AUSTRALIAN MEAT PROCESSOR CORPORATION

# A predictive model and tool design for firm level cost benefit assessment of the purchase and implementation of new processing technologies

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# Introduction

The Australian Meat Processor Corporation (AMPC) commissioned a study designed to provide a predictive model (and tool design) for firm level cost benefit assessment of the purchase and implementation of new processing technologies. The rationale behind the project is summarised below.

There is a wide range of technologies, processes and practices already implemented in the red meat processing industry aimed at improving productivity and efficiency. Furthermore, new developments in this field are continually evolving.

AMPC identified the need for the development of an model which incorporates all key costs and benefits associated with these activities to enable the red meat processing industry, at the plant level, to help improve decision making on future investments. The project has resulted in an economic model not only includes direct costs and benefits such as capital investment, savings in energy, materials and labour costs and increased throughput, but also has considered in its development and incorporated as a parameter (where it has been found to be appropriate as a key driving factor in technology purchase) potential savings associated with staff retention and associated training costs, OH&S issues, quality assurance practices and overall productivity. The model includes the ability to calculate net present value, internal rate of return and payback period, enabling the red meat processor to not only assess the potential returns from a specific project but also compare and rank alternative investment options.

The key objectives of the project therefore were to:

- Document the range of technologies, processes and practices available to the red meat processing sector commercially;
- Assess the costs and benefits associated with the implementation of each technology using data from the industry (business inputs and outputs);
- Develop a checklist of costs and benefits for inclusion in developing the predictive model for future technologies. Information relating to assumptions and implications for developing a new model are included in this step;
- Develop a predictive model through a series of inter-linked spreadsheets, enabling calculation of net present value, internal rate of return and pay-back period; and
- Develop associated documentation for processors to facilitate use and interpretation of the model.

The model and associated documentation is intended for use by the red meat processing industry to assist them in assessing the possible implications for their operation of installing a specific technology. The model allows for variations in key operating parameters which enables the individual plant to identify the level of benefits that need to be achieved for their specific operation to make a cost-effective benefit. In particular, the model will be useful for small and medium enterprises that may be considering implementing technologies but that do not have either the capability or capacity to undertake a cost benefit analysis without incurring additional costs.

# Methodology

A range of cost benefit analyses previously undertaken on a range of technologies and supplied to the Consultants by AMPC and MLA were examined to identify the key benefit drivers noted. A list of the reports examined is provided at Appendix 1. As previously noted in the Milestone 1 report for this Project, the key benefits observed from automated technologies generally related to:

- WH&S savings through reduction in laceration injuries, sprains and strains;
- Reduced wastage, resulting in increased yield from cutting technologies;
- Reduced bandsaw dust;
- Reduced labour requirements;
- Increased productivity as a result of more consistent throughput per shift; and
- Increased shelf life and reduced levels of discounting.

It should be noted that some of these parameters may not be applicable across the industry, particularly for operations that are primarily based on service kill contracts. The key benefit drivers were documented as a checklist for discussion with participants in the red meat processing sector. The project team consulted two businesses in the sector with regard to the impact of the adoption of automated technologies in their operations. Specifically, these businesses were asked to supply quantitative data in relation to the key benefit drivers both pre-implementation and post-implementation of the respective technology. Information was also sought regarding the main factors influencing the introduction of the technology as this might not necessarily coincide with the drivers identified as having the greatest financial benefit.

The businesses consulted were:

- GM Scott Pty Ltd, a lamb processor, which had installed the Robotic Ovine Cutter 450 (ROC 450); and
- Australian Lamb (Colac) Pty Ltd, a lamb processor, which had installed an automated lamb primal cutter, Leap III.

# Results from industry engagement

A summary of the information supplied by the industry informants is provided below.

GM Scott installed the ROC 450 in 2011, primarily in response to concerns relating to work, health and safety (WH&S) issues. Their experience has been a significant reduction in incidences of lacerations, sprains and strains with a resultant reduction in Workers Compensation premiums. The introduction of the technology also reduced the number of bandsaw operators from four to two. However, due to changes in product specification, the number of knife hands and packers employed at the facility actually increased, despite a marginal decrease in the number of carcases boned.

GM Scott provided detailed information regarding staffing levels and associated wages and on-costs, number of pieces of output by type and associated weights and total HSCW for a typical week pre-installation of the technology and for the same week post-installation. As GM Scott provides a service kill operation for a major supermarket chain, the number of animals processed and the range and mix of cuts provided is dictated by customer orders. The company is paid for a specified quantity of a particular cut and therefore does not benefit from the range of improvements associated with automated cutting technologies such as increased yield, lower levels of retail discounting and reduced bandsaw dust.

However, it was noted that the installation of the ROC 450 improved the labour efficiency in the boning room as it can be set to process a specific number of carcases per hour. Manual operation of a bandsaw can be affected by a range of challenges associated with human activity in a repetitive job, resulting in variable throughput. At the start of a shift, or after a break, the band saw operator may be working at a speed which is in excess of what the other employees are capable of matching, creating bottlenecks in production. Conversely, as the shift progresses, boredom may result in a decrease in the number of animals processed, reducing the efficiency of other labour in the boning room. The automated system controls the speed of the boning room operations and enables the staffing levels and associated efficiency to be optimised.

Australian Lamb (Colac) Pty Ltd had previously installed a prototype Leap III primal cutter, although it did not have the X-ray function that the current model has. Due to a range of mechanical issues, resulting in maintenance costs and downtime costs, the prototype equipment was removed. However, the company has ordered a new machine which is anticipated to be installed in August 2014.

The primary driver in deciding to install the new technology has been WH&S issues, particularly in relation to strains resulting from the operator having to lift carcases of variable weights and cutting injuries associated with manual bandsaw use. A second consideration was the ability to control the speed of throughput. The bandsaw controls the speed of the boning room and, as noted by GM Scott above, manual operation can result in bottlenecks or reduced efficiency of labour. It is also expected that X-ray information derived from the technology could be useful in other parts of the plant. Ownership of this facility, previously operating as CRF, was taken over by Australian Lamb Company (ALC) in late 2013. ALC's operation in Melbourne has a fully installed Leap III with X-ray function which the Consultants understand was the source of the cost benefit analysis on this technology. Their experience with the benefits of the technology has led them to install a new Leap III at the Colac facility.

# Development of predictive model

The industry informants consulted were not in a position to provide additional quantitative data regarding their experience with the relevant technologies, either because many of the parameters were not relevant (GM Scott as a result of it being a service kill operation) or already measured (ALC being the subject of the previous cost benefit analysis), development of the predictive model has been primarily based on previous cost benefit analyses undertaken for Meat & Livestock Australia (MLA) and supplied to the Consultants for this project. It should be noted that these cost benefit analyses adopt actual measurement of changes in various parameters both pre-implementation of the technology and after the technology has been installed. Whilst the various cost benefit analyses documented at Appendix 1 were taken into consideration, the detailed analyses for both the Leap III and ROC 450 provided the basis for the predictive model.
Clearly, a predictive model, designed to assist a red meat processor in assessing the potential net returns from a technology to their own business operations, does not have the benefit of real data post-implementation. Accordingly, the model developed as part of this project (AMPC Predictive

Model May 2014.xlsx) is designed to enable the processor to assess the impact on their operations by allowing them to vary percentage changes in a number of operating parameters. The observed variations from the cost benefit analyses have been incorporated as the base case in the model.

Key variables in the model, which should be collected by the red meat processor in relation to existing operations, include:

- Number of employees by category per shift and associated hourly wage rate, including on-costs;
- Hours of operation per shift, number of shifts per day and number of operational days per annum;
- Throughput per hour;
- Costs associated with Workers Compensation insurance;
- Estimates of yield losses through cutting inaccuracies or exceeding market specifications;
- Estimates of value of wastage from bandsaw dust;
- Revenue derived from the various primal cuts; and
- Level of discounting at the retail level.

A checklist for data collection is provided at Appendix 2.



# Findings from the cost benefit analyses

## Leap III Primal Cutter

The Leap III Primal Cutter has been designed to automatically cut lamb carcases into hindquarters, middle sections and forequarters. It operates with an integrated X-ray that enables more accurate cutting. It can perform up to three cuts on the carcase with WH&S and product quality benefits.

The ex-post cost benefit analysis for the Leap III automated lamb x-ray primal cutting technology[1] found that the key benefits derived from installation of the equipment compared with manual bandsaw cutting were:

- Accuracy of cut – 18% of total benefits;
- Cutting technique, including scallop cut, saw dust yield loss and improved shelf life – 50% of total benefits;
- Increase in labour efficiency – 7% of total benefits;
- WH&S savings – 7% of total benefits; and
- Labour savings – 19% of total benefit.

Overall, the benefits derived in the cost benefit analysis equated to $2.26 per head whilst total operating costs per head (excluding the capital cost) were estimated at $0.15. Overall, this generated a pay-back period of 1.6 years.

## Robotic Ovine Cutter 450

The Robotic Ovine Cutter 450 is an automatic primal cutting system able to operate at rates of up to 450 carcases per hour, depending upon the number of cuts. It utilises vision

[1] Ex-post value proposition for automated Ovine x-ray Primal Cutting Systems, Greenleaf Enterprises, March 2013 – MLA Project Code P.PSH.0574

profiling and dustless blade cutting technology providing accurate lamb and sheep primal cutting.

The cost benefit analysis for the Robotic Ovine Cutter 450 (ROC 450)[2] found that the key benefits derived from installation of the equipment compared with manual bandsaw cutting were:

- Accuracy of cut – 28% of total benefits;
- Cutting technique, including saw dust yield loss and improved shelf life – 17% of total benefits;
- Increase in labour efficiency – 16% of total benefits;
- WH&S savings – 12% of total benefits; and
- Labour savings – 27% of total benefit.

Overall, the benefits derived in the cost benefit analysis equated to $1.32 per head whilst total operating costs per head (excluding the capital cost) were estimated at $0.14. Overall, this generated a pay-back period of 2.07 years.

# Predictive model instructions

The predictive model (AMPC Predictive Model May 2014.xlsx) is provided as a series of inter-linked worksheets where calculation cells are locked to prevent inadvertent alterations to the integrity of the model. Cells where plant specific data should be entered are shaded in purple while cells where the operator can select variations in parameters from dropdown boxes are shaded in green. Instructions to use the model are provided below.

| Worksheet Name | General | Pre-implementation | Post-implementation |
|---|---|---|---|
| 1. Plant Specific Drivers | Select technology type from dropdown box in Cell B1. Currently the model allows selection of “ROC 450”, “Leap III” or other. | Based on current operations, insert the following data:<br>- No. of shifts per day<br>- No. of hours per shift<br>- Operating days per annum<br>- No. of head processed per minute<br>- No. of weeks operational per annum | The model assumes no variation in the number of shifts per day, length of shift or operational days or weeks per annum. This is to ensure that the model measures the net benefit of the introduction of the technology alone rather than changing operating parameters.<br><br>Insert the anticipated no. of head processed per minute, based on technology specifications (maximum) adjusted to reflect plant specific conditions. |

[2] Value Benefit of Automated lamb primal cutting using Robotic Ovine Cutter 450 (ROC450), Greenleaf Enterprises, August 2010

| Worksheet Name | General | Pre-implementation | Post-implementation |
|---|---|---|---|
| 2. Labour related costs | The model assumes no variation in hourly wage rates per category to ensure that the model measures the net benefit of the introduction of the | Based on current operations, insert data on average staffing numbers by category per shift. | Insert data on anticipated average staffing numbers per shift. Percentage reductions in staffing numbers per category, based on cost benefit analyses for ROC 450 and Leap III are provided as a |
| | rather than changing wage rates. | Based on current operations, insert data on average hourly wage rates (including on-costs) by category per shift.<br><br>WH&S issues – based on current operations insert the following data:<br>- No. of laceration claims over the past 3 years<br>- Average cost per claim<br>- No. of occurrences of sprain or strain from lifting per annum<br>- Real cost of light duties claim / loss of operator | |
| 3. Yield benefits | Yield benefits are based on reduction in band saw dust and increased cutting accuracy. The average values derived from the previous cost benefit analyses have been entered as the base case. Individual plants should estimate the value of wastage per head resulting from bandsaw dust and cutting inaccuracies and then compare these with the base data in the model. | | Reduced band saw dust – select from the dropdown box the value thought most applicable at the plant i.e. if no saving is expected select “0”, if a saving equivalent to that in the cost benefit analyses is expected select “1”.<br><br>Increased cutting accuracy – select from the dropdown box the value thought most applicable at the plant i.e. if no saving is expected select “0”, if a saving equivalent to that in the cost benefit analyses is expected select “1”. |

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| Worksheet Name | General | Pre-implementation | Post-implementation |
|---|---|---|---|
| 4. Costs | Information on capital costs associated with the technology is likely to be derived from costs provided by the technology manufacturer / supplier and plant specific variations from the plant engineer.<br><br>Information on ongoing operating costs is likely to be derived from information provided by the technology manufacturer / supplier combined with plant specific data e.g. cost of electricity per kWh.<br><br>The model incorporates an allowance for down time, based on unscheduled stoppages (excluding down time associated with regular maintenance). The costs are calculated based on labour costs for the boning room at an hourly rate. | | Insert capital costs associated with:<br>- Equipment purchase<br>- Changes to boning room layout<br>- Alterations to conveyor system<br>- Installation costs<br><br>Insert operating costs associated with the technology per annum:<br>- Electricity charges<br>- Cleaning<br>- Maintenance<br>- Training<br>- Materials / consumables<br>- Service contract<br>- Other<br><br>The estimated number of unscheduled down time (measured in hours per week) can be changed to enable the plant to estimate the impact on the cost benefit analysis. |
| 5. Results – current processing speed | This sheet presents the results of the cost benefit analysis at current processing speeds using the following measures:<br>- Net present value of net cash flow, measured annually for 10 years using real discount rates of 7% and 10%<br>- Estimated pay-back period expressed in years and months<br>- Benefit cost ratio, measured annually for 10 years using real discount rates of 7% and 10%<br>- Internal rate of return, measured annually for 10 years<br>- Percentage contribution of benefit variables to overall benefits from the technology | | |
| 6. Results – new processing speed | This sheet presents the results of the cost benefit analysis at new processing speeds using the following measures:<br>- Net present value of net cash flow, measured annually for 10 years using real discount rates of 7% and 10%<br>- Estimated pay-back period expressed in years and months<br>- Benefit cost ratio, measured annually for 10 years using real discount rates of 7% and 10%<br>- Internal rate of return, measured annually for 10 years<br>- Percentage contribution of benefit variables to overall benefits from the technology | | |

# Predictive model output

The output from the predictive model, expressed in two worksheets namely "Results – current processing speed" and "Results – new processing speed" assumes a 10 year life of the equipment. However, the key measurement variables are measured annually. The net present value of the net cash flow is calculated using a real discount rate of 7% in accordance with Federal Government guidelines. However, an alternative real discount rate of 10% has also been incorporated as this may be more appropriate in the commercial sector.

The simple pay-back period, expressed in years and months, enables the plant management to determine how long it takes to recoup the capital investment outlay, based on estimated net benefits from the operation. The result is calculated by dividing total capital investment by net benefits per annum (i.e. the total benefits per annum accruing from the installation of the equipment, less the annual operating costs). Clearly, the shorter the time frame, the more attractive the investment would be to the processing plant. In the red meat processing industry, a pay-back period of less than three years would generally be expected for this type of investment.

The benefit cost ratio measures the stream of discounted benefits using real discount rates of 7% and 10%, divided by the stream of discounted costs using the same discount rate. Again this is measured annually. A number less than 1 indicates that the costs outweigh the benefits while a ratio in excess of 1 means that the benefits are greater than the costs. Clearly, the larger the number, the better the benefit cost ratio is.

The internal rate of return calculation enables the company to ascertain whether the project has a yield that is greater than its established minimum acceptable rate of return ('hurdle rate') or cost of capital.

The outputs outlined above should assist the potential investor in not only determining whether the technology generates an appropriate return to the company but also permit comparison with alternative capital investment options.

# Challenges in the Commercial Adoption of Automated Processes

The development of automated processes in the red meat industry is influenced by a number of factors. Given that domestic consumption of beef and sheep meat per capita has remained relatively stable in recent years and, if anything, is actually declining, any growth in the industry must be directed to the export market. In order to maintain and improve its competitiveness, the Australian red meat processing industry is continually striving to increase economies of scale and productivity and improve the value and quality of product.

Key advantages associated with the various automated systems summarised include:

- Labour saving – many of the technologies are anticipated to reduce the labour requirements in the processing sector. Whilst the direct savings in wages and salaries may be an important consideration in determining whether or not the technology generates a net benefit to the individual processor, there are other factors to be considered. An ageing workforce, combined with competition for labour from other sectors, potentially requiring less physical work, might suggest that attracting new employees in the future may become increasingly difficult.

- Work, health and safety issues – virtually all of the automated technologies demonstrate, or are expected to contribute to, a significant reduction in injuries and accidents. This can impact significantly on insurance premiums paid, a positive benefit to the industry, but could also serve to make the sector more attractive to potential new employees. In addition, it may assist in improving staff retention in an industry with high employment turnover and, in turn, reduce training costs.
- Productivity efficiencies – improved accuracy as a result of automated processes is associated with improved productivity as a result of reduction in reworking required. The ability to set the operating speed of the technologies also minimises potential bottlenecks in production and enables the staffing levels and associated efficiency to be optimised.
- Improved quality and / or yield – a number of the technologies report improved yield through minimisation of wastage and reduced product shrinkage with improved product quality resulting from reduction in handling.
- Hygiene issues – minimisation of cross-contamination is often a feature of automated systems.

However, any benefits must be weighed against costs associated with the purchase and implementation of the technology. Clearly capital constraints, combined with the opportunity cost of capital, impact on a processor's willingness to invest in any one technology. The structure of an individual plant's labour force in terms of fixed and variable labour costs may also affect the attractiveness of the investment. Flexibility in expenditure associated with variable labour costs, derived from casual employment, if there is variable throughput needs to be examined in comparison with investment in a technology where costs are largely fixed.

Other factors impacting on take-up of technology include:

- Physical constraints – lack of available floor space and / or costs associated with new construction;
- Cost concerns – not only relating to capital costs, but associated with maintenance and operational costs, downtime if there is a breakdown, training costs associated with implementation of the technology, payback period and perceptions of reliability of any cost benefit analysis prepared.

# Appendix 1 – Cost benefit analyses reviewed

The following reports were reviewed as part of the development of the predictive model. It should be noted that they do not all incorporate a cost benefit analysis.

| | |
|---|---|
| P.COM.0135 | LEAP III primal cutter + X-ray (STA/RTL) |
| P.COM.0159 | ROC450 primal cutter (MAR) |
| A.COM.0056 | LEAP II hindquarter boning (STA/RTL) |
| A.COM.0058 | LEAP V forequarter cutting (STA/RTL) |
| A.COM.0184 | Forequarter (shoulder) semi-automatic cutting machine (ATTEC) |
| A.COM.0215 | Semi automated lamb frenching machine (MACPRO) |
| A.COM.0057 | LEAP IV lamb middle cutting machine - splitting, flap cutting, rack, loin separation, spine cord removal modules (STA/RTL). |
| A.COM.0202 | Automated chine boning integrated with LEAP IV or as separate unit (STA/RTL) |
| A.COM.0162 | Brisket cutter robot (MAR) |
| A.COM.0169 | SaniVac (Front/Rear) - MAR |
| P.COM.0168 | Kidney fat removal (MAR) |
| A,COM.0221 | Ovine tool manual spinal cord removal (FPE) |
| A.COM.0120 | Automatic Ovine Carcass Split[illegible] |
| A.COM.0074 | Hock tip cutting/neck sa[illegible]ing ovine robotic system (MAR) |
| A.COM.0163 | Bung cutter robotic system (MAR) |
| A.COM.0171 | Y cutter (IRL/MA[illegible] |
| A.COM.0052 | Aitch bone puller (Proman) |
| A.COM.0053 | Semi-automatic beef striploin saw (JBS/STA/RTL) |
| P.COM.0123 | Beef puller - aitch bone and knuckle (STA/RTL) |
| P.COM.0149 | HookAssist boning, including ScribeAssist R&D (STA/RTL) |
| A.COM.0209 | Semi-automatic O.P. rib (cube roll chine bone removal) bandsaw jig (JBS/STA/RTL) |
| A.COM.[illegible] | Automated beef x-ray and boning system (STA/RTL) |
| [illegible].0049 | Beef sc[illegible]/rib cutter robotic system (MAR) |
| A.COM.01[illegible] | Beef deloining machine (Beeftech New Zealand). |
| [illegible].COM.0129 | SafeSeal System 500 (beef bunging machine 501 & ring loader 502) |
| A.COM.0138 | Beef splitter robot (MAR) |
| A.COM.0161 | Beef hock cutter robotic system (MAR) |
| A.COM.0055 | 6 way cutter (MAR) |
| A.COM.0084 | Deboning technologies - pre 2008 (MACPRO) |
| P.COM.0130 | Bladestop (MAR) |
| A.COM.0075 | Beef robotic spinal cord removal (MAR) |
| A.COM.0214 | Picking & packing - automated guided vehicles (MAR) |

# Appendix 2 – Checklist of data requirements and / or estimates

| | Base Line data (pre-implementation) manual process | Post-implementation |
|---|---|---|
| **Operational Data** | | |
| No. of shifts per day | | |
| No. of hours per shift | | |
| No. of operating days per year | | |
| No. of head (throughput) per shift | | |
| Tonnes HSCW per shift | | |
| **Staffing numbers (per shift)** | | |
| Supervisor | | |
| QA | | |
| Cold room | | |
| Inspection | | |
| Band Saw operator | | |
| Boner | | |
| Knife hand | | |
| Trimmers | | |
| Packer | | |
| General Labour | | |
| Other | | |
| **Staffing costs (per shift) (including on-costs)** | | |
| Supervisor | | |
| QA | | |
| Cold room | | |
| Inspection | | |
| Band Saw operator | | |
| Boner | | |
| Knife hand | | |
| Trimmers | | |
| Packer | | |
| General Labour | | |
| Other | | |
| | | |

| | Base Line data (pre-implementation) manual process | Post-implementation |
|---|---|---|
| **WHS issues** | | |
| Number of laceration claims per year | | |
| Average cost per claim | | |
| Number of sprain & strain claims per year | | |
| Average cost per claim | | |
| Number of other claims per year | | |
| Average cost per claim | | |
| Cost of insurance premiums | | |
| | | |
| **Yield Savings/Losses** | | |
| Loss of product by type | | |
| Value of lost product by type | | |
| | | |
| **Level of discounting (shelf life)** | | |
| Number of items discounted by type | | |
| Weight of items discounted by type | | |
| True value per kg by type | | |
| Level of discounting applied | | |
| | | |
| | | |
| **Reduction in band saw dust** | | |
| Band saw dust per head (kg) | | |
| Retail value of carcase | | |
| | | |
| **Market Specification** | | |
| Output not meeting market specification (kg?, %?, $?) | | |
| Output exceeding market specification (kg?, %?, $?) | | |
| | | |
| | | |

| | |
|---|---|
| **Costs** | |
| Capital Cost (purchase of equipment) | |
| Capital Cost - changes to room layout | |
| Capital Cost - changes to conveyor system | |
| Installation Cost | |
| Other | |
| **Operational Costs per annum** | |
| Electricity | |
| Cleaning | |
| Maintenance | |
| Training | |
| Materials / consumables | |
| Service Contract | |
| Other | |
| **Risk of down time** | |
| Hours down per week | |
| Cost of down time | |
| | |