatives in meat automation research, nationally and internationally, for the long-term benefit of the industry.

2.0 INTRODUCTION

The livestock trade is a significant contributor to the Australian rural economy and has provided an important market for Australian cattle, sheep and goat producers for more than 30 years.

Recent reports places meat export in 4th place at A$ 10.2 billion (4% of the total export value in 2018), after the top three which include primarily the mineral fuel; metals, and other mined commodities. (http://www.worldstopexports.com/australias-top-10-exports/)

Employment in the meat industry is approximately 450,000. Leading Australian companies have expressed concern on increased international competition. Australia remains a higher wage country, with the complications of absence as well as shortages of staff who want to work in the meat sector. Labour is close to 75% of production cost, excluding the value of the meat. Efficiency and yield are compromised by manual processes, unless highly skilled operatives can be engaged to consistently process meat at competitive rates. Safety and work-related health issues are most important concerns. Technology and the management of change to adopt automation are key to the future sustainability of the sector.

Automation technology and robotics offers important solutions to reducing cost, especially with developments toward new applications becoming possible for skilled tasks, supported by research as a global priority. Manging change for progressive adoption, using proven automation, and driving R&D to create new cost effective and reliable robot solutions, are fundamental steps to the attainment of a competitive edge.

Australian processors continue to invest significantly to acquire automation from around the world. Adopting new technology requires careful management of change. The work under this project has considered industry requirements with respect to the specific priority areas of beef processing that would benefit from automation. Guidelines for in the management of change towards adoption are discussed, with recommendations for future R&D and infrastructure developments that can support the sustainable use of automation in the meat sector.

The project has considered change management as a discipline for transitions in the adoption of automation, to accomplish sustainable benefits and outcomes. (http://www.changeenablement.com.au/what-is-change-management/)

Figure 3 gives an overview of the change process followed in the course of the project with the focus on the beef industry interests in Australia to adopt automation in the cutting rooms with the objective to reach improved safety, yield, efficiency and quality. Management of change for effective and sustainable adoption of technology for beef processing from slaughtering to end of packing requires instigation and motivation at the most senior levels of a company. Formation of a project team to review, drive and procure robotics and automation is important in the execution of implementation (see Figure 3). Provision of space and consideration of human resource against specific solutions is necessary regardless of the status (readiness for use) of technology being adopted.

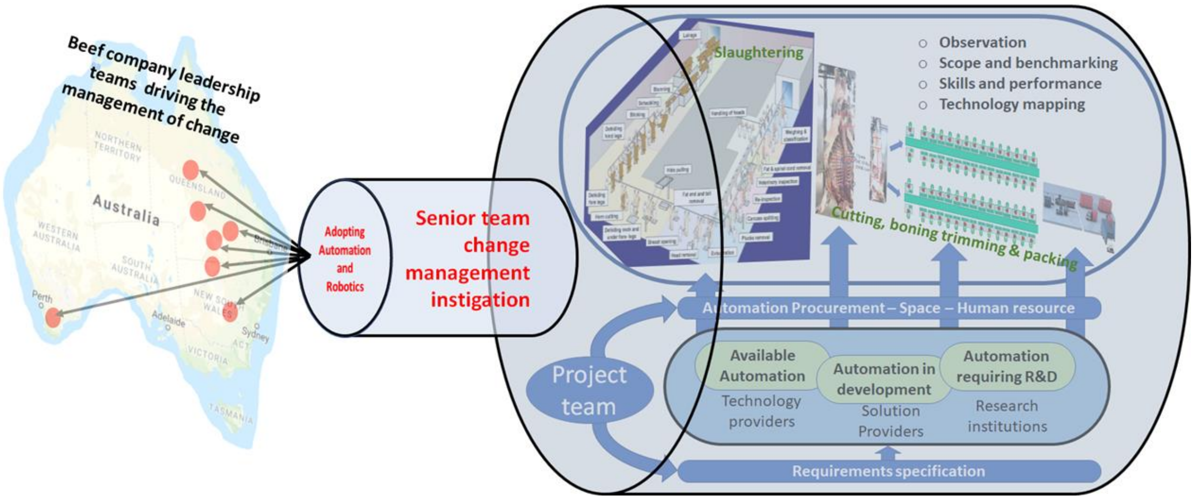


Figure 3: Management of change delivering robotics and automation solutions in beef processing

The project has followed the steps in managing change with support of Australian beef industry. The specific task of primal cutting has been detailed with input from leading beef processing companies.

2.0 PROJECT OBJECTIVES

The objectives of the project have included:

- **Review of meat processing operations and opportunities for automation in relation to cutting and handling tasks.**
- **Review of the benefits and barriers to change, with respect to automation and robotics, traceability and sorting of beef products, and yield control.**
- **Scope of opportunity and potential for implementation of automation and robotics solutions.**
- **Examining the framework for adopting present technology, with the management of change, and the scope for longer-term R&D.**
- **Scoping international co-operation between Australian processors and international technology organisations.**

4.0 METHODOLOGY

Management of changes requires a commitment to improvement objectives, identifying what needs to change, and creating a team with capability and capacity to become empowered to act. Automation in the Australian meat sector is considered a priority in the beef cutting area, where carcass breakup and handling schemes need "re-engineering” for automation, accounting for the associated skills in the manual tasks that achieve butchery. Automated systems that perform skilled tasks in meat processing operations require data from sensors. Traceability of carcass data and its use to drive automation is an important approach. Tracking information forward and backward or on-line during processing can provide the means for planning and online control of cutting processes using both automation and manual butchery.

The decisions by a plant to apply the latest technology within a meat processing plant must consider management approach as well as change implementation, including the need for new skills, and development of current, or new space for automation.

The methodology of this work has covered:

a) Examination of cutting schemes and practices for carcass break-up, butchery, handling and packaging to meet requirements of different customers;
b) Review of carcass and process attributes important to cutting, planning and control of break up processes;

and

c) Review of technologies in robotics and handling systems with integrated IT for improving performance and the evolutionary steps that need to be planned and managed towards adoption.

The approach has focused on a framework for the engagement of technology providers as well as defining adoption steps including skills development.

5.0 PROJECT OUTCOMES

The Australian beef industry has specific requirements for planning automation and robotics, integrated with traceability of information in the value chain. It is important to distinguish the traceability of information that may be required for the declaration of source of origin, in contrast with traceability that allows tracking of data for operations management, risk management (including hygiene and microbial aspects), and most important quality, yield and operator performance.

The adoption of technology is important to future branding and delivery of consistent quality, whilst creating transparency and trust in the supply chain through traceability of information giving effective mechanisms for accurate feedback. This also supports producers to meet the specifications demanded by current and future markets. To this end, robotics and automation technologies combined with traceable methods of handling, de-boning and trimming are important technological implementations. The work has considered automation possibilities, dealing with change management towards adoption in many areas focussing on beef cutting (see Figure 4). The industry requires a clear vision and appropriate mechanisms for managing change. It is important to specify and employ the best automation that support execution of tasks performed manually. It is also necessary to develop competences and commit to skills capability building that support the operation of new automation in the short term, whilst creating opportunities for the young to become engaged in the longer-term generation of solutions needed by the industry.

U- unknown	U-unknown	S= Scott Tech	AMPC-BMC Confidential - Australian Beef industry opportunities and management of change	Based on	Other
H-high	L- long	J= Jarvis	The findings and the tasks, requiring automation have been listed are result of observations during visits and discussions with senior management in Australian beef plants. Identification of supply companies is based on knowledge and direct contact with senior technical team members in the companies. This list is not exclusive. Items in the M-L present R&D opportunities and when highlighted.	60 h/h	H- Hygiene
M- medium	M- Medium	F= Frontmatec		Potential	Q- Quality
L - Low	S-short	M= Marel		staff	Y- Yield
Priority	**Timeline**	**Supply**	**Tasks not included are considered outside of the scope of consideration rather than omissions.**	**saving**	**S- Safety**
* Considered highest priority			**Operation post stunning: -**		
M	M-L	J, F, M	Sticking	1	
M	M	J, F, M	Horn separation	1	S
U	S	Other	Hide wash (optional)	?	H
M	M	J, F, M	Hide opening	1	H
			Hide separation: -		
M	L	R&D	Legging	2-4	H
M	L	R&D	Rump	2	H
M	L	R&D	Front-belly	1	H
M	M	Other	Back	1	H, Y
M	M	M	Final hide pulling	2	H, Y
M	S	S, J	Leg clipping (front and back) and rehanging	2-3	Y, S
			Operations prior to evisceration: -		
M	M	F, J, Other	Bung separation and containment	1	H, Q
M	M	F, J, Other	Brisket cutting	1	Q, S
M	L	R&D	Head separation and associated head operations	2-6	Q, S
			Evisceration and pre-chill operations: -		-
M	M	J, F, M	Belly opening	1	H
M	M	J, F, M	Viscera separation	1-2	Q, H
M	M	J, F, M	Diaphragm cuts	1	-
M	M	J, F, M	Offal separation	1-2	Q, H
M	L	R&D	Viscera and Offal handling for inspection	1-3	Q, H
M	S	S, J	Front leg tip clipping post evisceration	1-4	Q, H
H	S	J, F, Other	Carcass splitting	1-2	Q, S, Y
M	L	R&D	Trimming	3-4	Q, Y
H	S	Other	Carcass wash	-	H
M	M-L	S, J, R&D	Spinal cord removal	1-2	Q
M	L	R&D	Inspection and trimming	1-2	Q, Y
L	L	R&D	Final inspection (FSMA)	1	Q
H	S	S, F, Other	Weighing, grading and carcass labelling	1-2	
H	S-M	S, Other	Post chill scribing such as feather bone and neck bone separation	3-5	S, Q, Y
M	S	Other	Handling for chill room loading	2-4	H
M	M	Other	Carcass grading (marble score) including separation at 12-13 rib or 4-5 rib positions.	2-4	S, Q, Y
			Post chill operations: -		
			Boning room		
L	L	R&D	Pre- boning trim operations as necessary	1	Q
H	**S-M**	**S, Other**	* **Pre-cutting and scribing**	**2-3**	**Y, S, Q**
H	**L**	**R&D**	* **Primal piece separation**	**8-10**	**Y, Q**
H	**M-L**	**Other, R&D**	* **Chine cutting**	**4-8**	**Y, Q, S**
H	**M**	**Other**	* **Rib bone separation**	**2-6**	**Y, Q, S**
H	**M**	**R&D**	* **Button bone and flat bone separation**	**4-8**	**Y, Q, S**
L	**L**	**R&D**	* **Shank boning**	**4-6**	**Y**
L	**L**	**R&D**	* **Neck boning**	**4-6**	**Y**
H	**M**	**R&D**	* **Leg boning (front and back)**	**4-8**	**Y, Q**
M	**M**	**R&D**	* **Rib cage de-boning**	**2-4**	**Y**
H	**M**	**Other, R&D**	* **Striploin fat trimming for uniform fat cover**	**4-8**	**Y, Q**
H	L	R&D	Muscle pulling operations	12-20	Y
H	L	R&D	General meat handling	6-12	Y
M	L	R&D	General trimming	4-6	Y, Q
M	M	R&D	Bone separation	2-4	S
M	M	R&D	Bone slicing (specific to some plants)	2-4	S
			Post boning room		
L	L	R&D	Quality checks and grading	4-6	Q
M	M	Other, R&D	Bagging and vacuum packing	16-24	
M	L	F,Other, R&D	Trim grading and handling	2-4	Q
L	M	F,Other, R&D	Trim bagging or bulk packing	1-4	
			Primal Packing and end of line		
H	S	Other	Product labelling	4-6	
M	S-M	F,Other, R&D	Case packing	6-10	
L	S	Other	Box or crate loading	2-4	
L	S	Other	Weighing, lidding, and case labelling	2-3	
H	S-M	Other	Case storage and retrieval	4-8	
H	S	S, F, Other	Case palletising	4-10	
M	S-M	S, Other	Despatch including trailer loading	4-8	
			Retail operations		
M	M-L	Other, R&D	Primal piece unpacking, trimming, handling	2-6	
L	M	M, Other	Slicing machine loading/unloading (as applicable)	2-6	
M	M	Other, R&D	Retail packing (handling, loading retail trays, etc)	2-6	
M	M	Other, R&D	Retail pack case packing post inspection, weighing and labelling (including case/shelf ready)	2-6	
			Plant up-keep: -		
			Cleaning and washing		
L	L	R&D	Slaughter area	4-8	
L	L	R&D	Boning room area	4-9	
L	L	R&D	General plant	4-10	
			Services, water and drains		
L	L	R&D	Knife and power tool maintenance	2-4	
L	L	R&D	Sanitiser maintenance and daily up keep	2-3	
L	L	R&D	Hide processing	4-6	
L	L	R&D	General plant up-keep operations	6-8	

Figure 4. Automation opportunities and potential benefit areas.

Automation and robotics provide a range of solutions for the beef industry, several in development or adopted in other sectors of the meat industry. Consultations with senior industrialists representing the Australian beef sector, places post chill operations as the highest priority for automation compared with slaughtering and end of line tasks, especially with respect to R&D. Automation of primal cuts and separation by robotic cutting, to replace tasks performed by circular saws or bandsaws, is considered the highest priority. The work of the project has considered slaughtering as well as cutting room operations.

5.1 Scope and benchmarking

The extent of automation use varies in different beef plants. It would be beneficial for the learning of plants to be shared across beef operations in Australia, especially where such would bring lower reliance on scarce labour, improving productivity and the competitiveness. For example, certain plants have high levels of automation and robotics for case storage, palletising and despatch, including also appropriate IT solutions. An initiative to disseminate and facilitate the wide-spread implementation of such solutions with a structured approach to the management of change will bring significant savings to the industry as a whole.

The project has raised important opportunities, with senior leaders of the beef industry who have guided the direction of this project. The scope for change has included the following:

- There is requirement for de-skilling using mechanisations, especially in the tasks that are not yield critical functions. The main objective of such an activity would be to reduce cost of labour, whilst improving efficiencies. Assisted tasks reduce cycle time, increasing throughput or indirectly efficiency.
- Management of change requires planning with involvement from all areas of operation and business. Teams need to be established to drive forward improvements in operations with Automation and Robotics as well as initiatives to make better use of space, technology and human resource.
- Implementing change, especially when adopting automation, demands a parallel initiative in engineering skills development. Maintenance staff also need specific training in advance of automation acquisition planning, supporting projects that are to reach day to day operation.
- Updating everyone with the latest knowledge and keeping skills current, especially with new technology, are key aspects of management of change needing specific attention. Operations benchmarks are also required for skills such as cutting and handling as well as plant or equipment cleaning, and maintenance.
- Timing of adoption is critical, and, in many cases, it is necessary to implement a practice of two stage installation, especially if the automation is the first of its kind, developed from recently executed research. In the first stage, installation needs to be in an area, close to the final operating position of the equipment. This avoids interruptions during the 'bedding in' period, supporting tuning for dependable functionality as well as operator and maintenance training. In the second stage, installation at final location for day to day operation needs to be executed by fully trained operatives and support staff. The two-stage approach reduces

the impact of short stops during commissioning and handover. If a new machine or item of technology were to be employed directly into the process the cost of disruption could be higher than the total investment in the automation itself.

- Requirement for new space can be a major imposition and potentially a reason for abandonment by processors to adopt automation solutions such as robotics. In the plants observed, there is opportunity for space expansion in several locations. Placing automation before the existing manual position it is replacing facilitates the gradual phasing of the automation into operation, allowing the line to continue working with the manual step, whilst the automation is stopped for any commissioning work. The alternative could cause significant loss in operating time, with severe losses that affect the economic justification of the solution being adopted.

Other than end-of-line operations robotics and automation are requirements in the following areas:

5.1.1 Slaughtering:

a) Front leg, (hide-on) hock cutting (Short term solution that may be adopted now). See Figure 5.

Tolerance of the separation position needs to be better than ±15 mm, away from the hock joint as an anatomical reference towards the tip of the leg.

Sanitisation is not required in between cuts. Speed of cutting needs to be 70 head per hour for smaller processors and for larger processors 200 per hour.

Figure 5: Leg Clipping (robot options from Jarvis or Scott Technology)

b) Horn cutting (Medium term solution requiring R&D). See Figure 6.

In several instances the task is a two-pass operation one to cut the horns prior to hide removal and then, to perform a more precise cut separating the root from the skull after the hide is removed. The stage after hide removal requires in-between cycle sterilisation of the tool. The tolerance of separation with the hide on is the same as hide-on hock cutting as in (a). Separation after hide removal requires a ±2mm cutting accuracy relative to the root of the horn at the interface to the head skull. The rate is infrequent in some operations as the incoming cattle may be without horns. Nevertheless, the cycle must be compatible with the throughput in the range 70-200 horns per hour.

Figure 6: Horn Clipping

c) Back leg hock cutting (Short term solution that may be adopted now). See Figure 7.

Tolerance of cutting needs to be better than ±5 mm, on the hock joint. Sanitisation is required in between cycles. The process is required as part of the leg de-hiding process. Speed of cutting for smaller processors 70 head per hour and for larger processors 200 per hour.

Two stations are required (left and right Leg). There is a rehang operation in-between the hock cut positions.

Figure 7: Hock Clipping

Solutions have been in development by BANSS and Scott Technology.

Given the requirement for manual hide separation before hock cutting, lower cost hock cutting automation solutions are options, where the operator places the hock in a simple holding device for cutting, also eliminating the need for complex sensing.

d) Bung and bag (Long term requiring R&D), Figure 8.

Requirement is adaptation of existing tools in pork with handling processes that also provide for bung bagging. The rate required is in the range 70-200 per hour.

This is potentially one of the most demanding tasks for automation engineers to develop, given the complexities of the handling stages of tool, bag and carcass tissue, with the added need to ensure hygiene and microbial containment. This is further complicated by the need for in-between carcass wash and decontamination of all items, coming in contact with the carcass.

Figure 8: Bung and bag

e) Hide opening (Medium term development transfer from similar solutions), Figure 9.

The process would use an incision to engage and follow through the length of the carcass to achieve the opening of the hide. It is also necessary to separate the hide from the belly surface of the carcass by a width approximately 30-50 mm. The separation is along the edge, away from the opening and on either side of the opening of the hide. The process is required to avoid contact with the exposed carcass surface. The opening needs to be complete, covering the length, 1600-2500 mm, at a rate 70-200 carcasses per head.

Hide separation using a power tool is common, however the seam following process is complex and requires significant skill.

Figure 9: Hide opening

f) Hide pulling (A semi-automated option, Short term), Figure 10.

Hide pulling is a complex process requiring skilled manual labour to perform the incisions with a knife or a power cutter to separate the hide, being pulled away under tension, using a manually attached chain. The requirement is to separate the hide from the carcass with minimum fat left on the hide. The fat remaining on the hide devalues the hide and compromises carcass yield. The process requires positioning a cutting edge of a knife at the separation point, moving it in a sliding action that releases the hide from the body of the carcass. Positioning tolerances need to be better than half a millimetre with a controlled pressure of the side of the cutting blade against the carcass. The tip of the blade needs to be kept away from the fatty surface towards the inside of the hide skin, during the pulling action, separating the hide at the seam. The automation of the action currently performed manually is part of a long-term research and development proposal under consideration by the Factories of the Future programme in the EU. In general, 2 operators perform this task at rates close to 130 head per hour. Nevertheless, a target speed would need to be in the range 70-200.

Figure 10: Hide pulling

g) Head separation (medium- long term solution). Figure 11.
A solution is required for automatic separation and transfer of the head to a secondary handling system. The requirement is to locate, attach, hold and separate the head from the carcass at the neck vertebra, transferring the head to a carrier. Rate of 70-200 head per hour is the range for different processors.

Figure 11: Head separation

h) Belly opening (Short term).
Once the hide is removed, opening the belly to expose the viscera and offal is a requirement. The accuracy of the cut path needs to be within ±2 mm along the length, with a process that avoids penetration or cutting into the belly. Adaptation of similar solution in the pork sector may be used, whilst allowing for a length variation to cover the range 1600 - 2500 mm. Throughput range is 70-200 head per hour.

i) Brisket cutting (Medium term development), Figure 12.
Separation of the brisket uses a powered saw. The accuracy of the cut path needs to be within ±2 mm and throughput range 70-200 head per hour. Adaptations of similar solutions in the lamb and pork processing can provide a starting point of a solution to this task in beef slaughtering.

Figure 12: Brisket cut

j) Viscera and offal extraction (Medium term solution adapting other exiting systems)

To be performed at 70-200 carcasses per hour, with a separation action that releases the diaphragm from the carcass, whilst leaving the 'skirt' attached. The separation of the offal and viscera tissue must avoid release or damage to the organs, whilst removing all such tissue from the inside of the spine with the tool that is used following the profile of the carcass back. Compliance in the tool carrying mechanism to adjust to the separation path, following the spine profile, may be needed. Alternatively, force controlled active path following is needed to maintain tool contact with the back of the spine, covering distances of tool travel in carcases in the range 1400-2500 mm.

k) Splitting (Short to Medium term), Figure 13.

Following the centre line of the beef carcass spine dividing it into left and right sides is a requirement at 70-200 head per hour. Separation tolerance needs to be ±2mm about the centre of the spine, avoiding soft-siding. Using a knife edge toothed cutting blade is desirable, giving saving in yield and generating negligible meat-bone dust as a long- term R&D.

<u>Figure 13: Splitting (robotics from Jarvis or Scott Technology)</u>

l) Spinal cord removal (Short term after splitting, Long term before splitting).

One approach is to use existing tools (such as the Bettcher cord cutter) integrated with robotic solutions to follow the split spinal cord cavity removing cord and nerve tissue from the carcass.

The positioning and path following process needs to meet with a ±1 mm accuracy with compliance that allows the trimming tool tip of the cutter to engage the walls of the semi-circular channel profile of the split spinal cavity, whilst following the spine column of the split half carcass. The rate needs to accommodate 140– 400 beef sides per hour.

A more elaborate approach would be removing the cord by a snake-arm entering from the neck after head removal, travelling up the spine before splitting. This provides for containment of high-risk cord tissue and has been the subject for R&D (see detailed in the final feasibility report, AMPC project 2017-1085).

m) Steam vac (Short term)

The robotic sanitisation using steam and vacuum for carcass de-contamination has been in use in lamb operations. In beef processing this is applicable and technology transfer can allow low cost solutions to emerge. Speed of operation would need to be at 200 carcasses per hour or 400 sides, with the cycle of 8 seconds per side, allowing maximum number of carcass areas of interest to be accessed for high temperature steam to be applied for de-contamination, with time to spare to move from one carcass side to another on a moving chain. Hock tips, neck region and bung cavity sections are among the high priority areas of the carcass for de-contamination.

Stations require in-between cycle tool wash and sanitisation to avoid cross contamination from one carcass to another. A complete end of shift or day wash is also required meeting the normal standards of slaughtering line cleaning, including chemical washing of the equipment.

Other operations in the slaughtering area such as Offal inspection, cleaning, head processing, etc., pose important challenges. Further effort is needed to document the requirements of such operations.

The operation of the tasks mentioned above, generally require one unit of labour over a single shift. Certain locations demand 2 people, because of the complexity in handling and information processing. The tasks in slaughtering require solutions that fall below a budget figure of A$ 180 for a one to one replacement of tasks per manual operator.

5.1.2 Cutting and boning room:

The scope of the main tasks in the cutting room (Figure 14) may be separated into the following:

- Bone cuts (performed on a whole split carcass hanging vertically)
  - Separation of chine bone from the main spine
  - Cutting through ribs
  - Separating the spine at vertebra positions for example to divide the hindquarter and the forequarter
- Bone-meat separation cuts
  - Featherbones
  - Intercostal meat

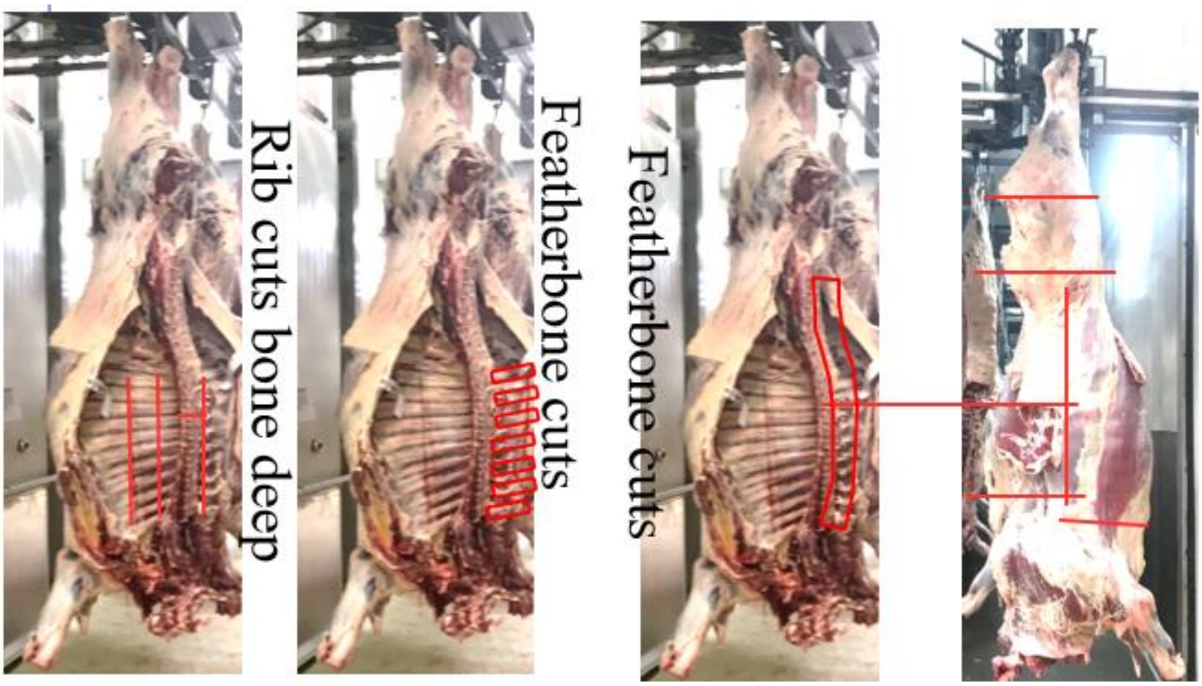


Figure 14: Boning room primary separation operations.

- Muscle separation
  - Meat from bone
  - Seam cutting

The requirement is to perform such tasks to the expected quality and desired accuracy using automation or mechanically assisting tools. The expected cut accuracy needs to be better than ±2 mm, with the ability to repositioning bone cuts with user selectable offsets in the range ±10 mm without compromising specification. Throughput rates need to match 50-150 (and potentially 200) carcasses per hour. Cuts performed automatically from the meat side, as far as the rib cage and spinal bone, would reduce butchery time for the processes that follow.

5.2 Cutting control and yield

The processes of cutting and handling need to be controlled to achieve the following:

- Positioning of cut lines to meet specification without compromising specification.
- Positioning cut lines to ensure that the best yield in higher value pieces is achieved, without compromising specification or quality.
- Controlling the cutting process to achieve the desired throughput efficiently.

Human capability provides for the flexibility to adapt to varying situations and complex range of tasks and products of different shape, size and composition. Automation to achieve the levels of control in beef cutting operations requires throughputs and accuracies ranging from 100 to 200 sides per hour, and potentially 400 for larger operations in Australia. The automation possibilities considered priority, where there is a match between available technology and the processors' requirements include:

- Robotic scribing and cutting
- Structured handling with integrated controls and sensors to provide the basic information and performance data including speeds, weights, yields as well as product quality attributes such as colour, shape conformity, tenderness, etc., helping value chain decisions to maximise profitability.
- Traceability and IT integration, with associated physical product movement controls supporting 'intelligent sorting' in the supply chain and value optimisation processes.

5.3 Automation and robotics

Automation solutions in other sectors may, with additional development, be applied to beef processing, delivering the desired levels of control in cutting processes, giving significant positive impact on both yield, efficiency and safety.

5.3.1 Primal cutting involving bone separation

Robotics is required for scribing bone. This involves performing anatomical cutting from the bone side with the blade tip penetrating bone as far as the meat, bone deep, ideally without entering the meat.

The capability has been available for over two decades. The images in Figure 15 show developments in pork (dating back to 2003), and in beef more recently.

Figure 15: Scribing carcasses by robots

The technologies relating to the scribing or break up of carcass sides have been developed by several providers including BANSS, Scott Technology, BMC, Marel, Frontmatec and others. Use is made of power-driven saw blades and existing industrial robots, adapted for washdown. Sensing is achieved by computer image processing that defines the cut paths for the robot to drive the blade through.

The process of separation requires control of the depth of cut that has not been achieved to acceptable levels despite the use of sensors such as x-ray imaging. The required cuts are shown in Figure 16, as marked in red.

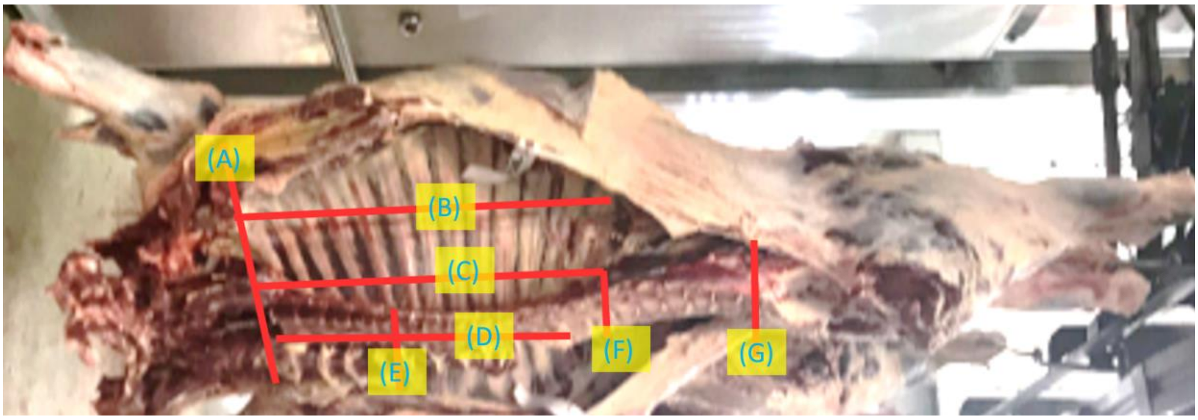


Figure 16: robotic cutting requirements for scribing beef sides.

The cuts are:

(A) Neck – Chuck separation as an optional cut when the neck has not been de-boned previously.
(B) Brisket rib cut from the top of the 13^{th} rib to the bottom of 1^{st} rib, bone deep.
(C) Short rib cut identical and parallel to (B), but 175 mm towards the spine and bone deep.
(D) On the spine at the root of the featherbones.
(E) 5^{th} - 6^{th} vertebrae cut.
(F) 12^{th} – 13^{th} vertebrae cut.
(G) Last lumbar vertebrae cut.

In general, the cuts are as above; however, the variations that exist in different companies can be accommodated by the capability, given the flexibility robotics provides to automatically position or reposition each cut line on a cut by cut basis.

As an estimation, yield gains from controlling the position of cuts (C), (E) and (F), could result in savings of over A$ 750k per year for a plant processing 70 head per hour on a single shift. An important consideration in bone cutting is the use of knife-edge saws with specific perforations that reduce the amount of bone dust, giving additional yield benefits as well as extended shelf life.

5.3.2 Rib removal - separation of intercostal meat

Robotics developments in de-boning pork ribs at Frontmatec supported by DMRI, has reached implementation for first industry adoption, Figure 17.

The solution provides for a system where ribs in a pork belly primal are sensed using imaging and a robotic puller guided by a round blade that engages the tip of the rib bone, allowing a nylon cord to drive under the rib separating the rib bone whilst the rib is pushed downwards along its length. There are several manual tasks in beef operations that may use such an approach for improving the process. These are shown in the images of Figure 18, including featherbone separation and rib cage intercostal meat cutting. Removal of rib bones from Striploin as well as rib roast primal pieces are also candidates.

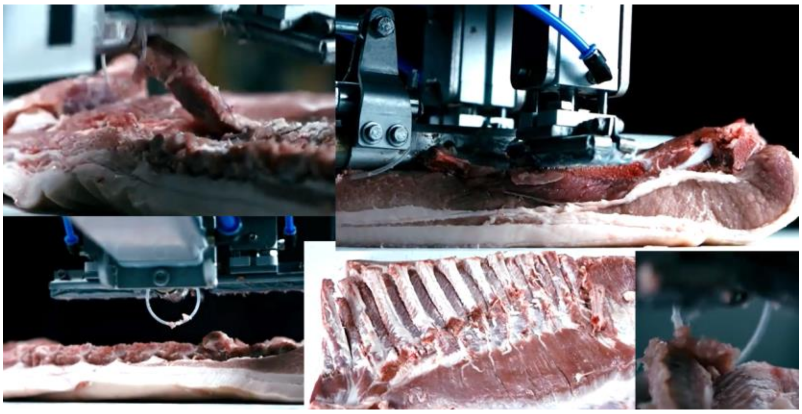


Figure 17: Rib separation

Figure 18: Beef operation for removal of intercostal meat.

R&D in this area is considered appropriate and would result in significant gains both in improved efficiency and yield.

5.3.3 Other opportunities-requirements

In addition to the above, automation solutions for several other tasks are of priority in beef processing with some in development or having reached first implementation, including:

- Chine bone removal (Figure 19)

Figure 19: Chine bone removal equipment

(https://www.midwestmachinellc.com/machine-type/smart-rib-saw/)

- Fat trimming of striploin primal pieces (Figure 20)

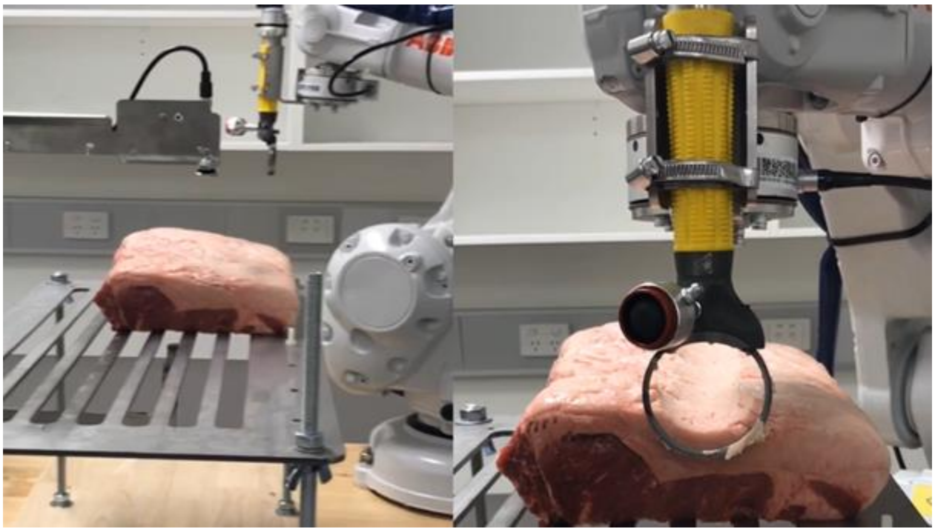


Figure 20: Uniform fat trimming AMPC Project 2017-1045

(http://icomst-proceedings.helsinki.fi/index.php?year=2018 – search Khodabandehloo and click on title)

- De-boning (Figure 21)

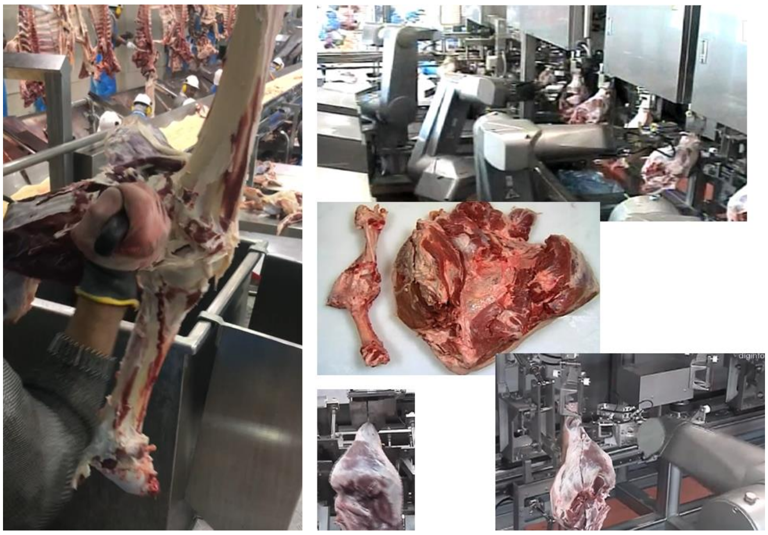


Figure 21: Deboning of beef legs based on developments for pork leg.

(https://www.bing.com/videos/search?q=robot+pork+deboning+japan&view=detail&mid=C4D6F8146A89DCBE5AB8C4D6F8146A89DCBE5AB8&FORM=VIRE)

- Leg bone slicing (Figure 22)

Figure 22: Beef leg slicing machine.

https://www.bing.com/videos/search?q=beef+leg+bone+slicing&qs=PF&cvid=b00156347db048f1a8f7f470103426bc&refig=419a9976f54644f3bbf50b5fa522fc22&cc=GB&setlang=en-GB&PC=HCTS&ru=%2fsearch%3fq%3dbeef%2bleg%2bbone%2bslicing%26form%3dEDGHPT%26qs%3dPF%26cvid%3db00156347db048f1a8f7f470103426bc%26refig%3d419a9976f54644f3bbf50b5fa522fc22%26cc%3dGB%26setlang%3den-GB%26PC%3dHCTS&view=detail&mmscn=vwrc&mid=9E59101021D3CA84E8D79E59101021D3CA84E8D7&FORM=WRVORC

The extent of R&D in robotic cutting varies as some of the developments are closer to adoption, primal cutting is an example. Quantification of carcass variability and the range of size as well as anatomical variability influencing the cut paths, from carcass to carcass, is an important topic for research.

5.4 IT and traceability requirements

The following has been considered with respect to IT and traceability requirements:

- **Task data:** Real time acquisition and tracking of processing information at each station along the production line from start of stunning to the end of packaging needs to provide for assessment of cycles of operation, process performance (with respect to conformance of the task as well as duration ang timing of execution), consistency of the work (quality), yield, and who performed the work and when (operator information).
- **Carcass, primal or product data:** Acquisition of product quality achieved and the attribution to carcass source information as well as end product grades relating to customer specification.

The IT solutions need to provide for the following with respect to traceability:

- **Backward traceability**: The acquisition and storage of task, and operator performance data, in such a manner that allows investigation, interrogation or assessment of the data at any point in the supply chain from the farm (animal genetics) to the point of consumption, tacked back to any stage of process for any given item. In this context, the process of traceability in electronic from would support access to a code or reference identifiable with the product, for example a pack of meat about to be cooked in a restaurant, where the code can reveal of the processor, the transport channels and who was involved in the step by step stages of processing and supply. At a detailed level, the process would provide animal information, transport and processing channels, temperatures, locations for storage, persons or equipment used for processing or handling, with times and dates. The nature of the traceability is historical and a matter of fact.

- **Forward traceability**: involves the acquisition and use of animal, carcass or product information, supporting the process of planning and supply decisions ahead of processing. In this case the requirement is to have IT solutions that provide for, and link with real-time systems of production, allowing attributes such as weights, quality as well as type and other characteristics of the animal, carcass, meat primal or pieces to be used for mapping the route the process takes to reach a delivery of specific form, controlling the logistics from one step of processing to the next, and eventually to a specific customer. This type of traceable process gives the structure and capability for managing the supply process to meet specific deliveries, the required order against quality and quantity, optimising the value chain for all involved.

- **On-line or dynamic traceability**, where the IT and traceable information would support decisions during the processing stages, for the product to follow a different route, meeting a different delivery to what was originally planned. The change may be based on new information relating to weights, quality, other product attributes or processing data, optimising performances and response to customers in real-time.

IT systems connectivity to achieve the above require interfaces to the physical systems of production and automation equipment, facilitating data acquisition in digital form as well as controlling flows or changes in flow to reach the desired result dynamically.

Application of artificial intelligence (AI), providing for management of the operations using the IT infrastructure, traceability and flow controls, optimising the value chain is an important consideration and require further specification and R&D.

Figure 23 gives the conceptual overview of the requirement for information traceability that needs to link automatic carcass cutting and handling system in the cutting room. The cutting room, in most if not all plants in Australia, is where the physical correspondence is lost between each piece of meat, its source and data relating to its characteristic or processing. This is because of the absence of step-by-step tracking of both product movement and information associated with the task.

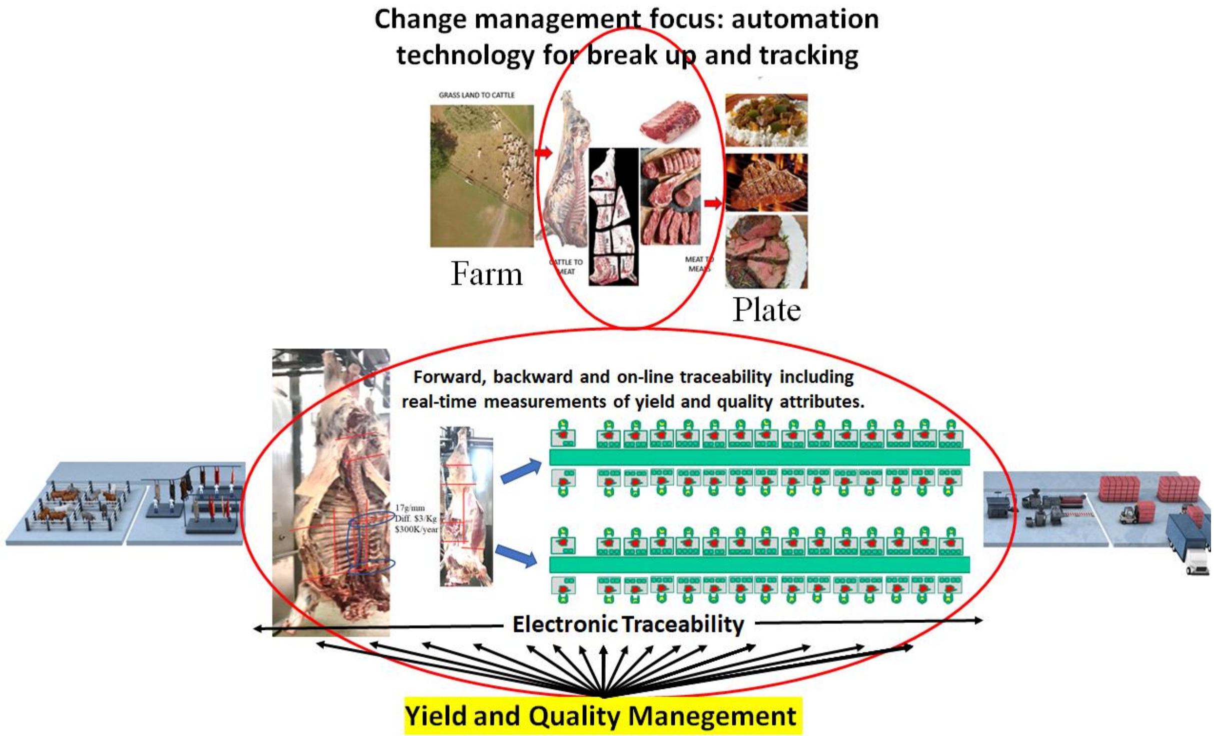


Figure 23: Break up and cutting room automation need to include traceability (see acknowledgements).

The technologies to reach information connectivity along the supply and processing stages of a plant has been possible for many years; however, in the management of change, the definition of the requirements document is essential before engaging solution providers. Given the nature of integration, many departments would have input to such a requirements document. The specific task of this project has followed the definition and preparation of requirements for the primal cutting automation, which has a direct connection with standard solutions (such as those offered by Marel) for traceable processing of primal, sub-primal and packing operations. It is important to note that such systems provide improvements in yield and quality, by the virtue of fact that there is transparent and specific information on the quality and the execution effort of each person working on the line: the information revealing the need for supervision action during operating shifts and/or needs for skill development as a matter for management action. The automation of the primary cutting or scribing, on the other hand, provides direct capability for adjustment of primary cut lines determining yield outcomes. This provides a skill capability for the execution of the task through the adoption of automation, whereas the implementation of a traceable cutting line provides for the management and supervision of the skills of people executing the task.

An important aspect of change management is the definition of requirements for a cutting room with respect to the acquisition of quality data and its attribution to carcass and end products. The schemes of backward and forward traceability would support the mechanisms for such data to be used in operations control and value optimisation. Evaluation and observation under this project indicate that optimum points along the production line for quality measurements or predictions, start at the end of slaughter (from the last slaughter room task onwards), with as much time for sorting prior to carcass break up. This is already a practice for current grading. There are also other opportunities to extend or enhance quality measurements, post breakup, in the cutting area including the following:

- Fat, lean bone weight ratios (using Dexa type technologies)
- Water binding capacity
- Tenderness
- Taste and Smell
- Colour
- Other meat quality attributes relevant to the consumer such as fat cover after slicing.

It is relevant to highlight that solutions for quality measurements on sampling basis, could provide many of the attributes for primal or sub primal pieces along the processing lines. Traceability incorporated at appropriate stages in the cutting, trimming and boning line, including at the point of packing, would provide for quality sorting to the point of labelling. Processors could target consumers who may be prepared to pay more for meat attributes of their choice. With backward traceability in place, where such data may be more appropriately collected after break-up, the reference to carcass relevant to genetics or supply chain value assessment.

Requirements for quality information have been of interest and high priority to the industry. The following technological barriers remain:

- Unavailability of on-line measurements for several of the attributes of interest such as tenderness or taste or eating quality,
- Lack of value proposition data that justifies investment in both the technology and the traceability infrastructure that provides for the capability for using the data for day to day optimisation,
- Last, but not least, the commitment to the management of change that delivers the process specification to include the requirements for the inclusion of the quality measurement capabilities as enhancements to exiting or an integral part of future production lines.

There are important R&D opportunities implementing on-line sensory capabilities and systems of data collection to provide quality information along the supply chain from the point of breeding to the point of consumption. Implementation of electronic data collection in a traceable manner can provide new grounds for value estimation. Optimisation of value is an important subject yet to be explored, specified, researched and introduced through the processes of change management.

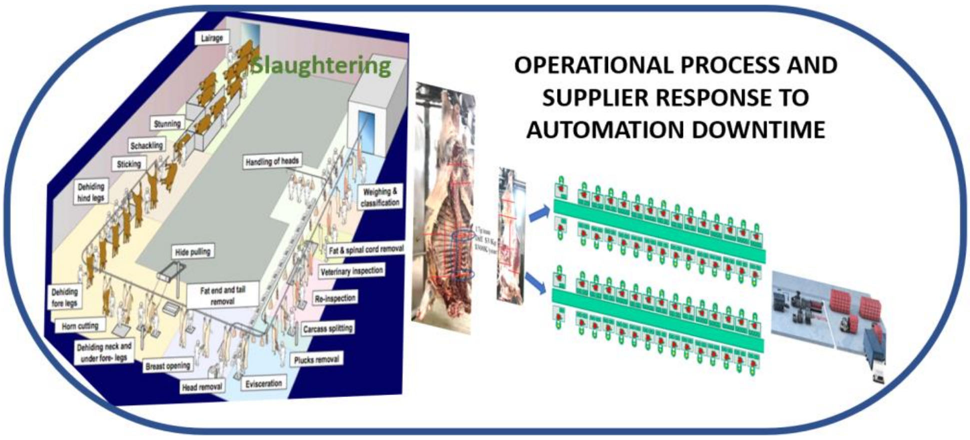
5.5 Skills requirements

The processes of meat cutting in daily production as well as the use of automation technology have high reliance on skills and the availability of trained staff. The processes of achieving change to implement best practice and to adopt appropriate technology require expertise to define, acquire and put into daily use all the possible improvements that support efficient production sustainably. The requirements include the following:

- **Basic labour**: for what is nominally referred to as 'unskilled tasks' – The meat sector may be considered as one of the few that has higher expectations in this respect. Almost every employee working in a meat plant needs to have clear understanding of hygiene, safety and basic rules of conduct as well as processing knowledge of the task.

- **Skilled labour**: performing tasks such as handling in end of line operations, slaughtering, butchery and cleaning. Additional skills need to be further developed for staff expected to operate equipment (as may be seen in packaging areas), including robotics or other technologies that include sensory (such as x-ray) and other forms of automation emerging in the modern cutting rooms utilising intelligent work stations.

- **Maintenance staff:** with skills to attend to robotic equipment and technologies with high IT or software content. The average processor often relies on external contractor for some of the needs, especially in IT; however, this is not ideal and a barrier to change where more automated systems are concerned. There is also a shortage of technical skills, especially in remote regions of Australia, where most meat operations are located. An important consideration is the level of reliance to attend to failure situations minimising downtime. Figure 23 highlights what may be planned when dealing with specialist automation such as robotics.



STOP Duration	PROCUREMENT PROCESS PLAN preparation for automation downtime
< 5 min	operators trained to take recovery action
< 8 hours	maintenance staff trained to accomplish recovery
> 8 hours	call out response from suppliers

Figure 23: Requirement for skilled staff to attend to failure situations.

Reliance on suppliers to deal with the day to day (even with remote IT based online support) is unrealistic, thus the importance of on-site availability of trained maintenance staff.

- **Supervision and management:** Compared with engineering companies, the recruitment tradition of the meat sector does not provide significant capacity in management resource for IT, engineering, or project planning, especially in the smaller beef processing companies. Technology or service providers are generally engaged to accommodate for the shortfall in this capacity, but this is not considered a sustainable approach.

The processes of technology adoption need to be supported by an accompanying skills development strategy as well as a plan. Engagement of skills in the adoption process is the most critical aspect of change management, with the scope of its development, through training or recruitment, requiring specification on a project by project basis.

5.6 Space requirements

All processing areas have constraining space and limitations for expansion opportunity. Automation and solutions requiring the use of the latest equipment have a requirement for stage implementation whilst production continues. Creating space at the appropriate locations in a plant for new installations is a challenge, especially when the equipment must integrate with the exiting flow of material, where interruptions can be costly if the positioning of the equipment compromises performance because of space constraints. In highly capital-intensive projects, the disruption cost, during the period of installation and commissioning alone, could result in production losses greater than the value of the total investment.

On average, a typical automation system, comprising one robot, requires 9-16 sq. metres or approximately 2 metres of chain (or conveyor) length with the area adjacent to the processing line. Installation space in the cutting room are more equipment dependent especially with automation and robotics, requiring sensing stations as well as access for handling or conveying cut items. A typical robot installation requires 6-8 sq. metres, with a sensing station needing half the area again.

An approach to meeting long term requirements would be to establish a ‘dynamic’ space for a first installation of automation to allow commissioning close to the final production line position; achieve performance checks and acceptances, using the space for training and tuning. Subsequent to the installation and operation of the automation the move from the ‘dynamic space’ to the permanent location may be planned and executed by those who are to become responsible for the day to day running and maintaining the system. Suppliers would take a secondary observing and advising role during the installation transfer, providing input as requested.

5.7 Implementation methodology and process

Discussions and observations involving Australian beef processing companies reveal diverse practices as well as varying approaches to managing change. The considerations of the project have included the following:

- Companies require a top down strategy with involvement from all departments in the change processes reaching the adoption of automation. The management of change needs input from:
    - Senior team members (including CEO)
    - Operations managers
    - Sales and Marketing team
    - Quality Assurance
    - Engineering and maintenance team
    - Human resources

- The path to defining the specification for automation needs input at the practical level, where the process of cutting, and associated handling, is defined to suite the capabilities of automation.

- The production process and flow, needs to be traceable in a controlled handling structure, incorporating manual tasks as well as automatic processing and measurements, relating to weights, yields, sizes, meat piece features such as colour, tenderness and other characteristics relevant to the consumer or the supply chain.
- Cutting schemes suitable for automation require technical specification of accuracies for cutting control. The general need is for a ±2 mm, or better, positioning accuracy with the cut position offset capable of being controlled to the same accuracy. Note that to achieve such accuracy, carcass handling and fixation needs to be correctly engineered and performance evaluated in relation to each cut.
- The validation of the processes and the path ways to adoption require engagement of both the internal teams and input from automation suppliers and/or experts that can assess or develop the capabilities in technologies against the tasks to be automated.
- The implementation process needs to engage and expand on engineering, logistics, services. space and human resource.

The instigation of processes that boost confidence in automation as well as team awareness is necessary in the management of change. The status of technology, as may be available or proposed for implementation by potential providers, falls generally into the following:

A) Ready for implantation as proven solution for beef processing,

B) Ready for implementation with enhancements or adaptations of the solution that is proven in a parallel application of similar nature to that required in beef processing,

C) Requires proof of capability with respect to speed, accuracy or performance including quality and consistency,

D) Requires R&D to prove the concept for basic validation of functionality supported by clear understanding of variabilities and the performances that need to be reached.

The automation areas highlighted earlier in 5.3 generally fall under categories B-D as no specific commercial systems that meet the beef processors' requirements have reached the stage of full industry acceptance for adoption. The change management process and the starting point need to be understood, with the buy-in from all involved confirmed before committing to adoption.

5.8 Change process management and infrastructure development

The process of implementing and adopting automation, irrespective of the status of automation (Section 5.7 A-D), requires a commitment at the highest levels of the company, especially under a corporate structure. An important step is the formation of a Change Management Team (CMT).

A first step in planning automation adoption is the formation of a team for managing change with the seniority to appoint project teams. Impact of introducing automation and its benefit as well as implications for infrastructure change and human resource are necessary considerations, as are the following

- Establishing the priorities and defining the plan for bringing the CMT together to deliver against a time plan.
- Ensuring that the process for implementing the steps for the adoption of automation is transparent to the hosting area of the plant(s) and that there is a clear definition of the requirements.
- The understanding of actual capability to be reached needs to be communicated by the CMT. All departments need to be engaged in the assessment of the automation capability to be adopted, validating it against current as well as future expectations. Yield targets and efficiency improvements require estimation as these would normally form the basis of a performance acceptance criteria once the automation is commissioned. They also support the case for Return on Investment.
- The changes and their impact on the operations of the business need to be revealed and quantified against improvement benchmarks to be reached. Evaluation of the benefits in the total value chain is a necessity, as gains in one aspect of the operation may be nullified by practices that may have been overlooked. Specific attention to training is needed as the benefits may be realised only if the skills to operate the automation are in place.
- Process of monitoring progress needs to be established, with clear verification and audit points (or milestones) throughout the automation adoption life cycle.

The role of the CMT with respect to the above is key to the successful adoption process requiring accepted guidelines and reporting procedure.

Under the umbrella of this project the implementation methodology and process of change management has been practiced and may be followed beyond the project by specific processors that have been involved with the work.

5.9 Framework for adoption of current and future solutions

The adoption process requires confidence in both technology and capacity to receive the technology from a credible source. In some cases, the Processor needs to create the credible source through the change management process. An important critical step is the understanding and formal definition of the requirements for automation and its 'ownership' by all concerned, including the supply organisations willing to deliver the solution. The establishment of the framework for such understanding is best facilitated by the formulation of a clear document that provides a consolidated and verifiable set of technical expectation for the automation technology of interest.

It is important to produce a requirements document (See Appendix 1) with engagement of operating plant, following the stages below:

- Formation of a change management team (CMT) comprising:
    - Chief Executive Officer
    - Investment - Innovation Manager

- Value Chain Manager
  - Operations Director
  - Plan General Managers
  - Advisors, including those involved with QA
  - Members of the Operations Team from various Plants.

- Observation of current practice by all concerned in the CMT.
- Brainstorming and trials by the team in a series of planned sessions.
- Review of latest technologies and establishing the tasks requiring automation.
- Input through consultation including advisors to assess technology capability and benefits.
- Dissemination of options for automation and engagement of the operations teams to set priorities.
- Discussions with supply organisations.
- Drafting of the requirements document with input from CMT members.
- Internal Sign-off before issuing the requirements document (Appendix 1) for formal tendering.

The use of a detailed requirements document provides the clarity for engaging supply organisations. The effective process for managing change requires such a document for every acquisition or procurement resulting in automation installation regardless of the level of investment or sophistication of the equipment. A supplier specification in most cases is insufficient, but a useful starting point in the definition stages of the requirements to be documented.

5.10 Mapping processor needs to supply capability

Mapping the requirements against supply capability is necessary to judge if technology can or is capable of advancement in a reasonable timescale to deliver the critical elements of the overall automation solution. The confidence to proceed with a tendering process requires clarity as follows:

a) The overall solution achieves savings in labour and contributes to yield in higher value beef cuts,

b) The capability to supply automation is 'risk free', and contractually achievable by providers under a formally agreed technical specification.

The response to the requirements document from a provider for a given solution is indicative of technology readiness that may be delivered.

The requirements document (see Appendix 1) is an important vehicle by which the framework for change and the management of adoption of technology for automation, in this case primal break up, may be reached. The document of Appendix 1 ensures the supplier considerations encompass the actual needs of the processors once it is formally signed-off by the project team and not necessarily the solution the provider believes the user may have to adopt.

5.11 Change management capacity

The adoption of automation relies on the identification of all changes in an enterprise and the capacity for managing the change that provides for sustainable use of technology.

The steps in the definition of the requirements document, as an internal activity within the processors' organisation, delivers the following:

- Engagement of the key participants in the process of adoption,
- Understanding and awareness at all levels, especially the leaders in the organisation, of the possibilities, challenges and quantifiable opportunities,
- Technology awareness, by all concerned, including at senior level, based on practical evaluation of the possible solutions that may be required,
- The extent to which existing technology supplier installations, mapping the requirements, have survived the test of time,
- The extent of gaps in supply capability that must be filled to reach a minimum risk installation, with the total life-cycle of the automation being manageable, especially where new capabilities are to be achieved within the scope of supply, some requiring R&D.
- The clarity and scope of accountability that must exist in the supply process for sustainable automation to be delivered.
- A structure for communication between all parties, facilitating the processes essential to reaching a complete solution at an early stage of engagement, supporting a legal framework in the formalities of procurement.

The change management capacity of meat processors in reaching the outcomes that deliver the above as well as the procurable automation solution relies on the following:

a) The engagement of senior management and their time to deal with the internal change(s).

b) The establishment of mechanisms for day to day management of the step changes towards the adoption of automation, whilst delivering the daily results in the normal business of meat production.

c) The mobilisation of the resources that support the changes in space, services, operations and management practices as well as training and recruitment of human resource with skills that fully support the integration of the automation to be procured.

d) Planning capacity requiring management time, including operational support functions that sustain the daily use of the automation accommodating uncertainties, especially customer specification changes.

The instigation of a CMT in the automation adoption process is a fundamental step as a formal best practice approach with respect to the above.

Without the creation of the change management capacity and engagement of the team members to instigate and achieve short, medium and long term measures that embrace and adopt automation, including the mobilisation of supplier or provider talent, the industry's position to advance and sustain its competitiveness, in a global consumer focused market, would diminish. Such attention is considered a highest priority for the Australian beef and generally the red meat sector, given the conditions in the labour market and the necessities to making the best use of available workforce, increasing the production volume of quality meat at reduced operating cost.

6.0 DISCUSSION AND GUIDELINES

The work of this project has considered approaches to managing change in the adoption of automation. It identifies the most significant barrier to change in the adoption of robotics to be:

- the unavailability of significant number of skilled and qualified people, who may be prepared to work in the meat industry, project managing and operating the technology
- the lack of knowledgeable and experienced providers for practical implementation of automation solutions needed by the meat sector

  and

- the constraints imposed by the unavailability of suitable space in the processing area to house the equipment.

A focused action is needed in the establishment of sustainable capabilities and infrastructure in research and education to progress in tandem with the adoption of robotics and automation solutions, which are existing, newly developed or being developed through R&D.

6.1 Change process and automation adoption

Improvements requirements identification; change definition and management steps to achieve beef processing automation contribute to the sustainability of the industry. The adoption of automation requires motivation for progress at all levels of management. Figure 24 gives an overview of the progression in change management practice that instigates and executes the adoption of automation.

Figure 24: Spiral of change progress to reach automation adoption.

The high-level step change that is needed to start the processes of adoption must come from senior leaders. Once the agenda is set, the steps spiral towards a working automation solution in the progression shown in Figure 24 and elaborated below:

1. **Senior team agenda for improvement**

A sustainable adoption process requires senior management commitment and direction. Planning and implementation of automation requires change against clearly instigated improvement objectives. To reach the outcomes that have effectiveness and longevity an important task for the senior team, (generally the Company Board) is to set the automation agenda for the company, form a CMT (Change Management Team), and empower project teams to execute.

2. **Responsibilities and plant observations**

The identification of automation priorities is often a challenge in an organisation. Observations and analysis of day to day operating practices is necessary in a systematic manner. The mapping of automation options to the specific requirements provides the framework for assigning responsibilities and how the change process is to be achieved. An important step is the formation of a CMT involving participation of company leaders and senior plant managers, tasked with the responsibility to deliver the outcome(s).

3. **Change management team brief**

The direction from the senior team in an organisation to achieve automation implementation requires action at a working level that has connectivity with plant operation through the plant management operating the day to day. Forming a CMT with membership from senior team and plant management as a formal process is a step towards the procurement of robotic solutions for the plants. It is necessary to emphasise that robotics is a class of automation, different to conventional automation that may be installed following traditional project management approaches. The formulation of a brief for the team sets the clarity against quantified targets that need to be reached as the basis for commitment to robotics and automation as well as continuous improvement. The brief itself is a subject for review and improvement, and may be brainstormed by the CMT, bringing opted membership from different parts of the business.

4. Process review and technology mapping

An important brief for the CMT is the continual review of processes that may use robotics and automation technologies. Mapping technologies available or to be developed against tasks or skills is an activity that requires the engagement of team members with knowledge and experience of the subject. Engagement of expertise from within and outside the organization to carry out fresh observations to highlight new opportunities and possibilities is beneficial. Global awareness and keeping up to date enhance the effectiveness with which solutions may be mapped against requirements.

5. Consultation and automation scoping

The mapping process provides the clarity of the technologies with potential that need to be explored. The scoping of the solution with respect to the needs is a next important step in the 'spiral of progress' (Figure 24). Consultation with all departments that may be affected by the automation would ensure a complete scope.

6. Requirements documentation with supplier input

Once the scope for a given automation project is established, the next essential step, regardless of the state of technology, its historical 'successful' use or value, is the preparation of a requirements document (in Appendix 1). The engagement of supply companies to support the formulation of this document is important, especially where the technology has been the result of a recent development, or the application has variabilities that demand adaptation of the automation technology.

7. Tendering and solution evaluation

The requirements document forms the basis of a tendering action, against which supplier specification for the automation technology may be detailed and received by the CMT.

8. Skills mapping and training plan

In anticipation of the process of tendering leading to a contractual plan to acquiring automation, it is important to consider the requirements for skills and the training for those that would take the ownership of the technology and become responsible for its operation during its total lifecycle. Planning for skills recruitment or development and training parallel with specification of requirements and technology evaluation provides for a more complete adoption through the change management process.

9. Project planning and ownership

The planning process of a given project as instigated by the steps to the point of engaging supply companies must accommodate for all changes, especially those internal to the plant that is to receive and take ownership of the technology. The formulation of the plan must consider, and time plan all activities including the steps of tendering immediately after the generation and formal sign-off of the requirements document. It is practical to form a project team that connects with the CMT through its membership. The project team task includes working with all plant operating departments, taking formal responsibility for the automation procurement. Interaction between with the supply team and the project team prior to reaching a formal supply agreement is important. An important task of the project team is the updating of the requirements document to include a functional specification from the provider(s). Once completed, the document becomes part of the procurement contract. The time plan would need to account for all internal and supplier tasks that need to connect for a complete supply. Costing for the same solution from multiple suppliers provides for a more effective budgeting giving confidence in the choice of provider and the selected technology option.

10. Budget and infrastructure planning

Budget plans need to accommodate for internal changes as well as the external supply costing. Infrastructure planning must include works such as new buildings, additional power or other services, modifications to existing space, as well as all changes that need to be in place for the effective installation and operation of the automation. An important cost to be noted is that associated with installation and commissioning causing disruption to production or requiring material or product (which may be wasted) before the automation can be fully operated to perform the process it is replacing.

11. Supplier choice and feasibility

The creation of the requirements document and the tendering process needs to engage the supplier or provider of the service to accomplish the implementation. The project team need to establish a criterion for choosing suppliers. The considerations need to include the total lifecycle support as well as impact of change the procurement process may have on the supply organisation(s). It is necessary to examine feasibility beyond the technical capacity and capability of the technology, the solution being offered, especially with respect to service, spares and all the provisions that must be sustained beyond the point of installation and handover by the supplier(s); covering the periods during and after warrantee.

12. Technical evaluation

The evaluation of the automation on technical basis requires full involvement of all departments of the plant taking ownership of the technology as well as those on the project teams. The scope of the evaluation needs to be as close, if not identical to the operating conditions of the environment in which the automation is to be used. A useful action is visiting reference sites and, where possible, arranging for the team members to operate the same or similar equipment on a secondment basis at a plant where the equipment is in daily production. Verifying the capability of the technology before procurement, mapping the requirements of the application provides the best outcome and avoids misunderstanding. Where there is an element of development, or even research, in circumstances of the supply being the first of its kind, appropriate performance targets with clear planning for validation become relevant.

13. Value proposition validation

The senior team target for a value proposition from new automation requires validation once its technical evaluation confirms compliance with the requirements. The performances that contribute to the gains to be accomplished from automation need to become the essential parameters for acceptance against a contractual process. The dependable performance of the technology is what provides the expected value proposition from the supply process in a contractually binding arrangement.

14. Project team formation

Subject to the validation of the value proposition, a project team may be formed and tasked to execute the project following the procedures of the requirements document. The project team would have the responsibility to the plant receiving the solution. It is important to establish that the contractual obligations can be met by all concerned prior to contracting.

15. Technical specification for acquisition

The contractual acquisition of the automation solution must be against a technical specification, defined against the requirements. The technical specification must cover all requirements and functional performances to be achieved. It is normal for the documentation to be included in the procurement contract, also specifying the responsibilities of all concerned.

16. Supplier contracting

The change management process facilitation to formulate a validated requirements document, with supporting value proposition, provides the basis for supplier contracting, as a formal process. The contract documentation, detailing responsibilities and the legal framework must cover accountability, liability and compensations for lateness or shortfalls in functional performance.

An important consideration is the topic of variation. With the efforts that fully establish the requirements, the process of change and management of the supply to a fixed budget or price, the solution should be delivered to the specification against a maximum value contract. Clarity is needed in the event of unforeseen circumstances and such aspects must be contractually defined to avoid unmanageable situations.

The project team, with the assistance of legal representation have the task of placing a contract with all the terms that reflect expectation (accommodating also for uncertainties), whilst maintaining a clear working relationship for the best co-operation to reach the desired outcomes. The contractual agreement between the parties, starts the process and work can begin to reach specific milestones. The terms of supply must include supplier obligations to provide training and spares with identified costing. Spares provisions should follow the equipment and be available prior to the equipment becoming ready for pre-delivery inspection.

The spares need to accompany the main equipment to the point of acceptance and replenished as necessary beyond that point. Long lead time items must be available as spares as their failure in the supply process, especially at final acceptance testing, can result in significant disruption to the project completion and timing (see also item 26 below).

17. Execution actions to Factory Acceptance Testing - FAT

The progress of the project is a task for the project team and an appointed manager under the framework of the full supply agreement that also specifies all the internal activities for the automation solution to be implemented. An important milestone is the Factory Acceptance Testing (or pre-delivery performance acceptance). It is necessary for a clear acceptance document to be produced, agreed and signed by all parties as the basis for testing and formal sign-off before the equipment is to be shipped from the providers' premises. It is possible that certain automation projects cannot be tested with product at the supplier location prior to shipment. Or, it is possible that the equipment needs to be assembled and powered up at an interim location on-site or even at the final location. In such circumstances there needs to be clear understanding of acceptance testing process as part of the supply contract. The execution of the work needs to perform incremental evaluations of performance at appropriate stages of execution, adding to the confidence of the team receiving the equipment.

18. Technical recruitment

In anticipation of the equipment being installed it is necessary to forward plan recruitment of technical staff to operate and maintain the automation. The timing of such recruitment is ideally before the main milestone for FAT, allowing new or trained technical staff to become familiar with the automation being delivered.

19. Host team training

It is expected that after the equipment is delivered for installation, there would be an internal operations team who would be designated responsible for the day to day running of the equipment. Training of this team is a matter for the project team and needs to be scheduled, latest before FAT, but ideally prior to contract placement (with similar equipment or as a theoretical training with respect to the technology being a first of its kind). This will ensure early feedback from the operations team. Early training may highlight points of relevance for inclusion in the procurement agreement.

When all technical and contractual matters have been satisfied, training and staffing actions for daily operation of the automation, post final acceptance of the automation, remain the most important and critical aspect of adoption.

20. Site preparation

The scope for site preparation, from procurement of new building with customized services, to simple form of service connections, using existing plant provisions must be clearly defined and the work executed. If existing services such as electricity or compressed air are used, the additional loading resulting from the installation must be considered early to avoid surprises or delays, which can compromise the contractual process for the supply and accountability towards on-time completion.

The contractual responsibility for site changes is not usually a matter for the automation provider. In all cases, the tasks and timing of such tasks need to be compatible with the automation installation as specified.

21. Host team preparation

The team receiving and becoming responsible for the technology require time to prepare in advance of the installation; and during the stages of commissioning, performance testing and acceptance. It is normal for team members to have other work commitments in the day to day business of the company. To this end, there is a need for cover to release such staff to prepare and to become engaged in the activities of the project, especially handover.

22. FAT and training

The execution of acceptance testing under the formal process of Factory Acceptance Testing (FAT) is an important milestone. Training on the equipment may be scheduled as part of the process, as mentioned earlier, and the test must be formally documented and signed off as a contractual step.

23. Installation

The installation process on site is a process that needs careful planning and the project team must establish a methods statement, starting from the acceptance at FAT and including disassembly, packing, movement, delivery and unloading at plant, unpacking, transfer and placement to the point of installation, and the detailed steps to reach full installation of the equipment. It is important to be specific with respect to off-loading and the point in time when the responsibility for insurance cover for the equipment is to change from the supplier to the receiving plant. Of relevance is also the point at which delivery can be said to have been achieved as a contractual step against which a payment installment may be needed before installation can start.

It is also relevant to perform site and services capacity checks in advance of shipment to ensure readiness of the host location.

24. Commissioning and Site Acceptance Testing - SAT

The completion of installation to the point of first power up may involve a contractual stage payment. The commissioning stages need to include the project team and staff who will be taking the ownership of the technology. Further training needs to be scheduled during commissioning. Site Acceptance Testing, needs to follow a formal process against the format followed at FAT, extended to include performances that must be tested with product and at the production speeds. It is advisable to specify and test the equipment at 20% higher throughput. This is an important aspect of specification given that stoppages cause loss of throughput, and, to catch up, higher working speeds need to be possible.

It is normal to have FAT and SAT templates signed off as ‘blanks’, prior to the testing, to ensure that all acceptance checks are performed and recorded in full, preparing for handover. The ‘blank’ documents would need to list all test parameters, leaving only the test results to be added during testing. Inclusion of corrective action notes to reach performance in case of shortfalls is common.

User and operations manuals are usually part of the supply and their acceptance needs to be part of the formal process. SAT acceptance needs to include checks with respect to the equipment documentation and user manual, especially on quality of content and presentation.

25. Handover

The process of handover requires time and participation by all concerned. The presence of supplier experts at the start of handover for a duration that allows the equipment to be ‘bedded in’ is essential. The supplier needs to remain responsible for the equipment function during production runs in the first few days of operation.

The internal team trained to run the equipment can make gradual steps to take over the equipment, with the supplier experts observing adjacent to the line, helping as needed. Once the level of confidence is reached, the experts from the supply team would need to remain on site, but not adjacent to the equipment for a period that supports the operations team before final handover, after which the project team may sign-off, accepting completion.

26. Spares and maintenance

The provision of spares and training for maintenance are essential considerations when planning a robotics or automation technology project. The suppliers list of essential spares needs to be a contractual deliverable, with a formal sign-off, once the spares are physically delivered. The availability of such spares is important prior to FAT testing as emphasised before. It is possible that early faults with equipment require long-lead time spares to be available for rapid recovery in case of their failure. The provision of spares during and after warrantee periods as well as availability of supplier service staff need to be part of the contractual terms of supply and the requirements clearly specified in the procurement documentation, before contracting, see item 16 above.

Once adoption is reached, as a final stage in the ‘spiral of progress’ (Figure 24), the operation of the solution must become a matter for day to day management sustaining the following:

- Continued employment of skilled and qualified staff to operate and maintain the automation.
- Scheduled up keep of the equipment and upgrades that replace elements with new or more reliable parts.
- Continual review of advances that can add improvement to the solution adopted for better capability or capacity.

Much of the above relates to the procurement of established or recently implemented automation; however, with adaptations that accommodate for uncertain outcomes in research, the guidelines above may be applied to the management of change and procurement of R&D also.

6.2 Change process and automation research

The beef industry in Australia is dependent on tasks traditionally performed manually for which no established automation or robotics solutions are offered by technology suppliers. The process of change needs a long term focus as well as one that acquires existing technology for adoption and day to day use. The work performed in this project has observed beef processing operations and the following list includes tasks for which automation or robotic solutions specific to post slaughtering cutting are required:

- Scribing featherbones
- Pre-cutting the whole carcass
- Chine cutting
- Button bone and flat bone separation
- Neck boning
- Striploin fat trimming
- General meat handling
- Meat or bone pulling and other similar tasks
- Removal of featherbones
- Primal separation
- Rib bone separation
- Shank boning
- Leg boning
- Rib cage de-boning
- General trimming

The above continue to rely on human capability and capacity in beef plants throughout Australia. Furthermore, they are considered critical with respect to yield, quality or health and safety. Research action driven by the beef industry is an important aspect of change management. Universities and research establishments across the world can offer new thinking or solutions as well as human resource to execute development whilst supporting the transitions from laboratory solution to commercial systems working in plants. It is important for the Australian meat sector, especially the beef sector, to engage in the establishment of R&D infrastructure. One approach is facilitating the University sector and directing researchers to work on the automation challenges. There is also a need to establish facilities that provide resources for first installation of robotic technologies in Australia, ideally attached to an operating plant.

Increasing confidence and motivation in the industry to adopt automation is the key in achieving competitiveness in global markets. Australia is well placed to take advantage of the opportunities by managing change on a national scale adopting established or recently developed automation, whilst mobilising resource to create new solutions specific to the industry's requirements.

7.0 CONCLUSIONS/RECOMMENDATIONS

Change management has been applied as a discipline for transitions in the adoption of automation. The focus has been Australian beef operations, requiring robotics for cutting and handling in the boning and trimming tasks, with improvements in yield and efficiency as well as health and safety being high priorities.

The key motivations for the project have been the industries requirement in respect of the following:

- Maximisation of overall yields, especially in high value primal products;
- Reducing reliance on labour whilst improving work conditions;
- Customising and individualising the process of meeting consumer needs;
- Managing costs while embracing complexity, simplifying operations and maximising production performance;
- Achieving total electronic information traceability from the start of the process to the point of consumption, supporting the management of the supply chain.

The work has received input from several Australian processors, which is gratefully acknowledged.

Automation of beef processing tasks can give benefit with respect to quality, yield, safety, hygiene as well as labour saving. Several tasks observed and reviewed include those in slaughtering, cutting and end of line operations.

The main tasks ranked priority are in the cutting area as follows:

AMPC 2019-1112		S= Scott Tech	AMPC-BMC Confidential - Australian Beef industry opportunities and management of change	Based on 60 h/h	Other
H-high	L- long	J= Jarvis			H- Hygiene
M- medium	M- Medium	F= Frontmatec		Potential	Q- Quality
L - Low	S-short	M= Marel		staff	Y- Yield
Priority	Timeline	Supply	PRIORITIES FOR AUROMATION	saving	S- Safety
H	S-M	S, Other	Pre-cutting and scribing	2-3	Y, S, Q
H	L	R&D	Primal piece separation	8-10	Y, Q
H	M-L	Other, R&D	Chine cutting	4-8	Y, Q, S
H	M	Other	Rib bone separation	2-6	Y, Q, S
H	M	R&D	Button bone and flat bone separation	4-8	Y, Q, S
L	L	R&D	Shank boning	4-6	Y
L	L	R&D	Neck boning	4-6	Y
H	M	R&D	Leg boning (front and back)	4-8	Y, Q
M	M	R&D	Rib cage de-boning	2-4	Y
H	M	Other, R&D	Striploin fat trimming for uniform fat cover	4-8	Y, Q

Automation for many tasks in meat production have been attempted by several technology providers. In the procurement of the solutions, highest levels of management in processing companies must be engaged, defining the requirements. Generating a document defining the user requirement for each application is important. A tendering process may be followed based on the document (see outline in Appendix 1).

Guidelines provide the important considerations with respect to procurement. It is critical to have precise terms of supply against agreed requirements and a step by step progression towards adoption of automation and robotics. The technology must have sustainable operational life, contributing to business performance and profitability.

Where technology is a subject for research action, the beef industry needs to engage and lead the change management that engages universities, research establishments or advance engineering companies. The process would provide access to human resource and execute research capability, especially in the process of transitions from laboratory solution to commercial systems.

Increasing confidence and motivation of the industry to adopt automation is the key in achieving competitiveness in global markets. Australia is well placed to take advantage of the opportunities by managing change on a national scale, networking with international centres of excellence. The most critical barrier relates to shortfalls in skills as well as technical and managerial capacity within the sector. It is important to create mechanisms for steering and managing the processes that support long term solutions as well as human resource development, removing barriers and establishing longevity in outcomes. To this end, the following is recommended:

- Creation of industry led national steering group (NSG) combining the representation and interests of all stakeholders and developers, considering the value proposition to the sector and instigating change to drive forward the widespread adoption of robotics and advanced automation.
- Formation of a combined user industry, education and research community leadership group, supporting the NSG, to instigate new automation R&D and educational developments, planning and delivering on priorities.
- Establishing industrial facilities for first implementation of new automation technology, for the evaluation of performance, staff training in management, operations and maintenance.
- Establishing a centre of excellence in meat automation in support of research, development, feasibility evaluation and training covering apprentice, undergraduate, graduate and industry continuing education. The initiative needs to focus on a new infrastructure for execution of R&D and engagement of young talent to meet the expectations of beef sector initially.
- Establishment of facilities that provide for first installation of robotic technologies in Australian plants, with the engagement of systems integration or engineering companies with expertise in robotics.

8.0 ACKNOWLEDGEMENTS

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The opportunities for engagement and instigation of initiatives involving technology suppliers in Australia, and institutions in Europe mobilising R&D action by preparing EU proposals with the encouragement of AMPC deserve special and appreciative mention.

9.0 APPENDICES

The following is an outline for a Requirements Document to be written for each application.

9.1 APPENDIX 1

Tendering invitation

Requirements document: EXAMPLE – Full document is declared confidential.

AMPC project PR No. 2018-1112.

This document has been the result of active input from:

<TYPICALLY>

- Chief Executive Officer
- Investment and Innovation Manager
- Value Chain Manager
- Operations Director
- Plan General Managers
- Executor of AMPC project 2018-1112
- Members of the Operations Team from various Plants.

The document provides a template for similar requirements documents that may be prepared for other tasks to be automated.

The Purchaser: Processor

to

The Supplier: Service or Technology Supplier

1. Preamble

2. Requirements

2.1 Cut requirements

2.2 User interfaces

2.3 <Other headings>

3. Tender requirements

The Supplier must provide The Purchaser the following information with the quotation:

1. Functional and Technical Specifications of all items of equipment, including hardware and software.

2. Details of technology capability that demonstrates the functionality in sensing of carcass features and the method for defining cut paths allowing for carcass variability as well as the operational constraints posed by carcasses having a broken spine, deformation or other anomalies.
3. Specific description of sensing and cutting devices, including requirements for service and recommended replacement interval, etc.
4. Accuracy estimations in respect of cut positions that may be achieved.
5. AutoCAD drawing (in 3D where possible) of the proposed installation, quantifying space requirements.
6. The main dimensions of the space required to house the solution should be shown, and the position of control panels highlighted on the drawings.
7. The following should also be included:
    - operating procedure,
    - list of essential spares,
    - Gantt chart showing the stages of design, build, training, pre-delivery inspection, delivery, installation commissioning and acceptance timing, including provisions of staff in support of the phases of the supply.
    - approach to training and assessment of competency for operators and maintenance staff to become responsible for the system.
8. Running cost from the time when acceptance is completed.
9. Full cost from the definition of acceptance of technical specification of the solution being delivered to the time of acceptance,
10. A full list of services and special requirements, especially where there are expectations of work to be performed by The Purchaser including site preparation.
11. Any other relevant information that facilitates the smooth transition in the procurement, installation, commissioning, handover and lifecycle management of the system.
12. Clear explanation of processes of change and management (including responsibilities of The Supplier's staff and The Purchaser's input during the phases of delivery, installation, through to acceptance and handover). The explanation needs to be concise and complete; accompanied by a risk assessment, especially where timelines or costs may be affected. The scope of the supply must be all inclusive and completed at a fixed contract price to The Purchaser.

It is intended that certain suppliers would suggest alternative approaches. Such alternatives need to be clearly detailed and justified.

The Purchaser requires the quotation to be structured and mapped against a step by step implementation with clear Go/No-Go breakpoints, allowing recovery at no additional cost to The Purchaser, whilst The Supplier takes corrective action in the event of a No-Go situation at any point in the execution of the project:

STEP 1: Delivery of Functional Specification for sign-off.

STEP 2: Delivery of Technical Specification and execution plan for formal sign-off (including a detailed method statement with timing for installation with no, or minimal, interruption to the day to day operation during the final positioning, power up and commissioning of the system).

STEP 3: Initial set up of specific equipment to demonstrate capability against the technical specifications (to be signed off by The Purchaser) prior to contract signature committing The Purchaser. These may include, sensors, cutting tools, cleaning regimes or any subsystem performances that could pose a technical risk against the functional specifications relating to the requirements.

STEP 4: Installation in a location off-site (or temporary location at The Purchaser's site) to validate capability and performance, prior to start of installation.

STEP 5: Execution of training and formal issue of competency certificates, as well as training documentation for formal sign-off

STEP 6: Installation in final location and execution of process to formal acceptance.

STEP 7: Handover, including a minimum of 3 weeks operation with The Supplier's team present near the installation and a minimum period of 3 weeks with the key Supplier's team members available on site, but away from the installation; and finally, 3 weeks operation with key Supplier's team members on hot standby off site, leading to formal acceptance event at STEP 8.

STEP 8: Acceptance sign-off after a period of 'bedding in' of no less than 6 weeks un-interrupted operation, without The Supplier present.

The Supplier is required to provide a proposal that achieves a complete solution. Where a supplier is to provide only part of the equipment, this should be communicated soon after receipt of this document and clearly stated on the quotation.
The Supplier is to ensure that the links between the solutions being supplied link completely with the existing facilities for all elements of supply including physical, mechanical and electrical, IT, and all other aspects of integration, ensuring efficient flow of product and uninterrupted operation.

The Supplier must include drawings and descriptions of the process together with all costs and installation schedule. Before order placement, the expectation is that The Supplier shall conduct a full site survey to ensure that the proposed solution fits in the intended space. This must include space for electrical panels, services, access, any storage for spares and documentation.

Where possible, cost of supply should be broken down. It would also be important to stage the phases of installation with costing for each phase; according to the STEPS mentioned earlier.

Before order placement The Supplier of any equipment is required to conduct a full assessment of the location of existing equipment to be satisfied that the site, service, access and the location for installation and the necessary changes are accounted for and that the costs of any modifications are included. The process of transition from current practice to the new system needs to be clearly documented and included in STEP 1.

It is expected that the proposed installation would be in current or new space to be available, with the necessary modifications being undertaken by The Purchaser, where this is explicitly agreed. The Supplier must list all requirements for space and services under STEP 1, if not already included with the quotation. The requirements must integrate with the current facilities and, as far as possible, with the future needs of The Purchaser.

Separate documents (to be added under Appendices) to this document are in preparation and will be added to future versions of this document; to be reissued upon receipt of initial interest from The Supplier in response to this RFQ. The future updates of this document and the Appendices, to be added, will accommodate initial reactions and feedback from The Suppler. The Appendices will give further detail of the requirements for the design, supply, installation and commissioning of the equipment to be purchased.

The Appendices are intended to assist The Supplier to include everything necessary to provide a complete solution in accordance with the requirements. They will include:

- Compliance with standards and regulatory requirements including Safety, Hygiene and other requirements specific to Australia.
- Compliance documentation requirements including compatibility with Technical Specification signed-off and the same that satisfies The Purchaser's requirements with respect to health and safety.
- Communication process and the maintenance of relevant information to ensure a complete working solution to the standard expected.
- The Supplier management and project engineering functions to the point of customer acceptance for the scope of the supply to be contracted.
- Project monitoring process and engagement of The Purchaser's key contact personnel.
- Daily cost management and requested process for unforeseen changes.
- Equipment interfaces into the existing site services (Compressed Air, Electricity, water, etc.).
- Project programme details to meet installation and commissioning dates and format of presentation of such details.
- The Supplier contingencies to avoid or minimise interruption to current production.
- Scope of works and standard of fabrication.
- Skills provisions in support of the installation and contractors access process.
- Hygiene and cleaning requirements, dirt trapping points, bug accumulation, etc.
- Interlocks and error reporting.
- Energy and environmental considerations, including use of plastics, etc.
- Specific piping, wiring and electrical requirements.
- Lubricants and fabrication standards, including preferred suppliers and materials.
- Spares and critical provisions including cost control.
- IT, management reporting and Operator Interfaces.
- E- stops and recovery.
- Training process.

- Sign-off process including responsibilities for completion.
- Legal contracting process, Installation, Commissioning and Acceptance processes
- Project management and applicable compensations or penalties for lateness or non-conformance.
- General Information and Terms including: completeness of supply, noise levels. Warrantees, applicable law, arbitration, supervision, insurance, meetings, delivery of damaged items, co-ordination, submission of documentation and formats, Correspondence, Post Contract Changes, documentation approval process, Installation, Operating and Maintenance Manuals, Special Tools, Obsolescence, Exclusions, Preferred sub-suppliers and responsibilities, Maintenance and practices during the warrantee or service contract period, Delivery Process, mechanical and electrical design, construction, software, IT, Tracking, Online Management reporting, and exception management requirements.
- Test procedures timing expectations.
- Life-cycle and sustainability information and expectations from The Supplier.

Invitation

Suppliers are kindly requested to email the Contact Person at their earliest convenience, to register receipt of this document, briefly outlining their interest.