final report

Project code: P.PSH.0628

Prepared by: Koorosh Khodabandehloo
BMC

Date published: February 2014

PUBLISHED BY
Meat & Livestock Australia Limited
Locked Bag 991
NORTH SYDNEY NSW 2059

Lamb slaughter floor strategic review

BMC and GM Scott are grateful for the match MLA funding of this project.

Meat & Livestock Australia acknowledges the matching funds provided by the Australian Government to support the research and development detailed in this publication.

1. Abstract

Strategic review and feasibility for a new and efficient slaughtering facility is presented as a green field construction, giving 20% increase in throughput, better control over process and significant improvement in hygiene standards and work conditions. The facility is among the few to be considered and constructed in Australia in over two decades.

The opportunities for automation are considered and, where appropriate, included as part of the final layout presented. Aspects related to processing cost, water and energy are considered. Automation and robotics provide both opportunities and challenges. The review presents the automation options for inclusion in the short term whilst accommodating the potentials for future implementations. The future solutions reviewed include concepts draw from current and future R&D initiatives, including those in other sectors.

An optimised layout for lamb slaughter facility has been reached, which is now implemented in a new building, incorporating automation solutions available today, allowing space for future automation technologies. Visits to several plants, with awareness of automation developments outside the red meat industry, have supported the decisions and the resulting facility.

The project results reported cover considerations over the period 2012 to 2013, with the slaughter facility commissioned for first operation on 26 August 2013.

2. Executive summary

The future of the meat industry will rely on its ability to modernise its slaughtering operation for improved quality, cost, hygiene, safety and, where relevant, yield. Many small stock processors have the need to upgrade their facilities, also introducing automation where relevant. A few processors may be faced with the need for a complete re-build as a green field project, where the opportunity for using proven automation, with the possibility to allowing for future automation, presents itself. One of the main challenges of a green-field or upgrade slaughterhouse project is maximising the use of available investment, acquiring the most appropriate equipment, with high reliability and long life; to be housed in a best value building requiring minimum maintenance. This strategic review covers related consideration to such a green field approach to building a new slaughter facility. Inclusion of automation technology and designing a long life slaughtering plant, allowing for future possibilities for new innovations or developments, requires management of change and clear understanding of:

- Processes of slaughter and the development of skills
- Throughput and bottleneck limitations, including influences of skills and livestock quality.
- Equipment capability and tools
- Hygiene constraints and levels of control
- Veterinary parameters
- Legislative and regulatory requirements
- Quality assurance process and limitations of inspection
- Working practices and influences over quality, productivity and resource consumption
- Other operational considerations, including use of energy, water and consumables (such as cleaning materials or chemicals).

This project has focused on the feasibility of implementing a new slaughter operation for lamb processing, including the operating steps from stunning to end of slaughtering at final inspection before carcasses entre the chill room. In particular the following have been considered and being reported:

- Current practice and staffing
- Slaughter line equipment and assessment of suppliers
- Automation or semi-automatic tools including the following:
    - Y-cutting
    - Hock cutting and hock tipping
    - Punching tools and semi-automatic shoulder pulling (pelt)
    - Pelt removal
    - Sani-vac ops and brisket cutting
    - Evisceration, including bung drop and belly opening
    - Head cutting
- Traceability and IT
- Hygiene equipment and sterilisation
- Future automation including:
    - Automatic shackling

  - Grading and classification (with yield prediction and tracking)
  - Automatic or assisted inspection with information tracking

The interfaces between different operations such as the main slaughter floor and areas for offal processing are considered. Separation of processing and offal areas by placing them on two different levels in a new building provides for improved hygiene and reduced double handling.

Building considerations and provisions for reaching a workable solution at optimum cost are presented. Of particular interest has been the definition of a build that makes significant saving for the processor needing to justify investment. Modularity in design and sourcing equipment at best value without compromising quality of implementation for day to day use or life of equipment have been among the key factors in the review. The construction and start-up of a new slaughtering facility based on the results of this feasibility was reached in August 2013.

The results of the project are presented for the benefit of the Australian Industry (including Processors, Service providers, and R&D organisations) covering:

- Findings and evaluations that need to be considered when building or retrofitting a slaughtering plant or improving an existing one,
- Relevant and important specification in the construction of a new building for slaughtering,
- Payback considerations and optimised design for cost performance,
- Management of change and approaches to planning for change,
- Approach to implementation for best cost outcome,

The feasibility for a green field slaughtering facility has been the result of this project covering:-

- Building, services and fitting on 3 levels
  - Level 1, above the flood plain for ancillary and offal processing including runners, tripe cooking, red offal processing and chill, hook room load out and associated hygiene entrance, accommodating also for pelt operations
  - Level 2, main slaughter floor from restrainer (linking to new sheep ramp and stock holding facilities), though to carcass wash end entry into chill rooms.
  - Level 3, housing ancillary equipment such as control cabinets, power packs, etc., with easy access for maintenance.
- All slaughtering equipment, including tools and environmental controls
- Plumbing (excluding main hot and cold supply already available)
- Waste handling (excluding links with rendering)
- Hygiene equipment (including sterilisers and automatic boot wash, hand wash, hand soap and hand sanitiser equipment)

The project has provided the basis for implementation of the facility at GM Scott, where the new slaughtering operation in a green field construction started on 26th August 2013.

Contents

3. Background

GM Scott requirement for a new slaughtering facility has given the opportunity for this review to be conducted before the start and in parallel with the implementation of the facility. The approach to the project has included detailed consideration by the team that was to become responsible for day to day operation of the new facility including with the following:

- Location of the new slaughter floor within the compounds of the land available.
- Meeting regulatory challenges relating to standards and compliance with respect to home and overseas market expectations also opening new export possibilities.
- Current practice and constraints.
- Opportunities for improvement and savings by process rationalisation, removing constraints in flow or the work environment, imposed by historic evolutionary implementations,
- New practices, equipment, processes and operations sequence.
- Specification and assessment of existing equipment.
- Evaluation approach to new equipment for adoption.
- Equipment in development with longer term impact and potential for adoption including automation and IT technologies.
- Investment priority against phased implementation consolidating the above into an action plan for execution.
- Execution challenges, risks and management structure for team effort towards implementation.
- Management approach and responsibilities.
- Life cycle and implementation planning.
- Contracting practices and supply management.

In the GM Scott considerations two basic approaches were identified for feasibility:

a) Extending the facility with a new section that connects to the existing slaughter chain, post stunning and sticking, by linking a new chain to the current one after the bleed area. This extended area was to include all the operations on the pelt dealing with rodding, clipping, Y cut, punching and pelt removal followed by evisceration and dressing before the chain re-joins the existing chain again, to link with the weighbridge and classification/labelling point.

b) To implement a new building and slaughter facility linking with the sheep yards and ramp. Observations and assessment practices and equipment in a number of plants in New Zealand, Europe and Australia were to result in the definition of this facility to be implemented. The

option were to include new processes and steps requiring less space and more proven technology for efficient and hygienic operation

The disturbing impact of option (a) on the day to day business was considered too great given the period of change when the existing line would be joined to the new one; and during the commissioning of the new facility.

Option (b) was considered as the way forward for the following main reasons:

i) The tasks of implementation would have minimum interference with existing operation reducing or avoiding the risk of downtime during the changeover from existing to the new facility.

ii) The training and ramp up of the new operation would be gradual and parallel to the day to day processing, causing minimum disruption to the business.

iii) The commissioning process can be performed step by step allowing a 'bedding in' process of the new equipment.

iv) There is possibility to revert to old operation when early teething problems arise, especially with respect to processes or equipment new to the operations team.

4. Project objectives

The objectives of the project as originally proposed have been:

- To consider Slaughter floor options and reasoning in the selection process with a review automation possibilities
- To consider human resource, skills and change management
- To consider aspects of energy and the environment, water and waste, yield and efficiency as relevant, other factors such as quality, inspection, information handling, continuous improvement and total life cycle

5. Methodology

Slaughter operations are generally on a continuous chain and the steps are defined to allow actions to be executed in a specific time cycle. At certain throughputs, some steps require less time than the cycle time for execution by a single operator and others require more time, where duplication of position is required. When the cycle time is greater than the time of execution at each position (or duplicated position), efficiency is compromised. Taking a 'lean' approach to the design would combine steps or splits them for a cycle time that matches the rate of the line with little spare time between repeated actions at each position. In general the tasks at a given station being done by one person would take a specific duration with small time gap between the

cycles making it efficient and to the beat of the line. This approach has been successfully used by a number of plants and in the specification of the design as part of this feasibility for an efficient layout, the approach has been applied.

Automation possibilities have been reviewed and where such has been possible, equipment has been included in the layout for the steps that can use proven technology.

A number of consideration are relevant in the implementation of a green field slaughtering facility. The work has examined each to varying degree or depth according to the project's priorities, including the following:

- Automation technology in the slaughtering process for lamb:
    - Adjustable speed chain for Pelt or Dressing line operations
    - Current automation equipment (for pelt removal, hygiene control and other operations such as Sani-vac robotics, automatic brisket cutting, hock cutting and head removal)
    - Future automation equipment (shackling, evisceration, inspection, etc.)
- Computerisation:
    - IT and management reporting
    - Electronic traceability and acquisition of carcass quality and health data
    - Data capture and information processing for reporting and operations management
- Change process:
    - Management of change
    - Culture and organisation
    - Planning process
    - Strategies in business expansion and export
    - Meat industry policies
    - Human resource development
    - Environment and energy
    - Waste handling

Within the context of the above the approach to the feasibility has listed the following in respect of management of change supporting the implementation of the new facility:

- Training planning and execution phasing of training for all staff
- Supply contracting structure, project co-ordination and timely delivery against responsibility
- Life Cycle Assessment – meeting the total life cycle scenarios and continuous improvement
- IT and management of information with full traceability back to farm

- Hygiene and sanitation control including assurance procedures involving electronic inspection and automated sterilisation as appropriate
- Quality grading including techniques for yield prediction, planning, sorting and integration of carcass data for optimising end product quality and yield
- Automation including robotics and other devices for maximum efficiency
- Fault diagnostics, recovery procedures and redundancy or back up
- Human resource facilities and integrated processes for wash facilities, changing room, maintenance entrance, with full consideration of staff tracking, electronic monitoring to ensure safe and hygienic practice and safe work procedures, including maintenance tools tracking and management
- Integrated handling of offal and waste processing with minimum or no manual handling where such is practical
- Energy management and environmental considerations
    - Environmental design and reduced water consumption
    - Cleanability in design for walls, ceilings and floors as well as the equipment
    - Hygienic design and features that allow tracking of equipment cleaning process
    - Waste processing and reduction
- Waste control and handling
- Recruitment policies and human resource and skills
- Other factors and considerations
    - Automated cost monitoring
    - Change of staff and staff turnover with implications for training
    - Continuity and consistency in processes and tasks
    - Contract management: structure, specification and specification
    - Responsibility, accountability, liability
- Economic considerations, Operational, Environmental and Social
- Supply relationships and maintenance contracting
- Commitment to continuous improvement

5.1 Considerations and approaches

The practices in several Australian, European and New Zealand lamb plants have been observed. The main general concerns relate to cost of labour, efficiency, water consumption, energy use and maintenance including downtime.

The steps in processing lamb in typical plants compare with varying degrees of efficiency and operating practice. The operating practice to have carcasses hanging on 4 legs after sticking during the bleeding to the point of first intervention and inverted processing have been observed to give significant advantages. The efficiency variation in the plants visited during this review, corresponds to additional staff positions in the slaughter line to meet with specific requirements in hygiene or quality, generally related to customer specifications.

An important indicator of efficiency in respect of labour is that lamb plants can have one person per 6 to 10 lambs per shift to process from stunning to chill. This represents a wide range of efficiency capabilities across different plants worldwide. The levels of efficiency vary by a much wider degree than expected, suggesting that as a first step many companies can benefit from benchmarking and sharing best practice rather than focussing on the use of automation, which has its justified placement in the progression of improvement as the next high on the list priority. It is important to plan for automation and deploy technology as part of the general approach and culture to continuous improvement. The approach requires high level commitment and long term vision, with the focus that accommodates the forward planning of technology as part of day to day management.

Design and layout of plants have evolved over many years and many do not have the opportunity to invest in green field solutions. It is normal that commitment to creating a new design and implementing a new plant requires significant investment. Practices and approaches in designing new plants need to consider obsolescence and long term solutions. Often the process for new build design restricts itself to improving the known practices as apparent to the team involved, upgrading rather than advancing. To advance, it is necessary to reflect on future possibilities to ensure that the new solutions and design layouts accommodate the requirements against future practices including all foreseen eventualities in the technology developments, beyond R&D and conceptualisations. Plants designed and built in this manner accommodating for long term developments will benefit from continuous improvement over the life of the plant, if indeed there is an end to the life of the plant in a physical sense. Given the level of understanding in materials and modularity in design a plant can be designed for continual upgrade even in its fabric.

Space and access issues in existing plants are the two simple factors that prevent companies from progressing with new automation and robotics, even if the investment is justifiable. New build plants need to factor the need for accommodating new technology by engaging expertise of the suppliers as well as those engaged with new developments.

Operational Health and Safety (OHS) continues to be a most important consideration for all plants. Practices to avoid repetitive injuries by periodic job rotation in a given operating shift and using assisted mechanisms, ranging from counter balancing of heavy cutting tools, to moving platforms with automatic height adjustment, are among the approaches. Reducing contact with difficult to operate tools, whilst applying the latest principles of ergonomic and operator friendly work space design can bring significant benefits. Automation continues to be of interest, but this remains largely an opportunity for the future. A significant obstacle is the availability of space or cost of carrying empty space for automation, until it is commercially available. There is also a need to retain existing manual positions as back up to automation.

The main objective remains to achieve consistency and higher throughput in a safe environment without increasing staffing levels. Technologies improving

OHS as well as efficiency remain a subject for R&D for slaughtering and it is important that any development provides a clear specification for the expected process. In a few plants automation attempts have demanded higher levels of attention from maintenance than anticipated. The attempts have revealed issues related to the degree of judgement in quality assessment and hygiene during the processing steps, which require skill in visual assessment, currently beyond automation technology capability.

Aspects of traceability and information for management reporting remain somewhat manual or using limited computer or IT capabilities. IT in use may be considered conventional in many existing plants by today's standards. The main reasons for this lack of uptake may be largely related to the difficulties in estimating and justifying the returns on the investment. Furthermore, meat plants IT capabilities are often contracted as a service and the management of change has complications in such circumstances.

QA practices vary significantly. Aspects of training, monitoring, record keeping, data handling and managing the points of control continue to be among the challenges. The use of IT process in data handling in several plants has become normal day to day practice. A sharing process based on a network of companies actually using the technologies with those who could use the technology would provide progress through communication and adoption of best practice. Quality, inspection and microbial control in respect of issues such as microbial testing, sanitary process, cross contamination, trimming standards to meet conforming carcass grade, decontamination and sterilisation may all be improved using technology. The practices or methods however are diverse and wide ranging. Standards may become manageable once guidelines are clearly communicated and although there is clear understanding of issues to be managed, industry approach and a common policy towards future technology would help the process of change.

5.2 Alternative approaches

Practices in various plants and technologies as well as automation solutions available by major suppliers have been reviewed. The observation made during the visits to reference sites, highlight common approaches to dealing with issues such as hygiene, quality, efficiency shortfalls and use of resources including labour. The following are relevant:

5.2.1 Management

The approach in managing a plant continues to focus, and rightly so, on meeting the orders for the day through supervision of the processes of slaughter, dressing and preparation of carcasses to the expected standard. Dealing with variability and imperfection in livestock as well as the skills in a manner that achieves results requires decision and adaptability to circumstance. In conventional manufacturing of say cars, plants are designed to achieve conformity in product specification against variables that may be managed to engineering tolerances controllable through specific processes

and quality procedures. The uncertainties in livestock characteristics continue to pose challenges and equally opportunities for the meat industry. Important considerations include:

i) Management information

Real time KPI (Key performance indicators) reporting on operating parameters is a necessity. Data capture assisting management decision by 'live' reporting of anomalies or outside the range parameters in respect of the following are important:

a) Staff performance at each station influencing the timing of the line.
b) Steriliser water temperature and turbidity control as relevant for workstations affecting sanitation.
c) Instant reporting of breakdowns or positions causing line stoppage.
d) Reporting of average line speeds and updates on number of carcasses processed against target in respect of specific batches.
e) Status of inspection processes and losses from condemned carcasses or part carcasses, with computerised logging of the inspection information, especially in the case of re-work.
f) Status of secondary processes in respect of packed products such as red or green offal as well as processing of heads, tongue, feet tripe, etc., as relevant.
g) Weight correspondence and percentage losses where relevant.
h) Other plant specific information aiding supervision and management in operations and functionality including production, maintenance and QA.

Considerations in technology that support implementation of the above are available, although no hard data is available giving the quantified returns on investment. Effectiveness in management can result in significant efficiency benefits and it would be advantages if a pilot case can be benchmarked to provide quantification of the returns.

Management involvement in the specification of the reporting structure and training in using the data with the supporting IT equipment requires clear direction and high level commitment.

ii) Management training and skill development

In general management positions in the small and medium size plants in have been filled by internal promotion. The plants and their locations also pose a challenge for recruitment as the areas or locations of meat plants are somewhat 'isolated'. It is important for companies to have a clear strategy to management recruitment. It is also necessary to provide specific management training, especially in relation to:

a) Time management and decision prioritisation
b) Technology status and updates

c) Communications, staff relations, human factors in operations and motivation
d) Team culture and organisational management
e) Electronic communication and reporting
f) Personal conduct and professionalism

The above represents a basic list of topics among the many; however, the nature of management development in the typical meat company is such that promotions from the staff pool in slaughtering are natural and excepted. It is also the case that such promotions need to be complemented by clearly defined plans for staff development, education and professional training. The investments in training help with the management of processes that ensure consistency and compliance with standards in operation, control of cost and quality, and profitability, maintaining business position in a competitive market.

5.2.2 Process, Equipment and Technology

Over the past two decade advances in slaughtering technology have been significant. Transfer of technologies developed from R&D, dating back to the early 1980's in the pork industry continued to become processing technology for the plants that have used them since the early 1990's. Initiatives such as 'Future Tech' in Australia, although considered 'a thing of the past', have helped the necessary learning the industry and the technologist needed to progress. Better specification of solutions, with latest technologies that were not available at the time 'Future Tech' was conceived, provide for the much needed solutions the industry needs. The following provides the approaches adopted; some in use, and many having future potential:

a) Restraining and stunning position isolation

The physical isolation of the restraining and stunning position from the main slaughter area is important as it forms a barrier for dust and other air born particles to be prevented from entry into the floor. Many plants do not have this barrier or the positive air pressure within the slaughter floor that maintains a steady stream of airflow from the end of the line to the start of the line, where stunned sheep enter the slaughter line.

Automation technology for removing the manual task of stunning has not been possible due to the limitations in technology to provide the adaptability to position a stunning tool correctly relative to a moving lamb head, engaging it at the correct moment for attachment and activation. The process may become substituted by

other stunning methods at some point in the future as has been seen in the poultry and pork industry.

Several companies provide restraining conveyors and tools for electrical stunning (see links below):

http://jarvisengineering.com/

http://www.freund-germany.com/find-product-form.php)

http://www.kentmaster.com/product.asp?CatID=3

http://www.mps-group.nl/en/mps-red-meat-slaughtering/sheep-slaughter-lines/

b) Sticking and time to first intervention

After stunning the carcass may be required to be slaughtered for Halal meat. It is required that no longer than 25 second lapses between stunning and sticking. The time to first intervention; however, is not explicit by regulation or written documentation from any official authority in Australia. Notional times of 90 seconds, 210 seconds, 220 seconds and even 4 minutes have been quoted, but practices are open in this regard until a clear scientific practice based on the understanding of the requirements has been established, and explicitly documented.

Intervention is also a matter that requires clear understanding as tasks such as pelt opening around the neck for clipping is an important task to avoid contamination during the bleeding for commercial blood collection. In plants across the world the first intervention is normally the step at which the first pelt cut is made on the hind or foreleg (Y cut position).

Electrical stimulation is often integrated during the bleed time or after this period for approximately 30-60 seconds. It is also observed that electrical stimulation is repeated prior to the weigh bridge after the dressing line.

After sticking the practices vary in different plants and countries. In some cases the carcasses are hung on one back leg for blood collection and in others the carcasses are hung on all 4 legs with the front leg attachment around 200-300 mm lower than the back

leg. Many companies provide chain solutions and the links blow list some of the options:

http://www.mps-group.nl/en/mps-red-meat-slaughtering/sheep-slaughter-lines/sheep-restrainer/

http://www.mps-group.nl/en/mps-red-meat-slaughtering/anitec-blood-collection-storage-and-processing-systems/

c) Switch and Hock cutting

For the inverted processing process, the forelegs need to be hung on a shackle for the front legs to be driven by the chain in synchronisation with the back leg. Alternatively, after sticking, carcasses hang on all four legs. In both cases, a hock cutting step needs to separate the back leg hocks at the appropriate point in the line. Back leg hock cutting is generally above the elbow joint and not considered critical as an anatomical cut. The automatic solutions are low cost for this process and the cut is through the leg with the pelt on. There is a requirement after pelt removal to tip the back legs, as the leg tips at hock cutting and pelt pulling stages become contaminated.

Front leg hock cutting is more critical as it needs to be performed anatomically, and will be discussed later. Hock cutting solutions have been available from many companies and the following links provide options for reference.

http://www.wblhyd.com.au/index.php
http://jarvisengineering.com/

http://www.freund-germany.com/find-product-form.php

http://www.kentmaster.com/product.asp?CatID=3

http://banss.de/en/#slaughtering-technology-sheep-lamb-goats/

http://www.jarvisproducts.com/Jarvis%20Sheep%20AHC2.htm

d) Y cut and pelt operations on the foreleg, neck and brisket areas

The operations here have been considered for automation and the robotic Y cutting, which started in New Zealand, from the late 1990's, has been adopted in Australia. One of the key barrier to its widespread use has been related to the potential for wool contamination for a small percentage of pelt cuts, which demands the introduction of a corrective action position in the line as an extra

station as well as an inspection station to compensate for this issue. The technology has merit and needs to have further improvements for a 100% results as this operation needs to conform to a zero tolerance process. It is relevant to mention that manual processes pose risk of contamination and it would be important that benchmarks are established to compare the different practices. See useful links:

http://www.youtube.com/watch?v=n5KgPenjOeY

http://www.machineryautomation.com.au/meat/smallstock-slaughter/robotic-y-cutter/#.Uw6wA2pFCrx

http://www.irl.cri.nz/our-research/high-tech-manufacturing/robotics-and-automation/y-cutter-robot

An assisted tool for brisket rolling has been available to the industry as have trimmer knives. The level of skill to operate such tools has had varying degree of success and many companies continue to use knife operatives for the majority of pelt separation tasks along the slaughter chain. Brisket rolling by a mechanised device known as the 'Brisket Roller' poses similar contamination issues as those in Y-cutting, but this is a matter for training and operator skill, rather than equipment capability. Milmiq (New Zealand) and GM Steel (Ireland) are among those who supply such items with the chain.

http://www.milmeq.com/systems--equipment/systems-for-primary-food-industries.aspx?type=meat

http://www.gmsteel.com/

http://www.fea.net.au/

e) Tongue and head removal

The process is usually performed manually at 400 carcases per hour requires 2 people one for breaking the neck and the other to use a knife action to separate the head and to carry-release the head to a waste chute location. Jarvis (Jetco) have the most widely used equipment for head removal and where the recovery of heads for sale is not a requirement, then this equipment can provide useful saving. When heads are not to be saved, the removal of tongue needs to occur prior to head cutting position on the line. The main remaining issue is then the correspondence of the tongue to the

carcass through to the point of veterinary inspection. In general the tongues are collated in a group to account for the number of carcasses on the line from the tongue removal station to the inspection point. The group collected, is rejected as a group if one the corresponding carcasses from which a tongue in the group originates, is declared condemned.

The following provides links to the Jetco head cutting machine

http://www.jarvisproducts.com/Jarvis%20Sheep%20AHD1.htm

http://jarvisengineering.com/automatic-machinery/

To complement the automation for head removal, a simple handling system needs to be developed for the industry to help the rejection of tongues as a group when only one is declared condemned. The method may use a segregated handling process at the collection point linked with the inspection station that automatically releases the condemned tongue to waste when the carcass from which it came, fails inspection.

When saving heads as a product to sell, the following needs consideration:

- At 600 carcasses per hour, up to 6 additional staff would be needed: two people to remove the pelt off the cheeks and one to roll the pelt off the nose and the top of the head assisted by a semi-automatic device known as the Nose Roller. Up to 3 people would be needed after head removal to prepare the head and to perform packaging.
- Attention must be paid to design the line in a manner that allows carcasses, with heads attached, pass through all the points on the line, ensuring that there is no head contact with any parts of the line as carcasses travel from position to position.
- Rigamortis causes the neck to bend to an extent that the Jarvis (Jetco) head cutter requires adaptation to work and to date this has not been a commercial option for the industry. New research is needed if the head removal step is to be automated on the dressing line. It is important to note that the head would be attached to the carcass for inspection and thus the tongue removal step may be combined with the head preparation step giving efficiencies in the process.

f) Punching, pelt separation, shoulder pulling and pelt removal

The steps of pelt removal are generally labour intensive. Punching tools with varying capability assist the process and various types are available commercially. Preparation of the pelt for shoulder pulling, which in general requires 2-3 people is a critical step. The main requirement is easy separation of the pelt to a point where an automatic pelt puller can engage, grasp and pull the pelt off.

Automation of shoulder pulling has been achieved. Milmiq and GM Steel as well as FEA (Australia) provide solutions.

The main requirement with the automated option is that the pelt is prepared in such a manner that engagement of the pelt becomes possible automatically. When carcasses vary significantly in size, a fully automatic machine requires manual intervention.

The semi-automatic approach, costing about half the price, requires the manual loading of the pelt, the triggering a switch, which engages the puller to pull back the pelt. The adjustment of the machine allows the pelt to be pulled for a pelt removing machine to engage, attach and pull off the whole pelt at the next station positioned along the chain.

Pelt removal and shoulder pulling equipment for the industry has been available for several years for operating speeds at 600 per hour. For higher throughputs and indeed for any speed, the Peltomatic solution provides an alternative. The following link may be used to view the technology (http://www.youtube.com/watch?v=Fk6WYx2QArw).
Unlike the normal pullers, the Peltomatic works on a moving chain synchronising several gripper units to the moving pelt attached to the carcass, rolling the pelt off in a continuous action. The technology brings significant benefits, however it requires higher levels of skill in operators and maintenance personnel. For operation above 600 carcasses per hour, the Peltomatic has been observed to work successfully in a well maintained slaughter line.

http://www.milmeq.com/systems--equipment/systems-for-primary-food-industries.aspx?type=meat

http://www.gmsteel.com/

http://www.fea.net.au/pelting/

http://www.mps-group.nl/en/mps-red-meat-slaughtering/sheep-slaughter-lines/

g) Sani-vac and trimming operations

Various trimming and vacuum steam sanitisation steps are normally applied to ensure a conforming carcass is delivered to the dressing part of the slaughter line. Trimming operations require judgement and difficult to automate. Sani-vac operations have been automated and solutions have been successfully implemented by MAR in several Australian plants.

A key consideration is the requirement for inspection post Sani-vac steps. One approach would be include trimming positions post robot Sani-vac stations so that manual inspection corrects for any remaining issues, however this may prolong the trimming time and compromise efficiencies. The more appropriate practice requires R&D in automatic inspection which provides input to a robot station for intelligent Sani-vac steps and also guides the person trimming with intelligence on the positions needing attention on the carcass.

http://www.machineryautomation.com.au/meat/smallstock-slaughter/robotic-forequarter-sani-vac/#.Uw67lWpFCrw

h) Brisket cutting

This has been successfully automated by Milmiq, Jarvis and MAR, MAR seemingly providing the more cost advantageous option. In the inverted position this process step needs to come before shackling and front leg hock cutting.

http://www.machineryautomation.com.au/meat/smallstock-slaughter/robotic-brisket-cutter/#.Uw6702pFCrw

http://www.milmeq.com/systems--equipment/systems-for-primary-food-industries.aspx?type=meat

http://jarvisengineering.com/automatic-machinery/

i) Shackling, back leg hock tipping and front leg hock cutting

The steps are generally manual. A solution for back leg tipping is available as an automated option operating at medium throughputs

(5 per minute as observed). Solutions for front leg hock cutting as automated provide opportunities but at a cost. Use of vision systems in front leg hock cutting is noted, but the solutions give an accurate anatomical cut on only one leg and the other leg which may be sitting higher is cut above the elbow joint, requiring trimming at a later stage. Anatomical cutting for front legs remains to be developed for line speeds approaching 450-600 carcasses per hour.

http://jarvisengineering.com/automatic-machinery/

http://www.jarvisproducts.com/Jarvis%20Sheep%20AHC2.htm

j) Bung drop, belly opening, viscera and offal removal steps

These process steps are highly labour intensive and critical from hygiene and OHS (especially in evisceration) viewpoints.

Automation has been attempted, but to a limited extent and the steps continues to remain as important operations to automate for the industry. An integrated approach requires a new arrangement for the line to ensure non-interference with normal operation during installation and commissioning.

Milmiq and MAR offer solutions to the industry:

http://www.machineryautomation.com.au/automated-smallstock-evisceration-brochure/

http://www.milmeq.com/systems--equipment/systems-for-primary-food-industries.aspx?type=meat

k) Dressing line ops to the chill

Operations that follow require significant handling of complex items including the viscera and offal on a pan conveyor. The carcass inspection is an important step on the dressing line and this presents an important opportunity for automation, especially with the new regulatory requirements facing the industry from the export markets.

Procedures to retain a carcasses and practices that follow for corrective action need more specific logs, the procedures for which needing clearly definition. Automation for recording the reason for

retention and the follow up corrective action including facilitation to track the information presents a new opportunity to introduce technology options for better efficiency.

In the process of slaughter mouthing is an important step. Mouthing is done at the point of head removal. This information, when carried forward provides input to marking operation using a stamp, identifying the carcass as Lamb, hog or mutton. Health mark printing by automation has been common in Europe and such automation may be employed for marking, giving improved efficiency.

Handling of viscera and offal as well as packaging of offal, given the nature of tasks involved, pose challenges for the industry with limited R&D. The links below provide access to some relevant information:

http://banss.de/en/#slaughtering-technology-sheep-lamb-goats/

http://www.fpe.net.au/product_range.html

http://guoxinmachine.en.alibaba.com/product/736983452-219373257/Slaughtering_Squipment_of_Tripe_Cleaning_Machine.html

http://www.itec.de/index.php/casing-equipment.html

http://www.milmeq.com/

Automation for tripe, offal, tongue and other similar products, especially in packaging requires further development, receiving little R&D attention.

l) Decontamination

Carcass decontamination is an important topic for the industry. New technologies for surface decontamination have been in development for many years. Verify is a system that may be used to improve microbial control as it allows detection of urine, feces or non-visible contamination. The convention however, is to use a carcass wash in many plants.

R&D in this area covers aspects of surface decontamination and steam vacuuming including inspection of carcasses by automatic

imaging. Future R&D needs to replace processes that apply decontamination chemicals and use high volumes of water.

Relevant information may be searched using the following links:

http://www.meatupdate.csiro.au/new/Hot%20Water%20Rinse.pdf

http://www.ukmeat.org/FSAMeat/CattleSheepWashing.htm

http://www.meatupdate.csiro.au/new/Review%20of%20new%20and%20emerging%20technlogies%20for%20red%20meat%20safety.pdf

http://www.fsis.usda.gov/wps/wcm/connect/b6386c9f-8d2b-4179-810d-fe6534e4251c/25_IM_Slaughter_FS_Standard.pdf?MOD=AJPERES

m) Grading, classification, weighing and labelling

In the processes to the end of the dressing line post trimming and QA operations, technologies are available for carcass grading and classification. When combined with electronic traceability they provide the opportunities for sorting and selective processing post chill, for market alignment meeting customer specific standards in grade or quality of whole carcass. New approaches in technology integration can provide for traceability in the total process, whilst automation operations that can bring carcass handling and sorting prior to entry into chill rooms. This facilitates carcass selection for cutting or order picking. The sorting processes based on grade, conformation class, weight and other measurements such as fat cover on specific primal cuts supports planning and optimised processing operations including automated labelling and marking.

http://www.danishcrown.com/custom/horsens_uk/3896.asp

http://www.mps-group.nl/en/mps-red-meat-slaughtering/robotisation-of-the-pig-slaughter-line/fum-universal-marker/

http://www.carometec.com/

http://www.eplusv.com/start_E.htm

n) Cord removal, inspection and pre chill trimming

The spinal cord removal using a vacuum suction is common in beef operation and dates back to the times of BSE. In lamb the requirement for removal is more directly related to efficiencies in the operations that follow in the cutting rooms. Nominally 15% increase in efficiency may be expected in tasks that involve trimming tasks, which separate the cord tissue from the spine for bone in lamb products.

A current MLA project is expected to reach trials of a final tool and this is intended to be a new position along the line post dressing operations, before the weigh bridge.

In the procurement process all suppliers and contractors must meet requirements in food safety. The sign off process in the specification needs to pay specific attention and in particular guidelines in Food Safety Standards Australia are relevant in the preparation of procurement documents for equipment:

http://www.foodstandards.gov.au/industry/safetystandards/premises/Pages/default.aspx

The next sections expand the above into an integrated design and layout, which although specific to GM Scott, may be considered relevant for any lamb processor.

5.3 Design and layout

The considerations of processes and steps in operations may be translated into approaches for design and layout for slaughter rooms.

These approaches include:

a) Building designs that separate the main slaughtering rooms into two segregated sections for hide/pelt on and dressing operations maintaining greater microbial control. Placing offal, viscera and other processing areas below the main slaughter room in a three level building, that uses the top floor for services and ancillary equipment maintains separation of these areas for better operation and hygiene control.
b) Environmental control in the main slaughter area is critical. Designing for a positive atmosphere in the dressing line from the end of the line (clean areas) needs to ensure flow of air towards the less clean areas reducing possibilities for contamination.

c) Automating waste handling and organising drains and connection of services must provide for access for maintenance. The design specification that reduces the potential for damage caused by pipe expansion will give longer life to the building and lower running costs
d) Separation of access for staff is important as it segregates processing rooms for microbial control. Hygiene equipment for boot washing, hand drying and sanitisation using one way gateways have been in use in Europe for considerable time. Many plants need to consider, such equipment enforcing, by design, staff hygiene practices.
e) Automatic process control for monitoring water temperatures at all points in the slaughter area, especially for sterilisation is an important issue. In many plants QA practices are ineffective as the measures of logging temperature do not link with the equipment that supplies the desired water temperatures. Turbidity control and automatic water sanitisation testing as well as processing remain the subject for research, but fundamental with respect to cost effective management of hygiene. The process of automation can make significant reductions in water and energy use.

Among the many considerations, some of which are highlighted above, defining a layout for best efficiency remains a main task in the feasibility for a new slaughtering facility. The critical consideration in respect of efficiency is the definition of an effective design layout, which optimises the cost of the building against the positioning and configuration of the line as well as the processing areas. The next sections of this report present the approach to the layout and the results for a lamb processing operation at GM Scott, Coortamundra, Australia. The opportunities for labour savings and including options for future automation are included.

In the process of specifying a layout, it is necessary to reach a balance in length of the chain against halal slaughter requirements. An important issue relates to specific time to first intervention after sticking as required by different countries importing halal meat. Throughput has a major impact in this respect. Clear guidelines in Australia are needed in a documented form, as the time to intervention and its definition as well as scientific basis is not clearly established. The time to intervention after sticking ranging from 90 seconds to 240 seconds is too wide to specify equipment against. There is also a need for clarity of what constitutes intervention. In the approach to layout the important parameter that needs to be formally agreed is the distance from the sticking point to the point where first intervention is to occur. During this time over this distance, blood collection occurs, which is generally

slightly shorter in duration than the time to first intervention from the halal sticking station.

6. Results and discussions

The consideration and approaches presented earlier in this report have influenced the definition of a new layout, optimised for building cost and operating efficiency, with the potential for further enhancements with medium and long term introduction of additional automation. The results have been based on GM Scott requirements for a new slaughter facility and presented below, giving higher throughput, improved hygiene and better efficiency.

6.1 Feasibility of an efficient slaughter facility

The GM Scott process (see Table 1) has been evaluated and a mapping achieved over several weeks of team discussion and practical testing.

GM Scott		
Slaughter Ops as at 7th May 2012-Oct 2012		
No	**Process**	**No of operatives**
1	Restrainer	1
2	Stun	1
3	Shackler	1
4	Stick	1
5	Y-Cut	3
6	Change over	1
7	FQ Fleece	6
8	Shoulder	2
9	Tongues	1
10	Rod-clip & Change	2
11	Rear Legs clip	1
12	Head	1
13	Punch Down	4
14	Hide Puller	1
15	Trim Tail	1
16	Shackle	1
17	Change over	1
18	Trim	1
19	Bung	2
20	Stamp/Kidneys	1
21	Trim	1
22	Gut out	1
23	Brisket cut	1
24	Offal out	1
25	Floor	3
26	Rope/Kidney out	1
27	Final trim/neck	1
28	Aus trim Skirts	1
29	Offal table/chill	5
30	Offal room	5
31	Scales	2
	Total	55

Table 1: Process at start of project

GM Scott		**Heights at work stations**	
New Slaughter Floor Ops			
No	**TASK**	**Front Leg**	**Back Leg**
P01	**Stun**	**N/A**	**N/A**
P02	**STICK**	**N/A**	**N/A**
P03	**Shackle BL**	**N/A**	**1300**
P04	**Shackle FL**	**1300**	**N/A**
P05	**Plug**	**1650**	**1900**
P06	**Neck prep**	**1650**	**1900**
P07	**ROD**	**1650**	**1900**
P08	**CLIP**	**1650**	**1900**
P09	**FQ ops**	**1650**	**1900**
P10	**FQ opa**	**1650**	**1900**
P11	**ROLL**	**1650**	**1900**
P12	**WIZ trim**	**1650**	**1900**
P13	**Horn cut**	**1950**	**1900**
P14	**HEAD PELT**	**1950**	**1900**
P15	**HEAD PELT**	**1950**	**1900**
P16	**NOSE**	**1950**	**1900**
	BL HOCK Cutter		
	BL HOCK bkup	**2200**	**1500**
P17	**S-PULL BU**	**2200**	**N/A**
P18	**S-PULL BU**	**2200**	**N/A**
P19	**FLANK**	**2200**	**N/A**
P20	**PREP**	**1650**	**N/A**
P21	**PUNCH 1**	**1650**	**N/A**
P22	**PUNCH 2**	**1650**	**N/A**
	Shoulder m/c	**1900**	**N/A**
P23	**Pelt chech**	**1900**	**N/A**
P24	**checking QA etc**	**1900**	**N/A**
	Pelt remove	**1900**	**N/A**
	Robot brisket	**1900**	**N/A**
P25	**Post Pelt check**	**1900**	**N/A**
P26	**PLASTIC HOOK**	**1900**	**1400**
	Hock FL BKUP	**1400**	**1900**
	Auto FL hock cut	**1400**	**1900**
P27	**Tail trim**	**N/A**	**1900**
P28	**Bung drop**	**N/A**	**1900**
P29	**Belly open**	**N/A**	**1900**
P30	**Viscera out**	**N/A**	**1975**
	Brisket BKUP	**N/A**	**2050**
P31	**Offal out**	**N/A**	**2050**
P32	**Kidney out**	**N/A**	**1975**
P33	**Inspection CARC**	**N/A**	**1950**
P34	**Inspection TABLE**	**N/A**	**N/A**
P35	**Paunch**	**N/A**	**N/A**
P36	**Offal**	**N/A**	**N/A**
P37	**Kidney,etc**	**N/A**	**N/A**
P38	**HQ Trim**	**N/A**	**1950**
P39	**FQ Trim**	**N/A**	**2600**
P40	**Mting-tngue**	**N/A**	**2600**
	Auto stamping		
	Stamping BKUP	**N/A**	**2600**
P41	**Head cut**	**N/A**	**2600**
P42	**Final neck trim**	**N/A**	**2600**
P43	**Aus trim skirt**	**N/A**	**2600**
P44	**Sani vack 1**	**N/A**	**2600**
P45	**Sani vack 2**	**N/A**	**2600**
P46	**rubber band**	**N/A**	**2600**

Table 2: New process

Table 2 presents the overall process steps for the new slaughter operation. Based on Table 2 a compact layout has been reached after many iterations and this is shown in Figure 1.

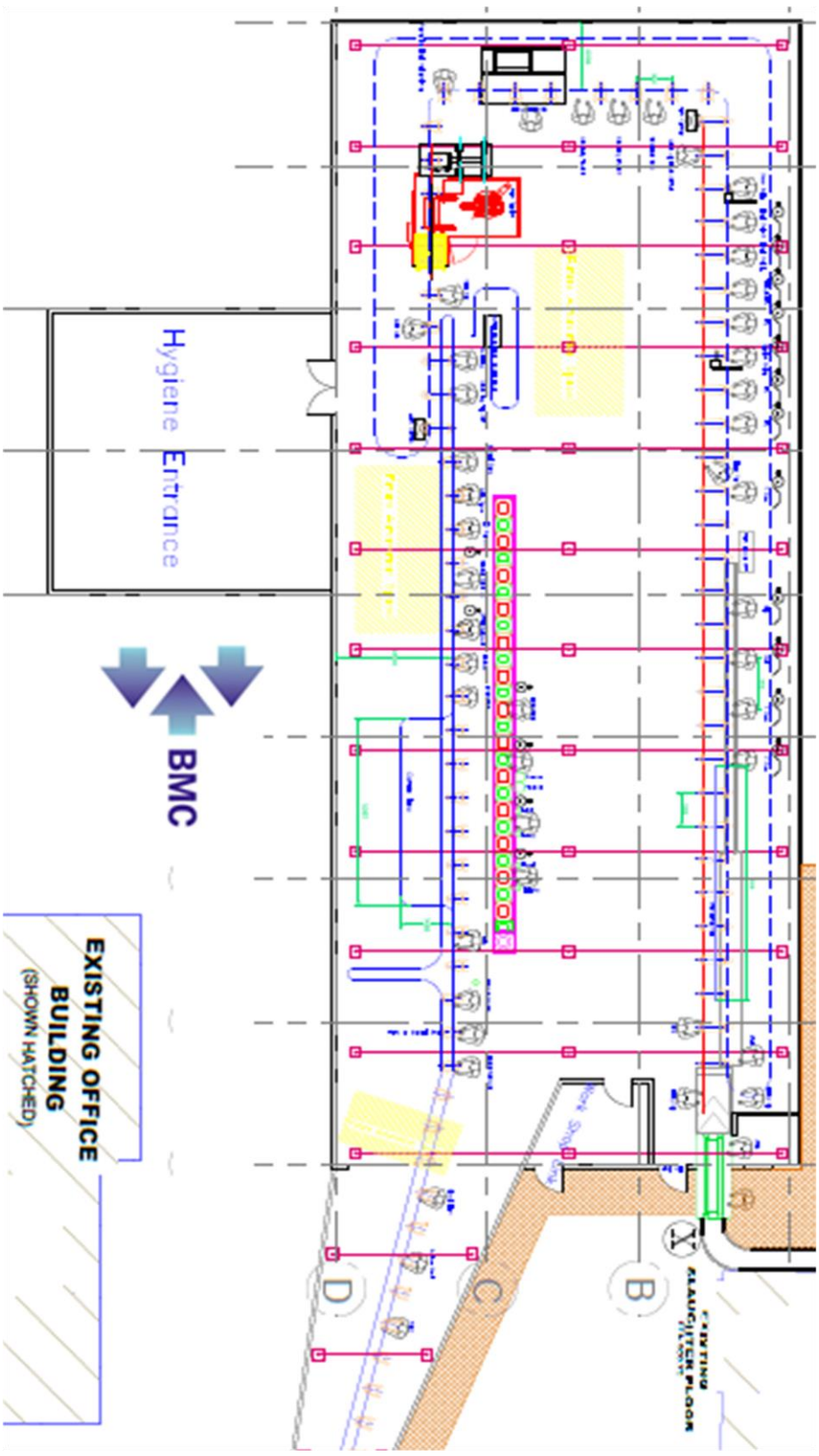


Figure1: Layout for a new slaughter floor

The restraining conveyor is located at position marked X bottom right of Figure 1. The chain starts after the stunning position, outside the building, traveling North to the right of the drawing in Figure 1. The stages of sticking, blood collection, pelt operations follow. Punching tools and shoulder pulling equipment are located to the North side of the room. The chain continues in an anti-clockwise manner, returning along the left side of the layout, which includes the pelt removal, robot brisket cutting and then the carcass is switched to the dressing section of the chain, which ends to the chill rooms through a decline section, in the link way bottom left of Figure 1. The hygiene equipment and staff entrance are located to the left of the building as shown.

The key features in the approach and the layout of Figure 1 are:

1. The design allows for alternative approaches to blood collection, with carcasses having a 2 meter distance to wall parallel to the direction of travel on either side of the chain, where this is appropriate.

2. Inclusion of proven automation to improve efficiency allowing use of scarce labour in other critical areas of operation where automation is not available and lack of staffing results in a daily throughput shortfall or unplanned overtime.

3. The handling of offal and paunch is separated and made more efficient through integration with secondary processing areas below the main slaughter floor.

4. Inclusion of a major service area above the slaughter floor for control equipment such as robot controllers, power packs for pelt equipment and other similar systems including future IT and automation equipment.

5. Integrated handling of finished cases for direct link to despatch and handing of waste in an efficient manner minimising current manual operations in the offal and runner rooms.

6. Introduction of new operation in paunch processing such as tripe cooking.

Table 2 highlights positions for automation and the chain heights at each station.

Note the design provides for a 600 per hour chain giving the potential for a 30% increase compared to the production throughput prior to the start of the new laughter facility.

Clearly to achieve the speed, significant strategic investment in training and skills management is required. To date the results suggest an actual increase in throughput of about 10%-15%, whilst the objectives to improve working environment and hygiene, maintaining standards of quality have been met.

6.2 Automation options and detailed considerations

The tasks performed in the slaughtering operation require judgement and skill, which poses challenges for automation.

In the definition and specification of automation processes for GM Scott, the project has considered solutions offered by leading technology providers including:

- Milmeq (New Zealand)
- Jarvis (USA and New Zealand)
- FEA (Australia))
- BANSS (Germany)
- MAR (Australia)
- MPS red meat (Holland)
- GM Steel (Ireland)

Several processors in Europe and Australia were visited and the author and GM Scott are grateful for the openness and hospitality of the companies:

Hartwicks (Australia)
CRF (Australia)
WAMMCO (Australia)
AMP (New Zealand)
Dunbia (UK)
Irish Country Foods (Ireland)
Nortura (Norway)
Fletchers (Australia)
T&R (Australia)
Frewstal (Australia)

The detailed consideration of automation has provided the basis for the understanding of the processes that should be considered for automation using established technology. Such, as identified and evaluated has been included in the GM Scott plan for procurement. Areas of new implementation considered beyond simple procurement for a supplier have been evaluated also and the opportunities for future implementation proposed with possible support from the MLA – AMPC being explored.

The following sections provide the details as an overview.

6.2.1 Automation in the slaughter area

The step by step process from the restraining position and stunning, through to the FSMA station have been considered in respect of the following:

- Process rationalisation - ensuring each step is required and cannot be eliminated or absorbed in other process steps, maintaining efficiency and quality of operation,
- Process re-engineering - ensuring that the steps required are in the most efficient sequence and if the capability in the step has possibility for improvement as a manual process, through training or introduction of tools,
- Mechanisation - the step may be improved by a mechanism or a tool that assists with operational efficiency
- Automation - the process steps may be automated and operator relocated in other areas of the slaughter operation to increase overall productivity.

A new layout with specific steps as in Figure 1 has been reached, applying the above approaches to reach improvements in each step. The outcome of having applied the above approaches to each step has resulted in a new sequence of operation for GM Scott as presented mapping the process of Table 1 into that of Table 2 the new processes as a starting point. Further improvements have been instigated as relevant since the formation of the layout of Figure 1.

In particular, the tasks of rodding and clipping have been repositioned and the blood collection area rationalised with the processes of manual Y-cutting re-engineered to accommodate brisket pelt separation in a more effective and hygienic manner. Stations for saving heads as considered have not been implemented due to limited return on investment.

The automation opportunities have included those from Jarvis, FEA, Milmeq and MAR as follows:

a) The automation options for the slaughter floor start with Y cutting, which has been considered. The evaluation of performance and quality based on experience of other processors has placed the inclusion of an automatic Y-cutting as a longer term project. The main reasons are related to costs, reliability and impact on efficiency, given that the labour saving justification cannot be substantiated in the short term.

b) A standard automatic back leg hock cutter has been specified and GM Scott have the task to add an automated hock knocking off device to support this simple hock cutter.

c) Automatic shoulder pulling for pelt separation has been considered. The fully automatic solution has been reported to pose complication for some plants, not adequately accommodating for wide variability in carcasses. The preceding pelt separation steps carried out manually

around the head, neck and top of the shoulder for automatic engagement or attachment to the pelt for pulling requires careful control by supervision. A semi-automatic option presents appropriate and cost effective approach for GM Scott and this has been specified for implementation.

d) Pelt remover: The automatic solutions considered included the standard pelt arm and the rotary pelt roller. Based on reliability information and consistency in operation without affecting operational efficiency, the pelt remover has the standard pelt arm and has been specified as the automation option for GM Scott. Peltomatic has been a serious option, however, concerns over the maintenance capability and capacity to support its day to day use, have placed this option lower on the priority list.

e) After pelt removal, a number of operations have been considered. From the range of automation solutions available, the Robotic Brisket Cutter has been the only robotic cell included in the implementation.

f) Space has been allocated for the following, which remain largely a matter for R&D and future inclusion:

- Automatic shackling after pelt removal - not available or being considered properly for development. This needs to incorporate a back leg tipping process also, for better return on investment, and an anatomical foreleg hock cutting automation unit for both front legs. Although a standard hock cutter may be, and has been, specified, front leg hock cutting must be done anatomically on both legs and all the developments to date have resulted in an outcome that gives correct anatomical cutting of only one front leg, with the second leg cut high and requiring tipping at a later stage. Further R&D in this area needs to allow for correct anatomical cutting of both legs.

- Automatic bung separation - in the R&D phase and requires further evaluation and improvement. The practical integration with a high throughput line will need to occur with operating experience that supports justification for implementation,

- Automatic belly opening – This has been successfully implemented for pork and its adaptation can result in a fast implementation through R&D for lamb.

- Automatic viscera and offal separation- in R&D phase and the acclaimed units in production are yet to reach steady state as a turn-key automation cell for Australian range of carcass sizes,

- Automatic head cutting- available only as a solution for separating heads along the pelt section of the line. This is included in the GM Scott solution and has justifiable ROI when heads are not saved as a product. When carcasses are prepared for saving heads, Rigamortis causes the neck and the head of the carcass to sit at close to right angle to the back of the carcass, when hanging vertically, making the task for head cutting out of scope of existing equipment specification and an important topic for R&D.
- Fat sucking and Sani-vac automation - which have been in use, require further refinements and integration for stable and quality assured performance. These automation options need to be considered as part of an integration R&D and a change management process that also provides for the new QA procedures.

Other operations such automatic cleaning, waste handling and stamping, linked with 'mouthing' operation and tongue separation, have also been considered and customised solutions are to be implemented where this can be reached by short-term engineering development, supported by R&D initiatives. Automatic cleaning presents a new area of opportunities, but little technology has been developed through R&D.

Given the approach to building design at GM Scott, automatic cleaning could be possible for the first time removing over 80% of the cleaning tasks during the running and at the end of each day. The cleaning is intended to be in modules for each section of the floor.

Cost benefit consideration in respect of specific automation solutions have been considered and the summary is as follows for stations considered priority:

Task	Brisket pelt roller	Nose roller	Shoulder puller	Brisket cutter	Back leg hook cutter	Front leg hook cutter	Automatic stamping
ROI Months	20	14	18	37	14	14	10

The GM Scott change management process has been directed to the decisions in planning and focused delivery of the short term automation solutions in the day to day business to achieve the benefits in ROI and quality improvements.

Figure 2 presents the layout of Figure 1, with automation options starting from automatic shacking after brisket cutting and pelt removal to the end of evisceration, including all steps from back leg hock tipping, bung dropping, bely opening, viscera extraction, though to Sani-vac automation and full

carcass inspection, including grading and classification and associated IT infrastructure supporting the concepts that support the strategies presented.

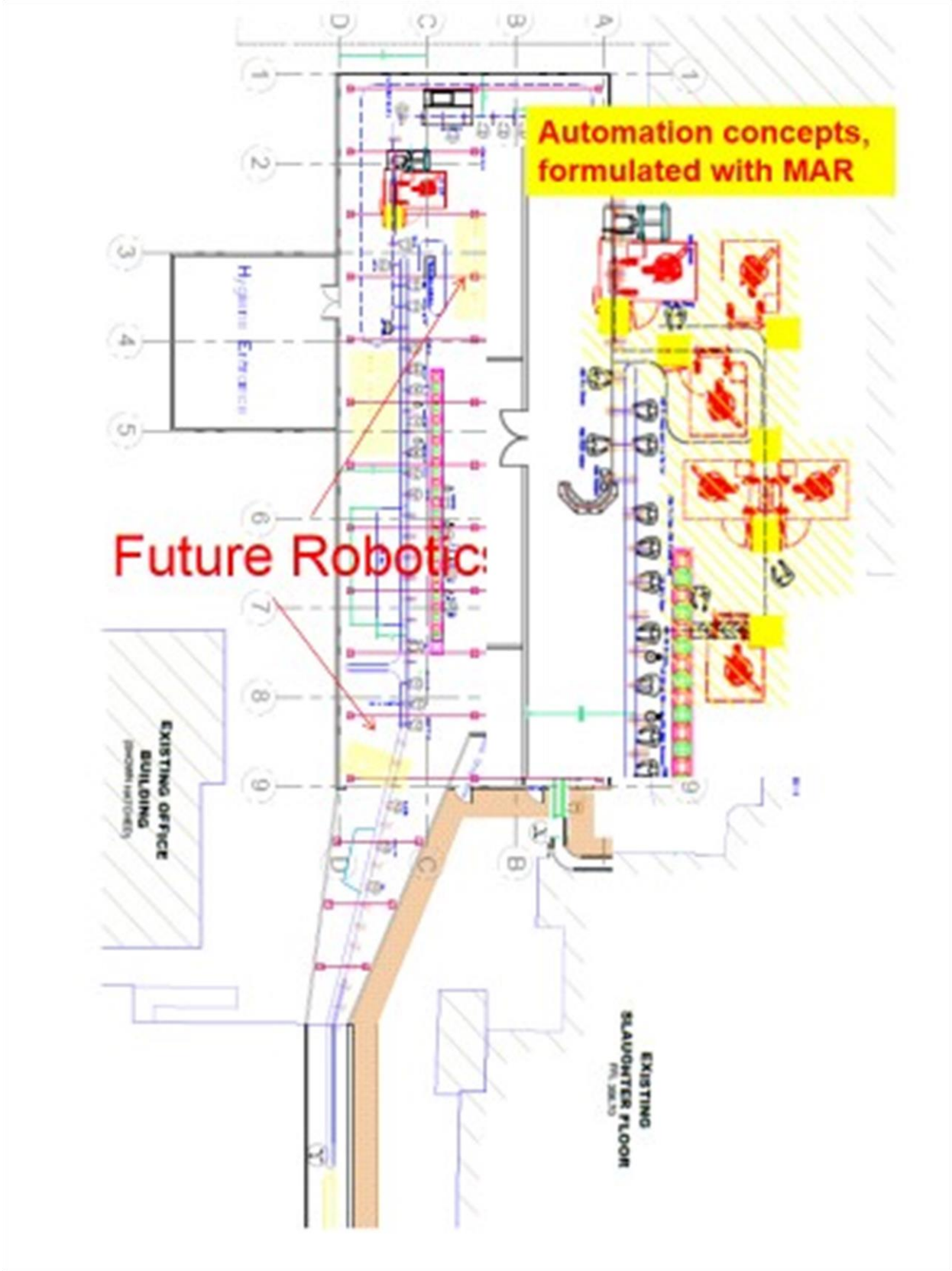


Figure 2: Automation options of the future mapping the layout of Figure 1.

6.2.2 IT considerations

In a modern slaughter plant a computerised system for monitoring and controlling operation is an important resource. Unfortunately the systems available in exiting plants have had significant customisation and there is a need for a more universal implementation. Operating parameters such as speed of the line and kill numbers are generally managed by supervision. The strategy for IT development may be considered at its infancy. Requirements and strategic developments need to provide for live information and reporting as possible, to include:

- Real time KPI reporting (weights, kill numbers, productivity, etc.).
- Real time QA reporting (carcass/product temperatures, steriliser/hand wash temperatures, contamination incidents, corrective actions on arrest carcasses, paunch and offal incidents, etc.).
- Real time R&M reporting (failure incidents, repair times, etc.).
- Electronic Traceability (tracking of: carcasses by mob, individual carcasses through the process, people, hygiene and veterinary information, tools and hand held equipment, QA tools-swabs etc.). Traceability is particularly important in relation to home and export markets and management of the supply chain back to farm and forward to the customers.
- Real time control of hot water supply, especially to sterilisers. Compared to what is generally the rate of water consumption, the initial process of sterilisation and wash processes will result in a greater than 25% reduction in water use. Based on a new approach, improvements of a further 50% or more may be anticipated using automation in water temperature and quality control. The process would also halve the energy spent, as a minimum, to produce hot water.
- Real time plant reporting (water consumption, electricity consumption, chill room temperatures, room temperatures and humidity, etc.).
- Summery reporting and exception management including mobile reporting (to smart phones) for example to alert to failures or throughput anomalies against planned targets per hour or operating period).

Automation of the processes in the slaughter operation as in section 6.2.1 need to be complemented by the IT and electronic monitoring systems that support management reporting as well as planning capabilities that allow real time decision support for minute by minute management.

6.2.3 Building considerations

The accommodation of the equipment in a well specified building at minimum cost has been the approach in the strategy and an important objective of this project.

Figure 3 presents the optimised solution that places the whole building above the flood plain and on 3 floors.

Avoiding columns in the centre of the building provides flexibility in the way layout of the equipment is defined. Architects and the building companies involved have been steered in a manner that resulted in savings of greater than 15% in total construction cost compared with initial pricing. The main feature of the building that has driven cost has been the floor size and in particular the width of the building at 13.5 meters. An additional 1 meter increase in width gives a 20% increase on overall cost and net increase of greater 15% on building costs.

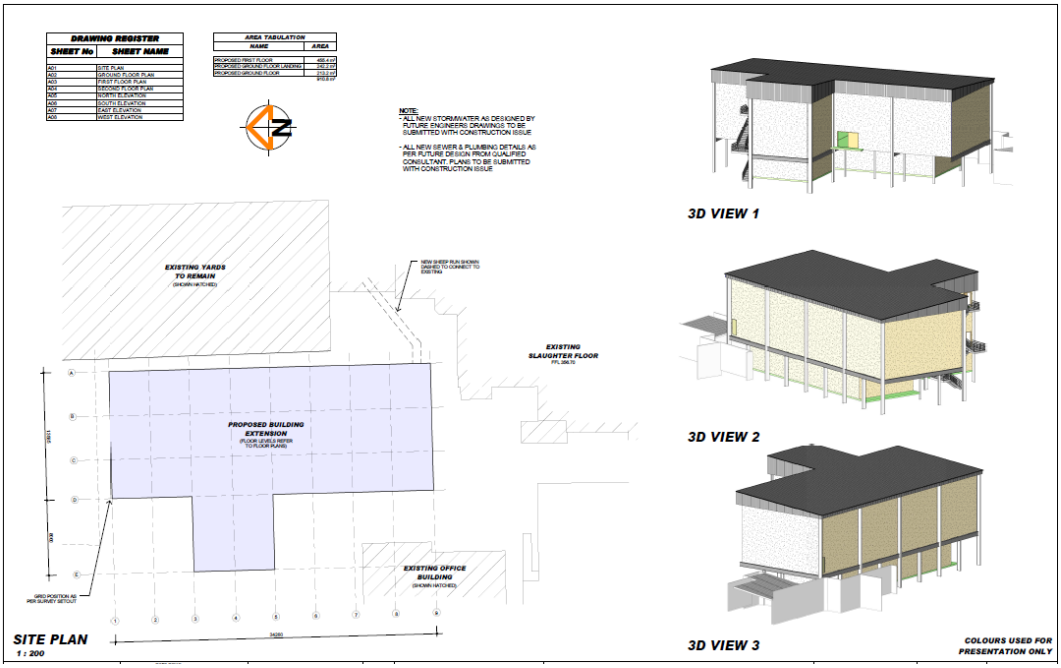


Figure 3: Building design optimised for flexibility at minimum cost

The exercise here, in early stages of the project, has needed carful direction and management, defining the interrelationship of equipment layout and building specification to achieve an optimum cost solution. This has been an important process, resulting in a best cost outcome as possible for GM Scott.

The definition of responsibilities and tasks that have been necessary for the implementation of the new facility has formed part of the strategy and planning, which has brought about the results in the form of a completed facility at GM Scott.

7. Concluding remarks

The strategic review of a new slaughter facility based on the assessment of existing facilities at GM Scott has been the focus of this work.

The project has considered the operating practices and automation opportunities in order to define a compact layout for a new and efficient slaughtering facility, to be housed in an optimum cost building. The following have driven been part of the strategic considerations:

- Change management, training and supply for a plant that is to operate for 30 years.
- The approach to the building, allowing all services including drains and waste handling systems to be accessible for routine maintenance.
- The specification to meet the total life cycle scenarios allowing for continuous improvement, including logging of the details and records in the process of build and installation, documenting relevant aspects of the building construction as it is being built and the installation phases of the equipment.
- IT and management information with full traceability back to farm as part of future strategy to comply with existing and to reach new export markets from Australia.
- Hygiene and sanitation control, including assurance procedures involving electronic scanning and automated sterilisation with accountability and reporting processes.
- Turbidity control and energy efficiency in hot water used in slaughtering operations.
- Quality and grading including techniques for yield prediction and planning, sorting and integration of carcass data for optimising end product quality and yield. This would provide for effective utilisation of carcass meat in finished products, giving improved impact on yields.
- Automation including robotics and other devices for maximum efficiency.
- High throughput with fault diagnostics, recovery procedures and redundancy or back up.
- Human resource management including integrated processes for wash facilities, changing room and maintenance access with full consideration of electronic monitoring to assure safe and hygienic practice as well as better work procedures, including the tracking of tools used for maintenance and repair.
- Integrated handling for offal and waste processing with minimum or no manual handling where such is practical.
- Energy management and environmental considerations including:
    - air conditioning and atmospheric control
    - water consumption and treatment
    - specification of energy efficient equipment
    - hygienic design (cleanability of equipment)
    - waste reduction.

Future developments in slaughtering automation include:

- robotics and automation for all steps in slaughtering using tools or requiring handling of difficult or heavy items
- traceability and operations control including IT and KPI reporting integration
- systems integration, linking automated processing equipment with management information systems
- sanitisation control and water management system
- veterinary and arrest corrective action process management

Australia is unique in its meat industry as the industry contributes in a significant manner to the wealth of the nation. The spirit of competition is healthy; however, as a strategic approach, the sharing of information and best practice needs to become a norm with networking for the industry in respect of:

a) Broader adoption of new practices improving operations especially with respect to safety, quality and use of resources,
b) Wider understanding of technology use,
c) Management practice and skills understanding,
d) Awareness of new developments and appreciation of the wider context of applicability of emerging or future technologies,

Involvement of and taking part in networking initiatives requires company commitment at a high level and resourcing. Although the approach is not new, the meat industry needs greater national encouragement facilitating networking.

Specific recommendations:

- Instigation of automation project that overcome limitations of current automation and achieve robotisation of new tasks
- Benchmarking, comparing practices and efficiencies on a task by task basis. This would provide industry with guidelines for improvements already achieved but not publically revealed.
- Networking opportunity at supervisor level complemented by training plans for line managers.
- Developments to reach maturity in the adoption of best practice and technology, supporting improvements in operations efficiency, quality, yield, control of energy and water use and better IT in support of the total supply chain.

This study based on observation of plants around the world and considerations at GM Scott has facilitated the construction of a new slaughter facility. The facility provides the foundations and the possibilities for new developments in line with strategies for automation and advancements of slaughter houses of the future.

8. Web summary

The future of the meat industry will rely on its ability to modernise its slaughtering operation for improved quality, cost, hygiene, safety and, where relevant, yield. Many small stock processors have the need to upgrade their facilities, also introducing automation where relevant. A few processors may be faced with the need for a complete re-build as a green field project, where the opportunity for using proven automation with the possibility to allowing for future automation presents itself. One of the main challenges of a green-field or upgrade slaughterhouse project is maximising the use of available investment, acquiring the most appropriate equipment, with high reliability and long life, to be housed in a best value building requiring minimum maintenance. This strategic review covers related consideration to such a green-field approach to building a new slaughter facility.

Inclusion of automation technology and designing a long life slaughtering plant, allowing for future possibilities for new innovations or developments, requires management of change and clear understanding of:

- Processes of slaughter and the development of skills
- Throughput and bottleneck limitations, including influences of skills and livestock quality.
- Equipment capability and tools
- Hygiene constraints and levels of control
- Veterinary parameters
- Legislative and regulatory requirements
- Quality assurance process and limitations of inspection
- Working practices and influences over quality, productivity and resource consumption
- Other operational considerations, including use of energy, water and consumables (such as cleaning materials or chemicals).

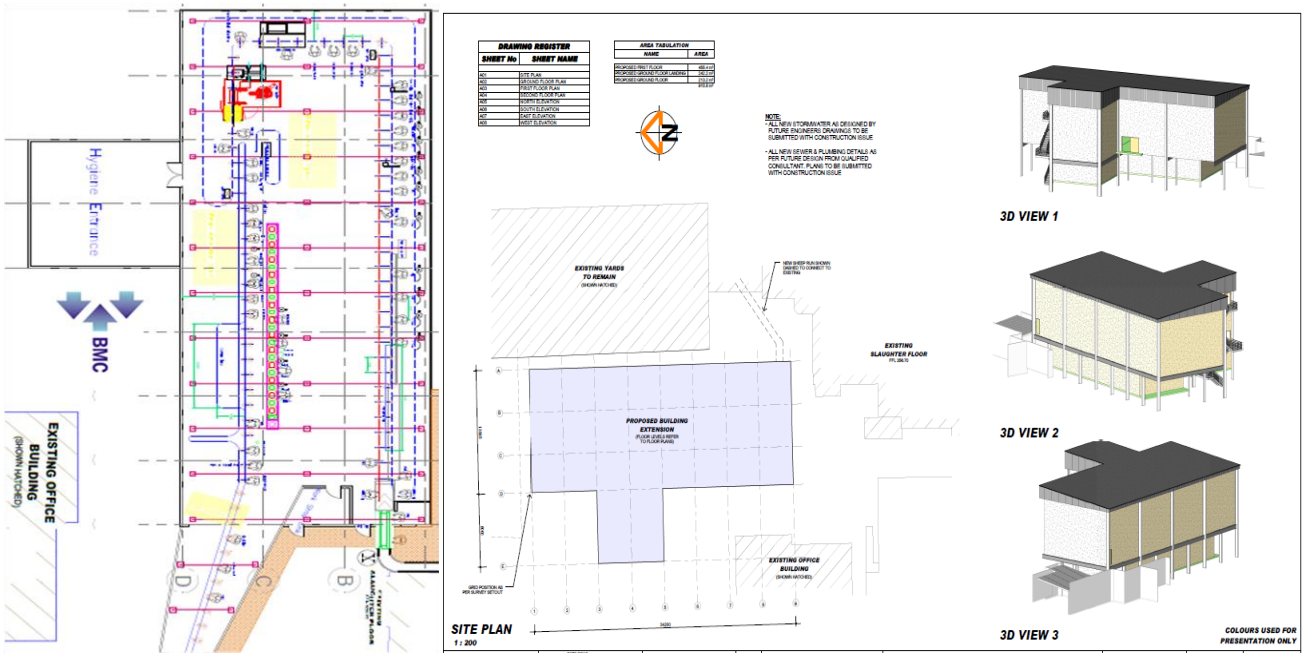
This project has considered implementation of a new slaughter operation for lamb processing, including the operating steps from stunning to end of slaughtering at final inspection before carcasses entre the chill room. In particular the following have been considered:

- Current practice and staffing
- Slaughter line equipment and assessment of suppliers
- Automation or semi-automatic tools including: Y-cutting, Hock cutting and hock tipping, Punching tools and semi-automatic shoulder pulling (pelt), Pelt removal, Sani-vac ops and brisket cutting, Evisceration, including bung drop and belly opening, Head cutting
- Traceability and IT
- Hygiene equipment and sterilisation
- Future automation including: Automatic shackling, Grading and classification (with yield prediction and tracking), Automatic or assisted inspection with information tracking

The feasibility for a green field slaughtering facility has been the result of this project covering:-

- Building, services and fitting on 3 levels
  - Level 1, above the flood plain for ancillary and offal processing including runners, tripe cooking, red offal processing and chill, hook room load out and associated hygiene entrance, accommodating also for pelt operations
  - Level 2, main slaughter floor from restrainer (linking to new sheep ramp and stock holding facilities), though to carcass wash end entry into chill rooms.
  - Level 3, housing ancillary equipment such as control cabinets, power packs, etc., with easy access for maintenance.
- All slaughtering equipment, including tools and environmental controls
- Plumbing (excluding main hot and cold supply already available)
- Waste handling (excluding links with rendering)
- Hygiene equipment (including sterilisers and automatic boot wash, hand wash, hand soap and hand sanitiser equipment)

The project has provided the basis for implementation of the facility at GM Scott, where the new slaughtering operation in a green field construction started on 26th August 2013.



Layout for a new slaughter floor and concept for the building resulting from the strategic review of this project

9. Web key words

Slaughter line, robotics and automation, lamb processing, green field design and build, lamb slaughtering.