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final report

Project code: A.TEC.0098

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Date published: 3rd June 2013

PUBLISHED BY
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Band-saw Benchmarking

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

Abstract

The Australian meat industry has been using band-saws in the process of cutting as one of the most common machines available for this task. This project has been instigated to benchmark and document opportunities for the status of their use and safety. The project has been facilitated by BMC and includes members from Australian meat industry, AMPC and the MLA. The methodology for execution has involved visits to several lamb and beef plants in Australia. The main objective of the project has been to provide reports of current practice and the opportunities based on the brainstorming ideas of an industry working group, leading to an action plan to create a safer solution for meat cutting whilst improving practice, work environment and reducing cost. The main findings are that for lamb most operations can be automated today on an efficient and cost effective manner and the main task is facilitation of companies to adopt the technologies already available. For beef, there are a number of mechanisms available as jigs and these are in use in certain plants. The awareness of techniques, technologies and practices that make operators work safer may be emphasised by more regular and frequently scheduled industry workshops. New machines may be developed for lamb cutting, beef bone break-up and in other operations. Each company is encouraged to make its own assessment of use of band-saws applying the findings and approaches of this report to determine an action plan for making band-saw use safer or replaced by proven alternative technologies.

Executive summary

This project, supported by AMPC and the MLA has been facilitated by BMC and has involved an industry working group comprising companies processing beef and lamb in Australia. The project has involved one to one meetings with industry members during visits to plants represented or taking part in the project. The project is to be considered as a starting point for the journey that eliminates risk associated with cutting meat when using a band-saw. The findings include:

1) Current practice and industry process to provide safer work environment:

    a. A first step is regular and structure training of band-saw operators, refresher and awareness schemes for all using and in the vicinity of band-saws and daily instruction and testing for competence and fitness of operators.
    b. Use of jigs and simple mechanisms to distance operators from the cutting edge of the blade on the band-saws is an effective low cost approach.
    c. Using alternative cutting devices such as circular knife blades or machines such as the BLM machine for chine boning.

2) Use of machinery such as Robotics for primal cutting and other machines or automated hand tools such as the Wittmann device for slicing shoulder chops or Trief machines for the same.
3) Applying protective devices such as blade-stop to prevent serious accidents complements the above.
4) Development of protective gloves would prevent serious cuts, with the wider applicability than the use of band-saws at processing plants but also in butcher shops or retail stores.
5) Developments continue to create new machines currently in R&D or in final stages of development for adoption such as those recently launched for lamb shoulder, middle and primal cutting at IFFA by ATTEC.

To follow up on the project, the main recommendations are:

- To hold workshops for exchange of ideas, especially cross fertilisation of what already works, for example through training or use of jigs (especially those seen at ACC for beef).
- Continuation of completion of adoption processes for the technologies such as those from Kennovations, Scott Technologies, MAR, ATTEC, BLM and other companies developing solutions as protection devices or cutting alternatives for Band-saws.
- Support for new R&D considered priority by industry.

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1. Background

The process of meat cutting requires skill and capability in manipulation and handling. In beef and in a more substantial manner in lamb processing, band-saws are used for breaking up meat carcasses and primal pieces mainly because:

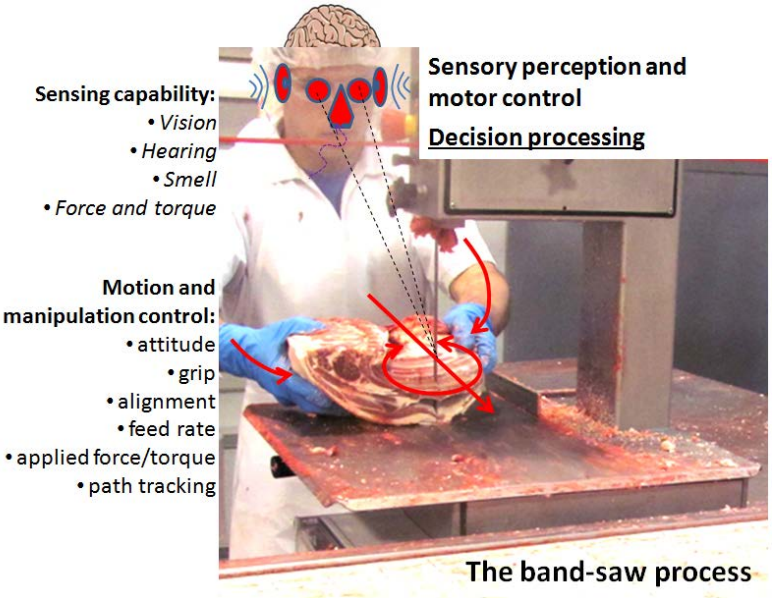
- Band-saws are a low cost option in meat cutting,
- Band-saws require little effort to operate as the forces and reaction loads during cutting are low making it easy for a person to cut meat and bone with ease,
- Band-saw cutting is fast and thus time efficient,
- Band-saw cuts can be made to fit a curved path given the skill capability of a person.

The human task using band-saws involves processes that require

- judgment and evaluation of the carcass or the meat piece,
- strategies for holding and manipulation,
- dexterity in achieving attachment or grasp using hands or tools manipulated by hand,
- physical movement and manoeuvring,
- Spatial positioning in order to achieve attitude for break up separation of meat and bone or separation of one type of tissue from another,
- and a considerable degree of sensing and 'data' or information processing.

The skill and the judgment that is required is significant when positioning or handling a carcass or the meat piece relative to cutting devices such as a band-saw, and yet, people carry out tasks of this kind with relative ease (See Figure 1).

Figure 1: Human capabilities applied in carrying out tasks on band-saws. Note that people use sense of hearing and smell to detect abnormalities, such as the burning smell when the blade becomes blunt or high noise levels when the blade drive is malfunctioning or the blade is misaligned.



Human beings have sensory perception, hand eye coordination and dexterity in physical manipulation of complex objects such as carcases or meat pieces. The basic capabilities for object recognition, grasping and handling have been reached though natural processes of a person we call a 'butcher' from birth though childhood to the point of maturity when the individual may be employed and trained in the art of butchery.

In break-up of carcasses or meat joints using band-saws a trained individual is expected to carry out the task repeatedly with consistency and accuracy during a normal course of a working shift.

The safe and effective capabilities of a person to perform the task of meat cutting rely on factors other than the acquired skills. The inconsistencies and accidents are the result of many factors, including:

- Level of concentration and the person's ability to remain focused,
- The health of the individual in carrying out the task without physical hardship or pain.
- The familiarity of the person with the type of cuts and work environment,
- The minute by minute, hour to hour or day to day alertness of the person (eg. not being under the influence of medication or alcohol).
- Other factors, work conditions or personal thoughts that can distract an individual during a given period causing loss of:

    - Time, leading to inefficiency in operations
    - Performance, such as placement positioning accuracy of a meat joint relative to a band-saw blade,
    - Caution being applied to avoid incidents or accidents, including harm to one's self. For instance unintentionally placing a finger along the cut path and cutting it.

The band-saw has continued to be a major separation tool for many reasons compared to other cutting tools such as an axe or in some cases powered rotary knife blades. To use a band-saw, the operator applies skill to manipulate a carcass or a meat joint in such manner that aligns the cut to be made in line with the band-saw blade. The next step requires the movement of the carcass or the meat joint towards the cutting tip of the band-saw blade, applying force to accelerate the item to be cut to a speed compatible with the cut required. Note the speed of cutting determines not just how effective the cutting action will be but also the quality of the finish in the resulting cut pieces. As an instance, cutting too fast may cause bone chipping and too slow, a poor surface finish. The movement to achieve cutting requires the carcass or the meat joint to be pushed beyond the blade, whilst the level of control must allow a desired cut path for separation. In the process of separation the tip of the saw blade effectively grinds away at the meat and bone with minimum resistant force to the force being applied by the operator.

Whilst the meat is being pushed against the band-saw blade the task of the operator requires, not only judgment to control position and orientation of the carcass or meat joint, but also there is attention being paid to avoid fingers or limbs being in a position along the path of the cut or in close proximity to the blade. The forces being applied by a person using a band-saw are minimal making the band-saw an easy cutting device to use as it avoids stress on the person carrying out the task of breakup.

Although the band-saw continues to be the manually operated industry wide machine and traditionally recognised to achieve the production results expected, it relies greatly on the ability of individuals in respect of the following:

- ***The correct line of cuts,***
- ***The correct quality of cut in geometric terms,***

- ***The correct yield, which is linked to cutting line being correct, but also reflects on the positioning control of the cut and the cut deviation from the nominal specified path or anatomical definition of the cut,***
- ***Throughput or ability to perform cuts at specific rate per hour. This rate would vary from cut to cut and time to time depending on the person physical or mental state in relation to the work being done,***
- ***Undamaged products,***
- ***and, most importantly, avoiding risk of injury during the cutting process.***

The level of concentration in human beings, the variability in skills, alertness, soberness or fitness when at work, all contribute to the overall day to day performances in operating a band-saw and operating it safely.

2. Project objectives and Scope

The project has considered and encourages industry to perform specific benchmarking of its specific cutting operations in respect of the following:

- Determine the key performance parameters with respect to band-saws that the meat industry wishes to control or manage including:
    - cut accuracy and quantified relationship to yields
    - cut positioning with respect to product specification
    - efficiencies in operation in terms of speeds and throughputs,
    - operating cost including capital, material and service,
    - other factors that may be identified in the course of the project
- Operators safety and aspects of:
    - ergonomics
    - human factors
    - machine design including safety features (such as blade stop)
    - litigation and accident history
    - cost of injury and insurance
    - other factors that may be identified in the course of the project
- Automation and its benefits and impact in plants with specific consideration of
    - cost and space
    - change processes
    - training and operational factors
    - flexibility and compatibility to process
    - other relevant factors
- Use of tools to make tasks easy for operators
    - jigs
    - mechanisms for putting distance between operators and the band-saw
    - use of alternative blades such as circular knife blades
    - cost comparisons and benefits in respect the use of such jigs or mechanisms
- Human factors and organisational matters including
    - operator training and plans for skills development
    - cultural and change management processes
    - management training
    - safety legislation and policies
    - continuous improvement and strategies in approach to change

The strategy for this work has been to mobilise the industry and bring about a national Australian motivation with a buy-in process that aims to create safe or wide spread elimination of use of band-saws without compromising, but indeed improving, the key drivers in the business. Accurate and controllable cutting of ovine and beef needs to give effective yield optimisation, maximise efficiency and eliminate risk of injury in tasks that require constant manual use of band-saws. The working group formed and facilitated by BMC (Koorosh Khodabandehloo) has considered the above and the main aspects are reported. The leadership of the project working with the working group continues to facilitate the initiative to raise the level of commitment and the ownership of the tasks that are to bring about safe use of band-saws or creation of alternatives to band-saws.

3. Method for execution

The process of executing the project has included:

- Industry visit to observe and where possible document current practices, also by means of video and photographic recording as permitted.
- Desk top evaluation of the cutting schemes for break up have been documented with ranking of importance.
- The visits have defined the criticality of each cut in respect of yield and the variability of human performance, where this is done by a band-saw. Parameters that should be quantified on a cut by cut basis have been identified and documented.
- The KPI and business drivers that rely on band-saw use have been assessed and a review document produced as the basis for consideration of opportunities for alternatives to or enhancements of features in band-saws.

In particular the following have been included for lamb (which provide possibilities for extrapolation to beef also):

- Accuracy performance capabilities of band-saw operatives to perform cuts on a cut by cut basis.
- Evaluation of yield dependencies and operator performances on a cut by cut basis.
- Quantification of yield losses using different band-saws on a cut by cut basis.
- Evaluation of risks of injury on a cut by cut basis
- Assessment of historical accident records and patterns where available.

Industry feedback has been recorded and reported separately by the AMPC.

4. Results and discussion

The band-saw has continued to be a major separation tool for many reasons compared to other cutting tools such as an axe or in some cases powered rotary knife blades. To use a band-saw, the operator applies skill to manipulate a carcass or a meat joint in such manner that aligns the cut to be made in line with the band-saw blade. The next step requires the movement of the carcass or the meat joint towards the cutting tip of the band-saw blade, applying force to accelerate the item to be cut to a speed compatible with the cut required. Note the speed of cutting determines not just how effective the cutting action will be but also the quality of the finish in the resulting cut pieces.

Figure 2: Bone dust contamination from band-saw cutting compared with knife blades (see Figure 3)

Figure 2 shows a pictorial quantification of cut finish when using the band-saw. Number of band-saw particles per square centimetre is one approach and on the images shown this is approximately 15 compared to zero or close to it when cutting by a knife blade.

Cutting too fast causes bone chipping and too slow, a poor surface finish. The movement to achieve cutting requires the carcass or the meat joint to be pushed beyond the blade, whilst the level of control must allow a desired cut path for separation. In the process of separation the tip of the saw blade effectively grinds away at the meat and bone with minimum resistant force to the force being applied by the operator. There is loss of meat and bone as a result of this grinding action.

Whilst the meat is being pushed against the band-saw blade the task of the operator requires, not only judgment to control position and orientation of the carcass or meat joint, but also there is attention being paid to avoid fingers or limbs being in a position along the path of the cut or in close proximity to the blade.

It is important to note that the forces being applied by a person using a band saw are minimal making the band-saw an easy cutting device to use as it avoids stress on the person carrying out the task of breakup. On the other hand this is the precise reason for easy occurrence of injuries.

Although the band-saw continues to be the manually operated industry wide machine and traditionally recognised to achieve the production results expected, it relies greatly on the ability of individuals in respect of the following (part of the benchmarking process):

4.1 Cut Accuracy

Achieving the correct line of cut, depends on skill, fitness and conditions of the day, the mode, the health or the mental state of people carrying out the task using band-saws.

Band-saw benchmarking A.TEC.0098_(2012-05-31) - BMC (UK) AMPC MLA				
Band-saw hit rates		**Accuracy estimations based on observations**		
Cutting accuracy estimation based on average experienced band-saw operator		± mm error	Cutting manually	
Note practices would vary in different plants. Best case worst case hit rates are estimated		as worst case	% within ±3 mm	% within ± 8 mm
1	Shoulder cut (1) between 4th and 5th rib or 5th and 6th.	25	40	76
2	Loin and rack cut (2) at last rib leaving the rib on rack	12	60	80
3	Loin-chump or long leg cut (3) or at the last lumbar vertebra.	10	70	80
4	Chump or Short leg cut (4) about 90 mm above loin-chump cut 3.	10	70	80
	Break up of shoulder			
5	Neck end tip cut (5)	15	50	70
6	Shank end tip cut (6), done also on shank from de-boned shoulder	25	40	65
7	Neck cut (7) (note this may be missed for split neck on shoulder)	30	40	60
8	Shank and brisket cut (8) to produce square cut shoulder	20	50	70
9	Split shoulder in half the spine length of at the midline	12	60	80
	Note shoulder chops may involving another 10 band-saw passes	3	80	95
	Rack Barrel cuts			
10	Rack cut (9) to split rack barrel in two along the spine	8	80	95
11a	Rib cut (10) on half rack barrels to separate flap from rack.	20	55	70
11b	Chine bone cuts	8	60	85
	Loin cuts			
12	Loin cut (13) along spine to split loin barrel in two	8	80	95
	Leg cuts			
13	Leg splitting cut (14) to produce two leg sub-primal pieces.	12	70	90
14	Leg tip cut (15) on the leg shank	20	60	85
15	Leg hock cut (16,17) done prior to deboning for boneless leg roast	20	60	85
16	Leg shank cut (18, 19)	20	60	85
17	Shank 'crack' partial bone cut (19,20)	15	80	95
18	Shank cut on foreleg from a de-boned shoulder	15	70	90

Table 1: Accuracies and hit rates: based on observations and measurements

Table_1 gives a representative overview of what may be generally observed in respect of band-saw cutting accuracy of Ovine carcasses. Operators perform 60% of cuts within ±5mm 80%-90% within ±15, but in some cases cut paths may be 30 mm out compared with the anatomical line of cut. Each plant would have their own staff capabilities and if required specific benchmarking may facilitate calculations that support decisions for change, however the figures in Table 1 are representative. Plants need to consider:

- The correct quality of cut in geometric terms (again the line of cut may be out by similar magnitude of deviation as stated for the line of cut but on the 3D face of the cut),

- The correct yield, which is linked to cutting line being correct, but also reflects on the positioning control of the cut and the cut deviation from the nominal specified path or anatomical definition of the cut,
- Throughput or ability to perform cuts at specific rate per hour. This rate would vary from cut to cut and time to time depending on the person physical or mental state in relation to the work being done (In general people operate at a higher speed with band-saws than other types of cutting systems such as circular knife blades),

- Undamaged products (band-saws in general cause surface damage requiring scraping or knife finishing),

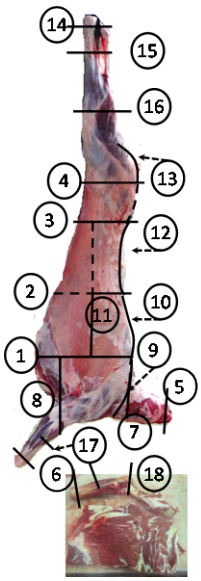
- and, most importantly, risk of injury during the cutting process, what cuts and how frequently accidents occur.

The level of concentration in human beings, the variability in skills, alertness, soberness or fitness when at work, all contribute to the overall day to day performances in operating a band-saw and operating it safely. Many initiatives have contributed to improve performance and safety collectively using available engineering and automation options. These initiatives have lead to enhancements of band-saws using engineered features for safety such as blade-stop or aim to create protective devices such as protective gloves, and a few, aim to automate the process in part or fully such as the initiatives undertaken by Scott Automation and MAR.

4.2. Safety, overview of the benefits and accesses to technology

Table 2 gives the status of technology for automating tasks for lamb. The OH & S benefits have been ranked against each cut performed manually and if the technology can perform more accurately than people, an assessment of the benefits in a qualitative manner is given.

Note that there are cost benefit assessments of technologies already available from users and in particular the reports provided by Greenleaf. For further information contact AMPC or the MLA



Ranking (H=High, M=Medium. L=Low. A=Available, D= in development, ? Not yet cosnidered

	OH&S	$ benfit	Technology
1. Shoulder cut	H	H	A
2. Rack cut	H	H	A
3. Loin-chump	H	H	A
4. Chump cut	H	H	A
5. Neck end tip cut	H	L	D
6. Shank end tip	M	L	D
7. Neck cut	H	M	D
8. Shank and brisket	M	M	D
9. Split shoulder	H	L	D
10. Rack cut	H	H	A
11. a Rib cut	H	H	A
11. b Chine bone cuts	H	H	A
12. Loin split	H	H	D
13. Leg splitting	L	M	?
14. Leg tip cut	M	M	?
15. Leg hock cut	M	L	?
16. Leg shank cut	M	L	?
17. Shank 'crack'	M	L	?
18. Shank cut	M	L	?

Table 2: Safety, benefits to automate, technology status

4.3. Alternatives to band-saws and potential technologies-options

In its simplest form the knife blade otherwise termed circular saws provides alternative to the band-saw, however this is suited to specific cuts where break up avoids large bone sections such as a leg bone. Figure 3 shows example of the saws in use in a few Australian plants for primal break up.

Figure 3: Knife blade circular cutters as alternative to band-saw for certain cuts (photos from ATTEC –right and Freund –left).

In assessing the knife blade as an alternative to band-saws, the main considerations, other than safety, would be quality and yield. The quality avoiding bone dust contaminated surfaces are self evident as in Figure 2 and yield which will differ from cut to cut. An example calculation is based on measurements of 2 cuts on an 18 Kg lamb where approximately 1 mm of the cut, which becomes bone dust on leg and shoulder cuts. If this were measured (which is recommended to each plant reading this report), and that the figure is 25 grams per carcass, then at 400 carcasses per hour this is 10 Kg per hour which at 7.5 hours per day, 5 days per week for 48 weeks and $5/Kg is about $90,000 saving give or take a few hundred dollars.

The options for automation in relation to cuts in lamb have been assessed with respect to technologies available and in development.

In all cases the KPI and business drivers that rely on band-saw use must be assessed as the basis for consideration of opportunities to use alternatives or enhanced features in band-saws, without compromising profitability. Other than the opportunity for using circular knife blades mentioned earlier, a number of other opportunities are available which for ovine cutting may be used for a series of cuts such as the ROC system by MAR in Australia - web link:

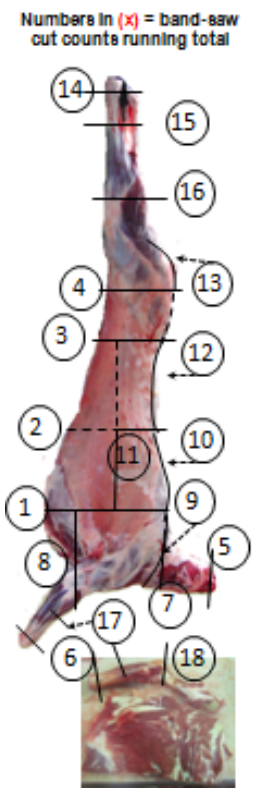
http://www.meattradenewsdaily.co.uk/news/051011/australia___robots_are_making_light_work_of_cutting_lamb_at_meat_works.aspx

or the Leap system from Scott Automation New Zealand -web link:

http://www.youtube.com/watch?v=MZIv6WtSF9I.

The assessments have been elaborated for cuts as in Figure 4. In the schemes of cuts for Ovine and in particular Lamb the cuts and the number of band-saw actions (in brackets) to achieve the cuts are presented. For each cut(see Figure 5), there is

consideration of technologies or methods for separation avoiding band-saws or distancing operators from the cutting edge of a band-saw.



Main Primal separation of the whole carcass

1. Shoulder cut (1) between 4th and 5th rib or 5th and 6th.
2. Loin and rack cut (2) at last rib leaving the rib on rack
3. Loin-chump or long leg cut (3) or at the last lumbar vertebra.
4. Chump or Short leg cut (4) about 90 mm above loin-chump cut 3.

Break up of shoulder

5. Neck end tip cut (5)
6. Shank end tip cut (6), done also on shank from de-boned shoulder
7. Neck cut (7) (note this may be missed for split neck on shoulder)
8. Shank and brisket cut (8) to produce square cut shoulder
9. Split shoulder in half the spine length of at the midline

Rack Barrel cuts

10. Rack cut (9) to split rack barrel in two along the spine
11. Rib cut (10) on half rack barrels to separate flap from rack.

As an alternative if cut 2 is not performed to save flap as one piece, cut 11 is made on a split whole barrel with cuts 10 and 12 performed in one pass splitting the whole barrel. Cut 2 is then performed to separate only the loin and the rack. Two additional cuts (11,12) may apply on to remove chine bone.

Loin cuts

12. Loin cut (13) along spine to split loin barrel in two

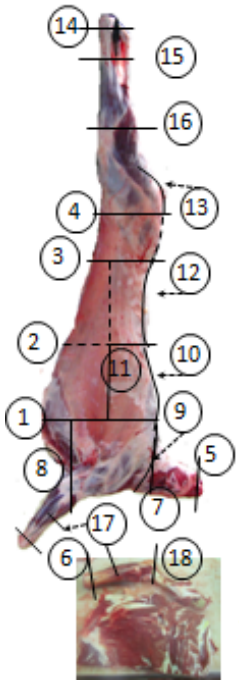
Leg cuts

13. Leg splitting cut (14) to produce two leg sub-primal pieces.

For chump on leg the cut would continue to the line of cut 3.

14. Leg tip cut (15) on the leg shank
15. Leg hock cut (16,17) done prior to deboning for boneless leg roast
16. Leg shank cut (18, 19)
17. Shank 'crack' partial bone cut (19,20)
18. Shank cut on foreleg from a de-boned shoulder

Figure 4: Scheme of cuts for lamb



	Technology or process
1. Shoulder cut	Attec or Freund circular blades – ROC or Leap system
2. Rack cut	Attec rack barrel machine or BLM chine machine
3. Loin-chump	Attec or Freund circular blades – ROC or Leap system
4. Chump cut	Attec or Freund circular blades – ROC or Leap system
5. Neck end tip cut	No solution other than band saw, however, tipping on slaughter floor can be a solution.
6. Shank end tip	Possible solution under examination by Attec, however, tipping on slaughter floor can be a solution.
7. Neck cut	Part of Attec shoulder machine or Scott Automation solution
8. Shank and brisket	Part of Attec shoulder machine or Scott Automation solution
9. Split shoulder	Part of Attec shoulder machine or Scott Automation solution
10. Rack cut	Scott Automation solution or Part of Attec rack barrel machine (splitting in development)
11.a Rib cut	Part of Attec rack barrel machine or Scott Automation solution
11.b Chine bone cuts	Part of Attec rack barrel machine and BLM machine
12. Loin split	Scott Automation solution (also under development as extension of Attec shoulder machine)
13. Leg splitting	No solution, but may be performed by simple knife when leg is cut but still travelling on the hook or this can be knife action. Part of Scott Automation solution when H-boning
14. Leg tip cut	Possible solution under examination by Attec
15. Leg hock cut	Possible solution under examination by Attec
16. Leg shank cut	Possible solution under examination by Attec
17. Shank 'crack'	Scott Automation solution. Also under consideration by Attec
18. Shank cut	Scott Automation solution. Also under consideration by Attec

Note that there are cuts that use band-saws in particular as alternatives in shoulder break up and also in beef leg bone and forequarter rib cage break up which will be considered during the plant visits.

An important observation is that over 80% of the cuts may be done by avoiding band-saws using machines or circular blades with ROI of less than 12 months in most cases.

Figure 5: Alternatives to band-saws and possibilities in Ovine break up (subject to review and update after plant visits).

It is clear that almost all the cuts have potentially the possibility to be automated, even when the variation in carcasses is as large as that in Australia. The industry visit provided the complementary information to the work documented above.

5. Industry visits

Industry visits have provided views on:

- Options, benefits, values and issues based on interview or discussions
- Information and video material collected during the visits

The lamb plants would generally operate a minimum of 2 band-saws with some having 6 or 7 in use with one or two additional spares. In beef plants depending on throughput on average 2-3 band saws have been observed, with a few larger processors using band-saws at 6-8 different locations in their boning rooms.

The rates of operation vary significantly with some lamb operators using a saw station to cur up to 400 carcases an hour at a given point in the daily operation and approximately 300 pieces per hour on average.

In beef the throughput is much lower, with operations requiring multiple passes of pieces during at a rate of 120 pieces per hour or less.

An important aspect of the observation made is that on the whole less than 10% of the time actually involves separation using the saw, with most of the time being used for handing, manipulation and positioning of the piece so that the cut can be performed.

The general view expressed is that the Australian processing industry would like to have alternative machines to band-saws operating at the same efficiency levels as the stations using the band-saws.

The expected value of using alternatives include in the order of importance:

1. Safety – alternatives, whether they be simple jigs or tools or semi-automatic or fully automated solutions, all must prevent the accidents industry faces on frequent basis with band-saws. It is estimated that there are at least one band-saw incidents per day or so in a plant somewhere in Australia. Some processors have reported one per month in their plants.
2. Yield – options as alternatives must not compromise yield. A view shared by all visited, however, machinery to replace band-saws, should give better control of cut positions and improve yield on higher value parts of the cuts for every cut being done presently on a band-saw.
3. Quality – again, any option or solution must not compromise quality in respect of cut specification and quality of the finished products in appearance or profile. Machines should ideally provide for improved meat quality and increased shelf life.
4. Any technological solution is expected to provide a return and in most plants the expected Return on Investment of less than 24 months is expected from implementing new options, be they simple mechanisms or full automation.
5. The management of change, especially with more advanced and fully automatic operations is considered key in the process of adoption. Many

plants considered this an issue, especially, where high value automation is the approach to the replacement of band-saws.

6. In a number of plants, practices and management of safety, through training and increased awareness were considered important, though the approach in adopting not technological measures was not as wide-spread in the thinking. It was clear during the visit that all desired to have simple solutions of full automation which has low capital cost and easy to operate, including maintenance.
7. Use of protective systems such as gloves or blade-stop as means of protection was considered important by all processors. The confidence in the established availability of the systems with proven and documented evidence was not strong. Most processors did not consider the solutions on offer as having reached proven or steady state. Focus on cost effective and low cost automation was favoured as a matter of urgency.

6. Opportunities and options

Considerations in respect of Small Stock production, in particular lamb, and also beef have been reported to the working group on several occasions. AMPC have held a number of meetings, also by phone conferencing g to seek views and to consider options.

Two working have been produced and these consider each task for lamb and beef and elaborate the following against each task:

- Current practice / solution for band-saw use
- Benefits from the solution reported
- Challenges and gaps
- Options/ opportunities
- New alternatives
- Yield considerations
- Training, OH&S, education considerations
- Optimal band-saw solution/ recommendations on practice now
- Future possible solution for consideration

7. Recommendations to industry

The main recommendations

1. Consider best practice and adopt a continued commitment to best practice
2. Implement a daily instruction to ensure alertness and adherence to best practice for band-saw operators
3. Encourage and adopt new low cost approaches that prevent exposure to daily risk for band-saw operators
4. Ensure maintenance practices for best operating conditions of equipment and environment for the use of band-saw
5. Perform regular and frequent checks to ensure best practices by all concerned are being applied to avoid risk of injury in the use of band-saws
6. Make use of jigs and fixtures and consult other companies with experience in this area and consider how established and adopted solutions may be used
7. Take part in initiatives and be open to give opinion and to take up new ideas

8. Consider new opportunities such as use of protective devices such as blade-stop, protective gloves and use of simple, proven jigs, especially in tasks for beef cutting
9. Consider automation opportunities and plan ahead for the emerging technologies
10. Calculate the cost benefits of new emerging technologies and be ready for up-take.

8. Concluding remarks

The direction to avoid accidents using band-saws may be achieved by automatic and semi-automatic solutions. Safety devices as options feature highly as these may provide more immediate solutions as would use of jigs and fixtures to eliminate contact between operators and the cutting edge of a band-saw. The options considered new complement the current AMPC-MLA initiatives as well as the work or technologies from several supply or user companies. The Working Group recommendations through AMPC provide the latest in defining priority.

Industry encouragement and facilitation through the recommended Workshops is the best way to ensure adoption of best practice and proven technologies. This would also support and indirectly drive the generation of new R&D and its management from concept, to proof of concept and adoption in daily use. The management of change to pave the road for new equipment resulting from R&D to commercial use is a task that requires facilitation and remains a responsibility for all involved as a team. This project has been a stepping stone. A formal structure for the organisation and management of the Workshops mentioned is recommended as a means for continuing the momentum in this focused initiative to deal with band-saws and safety of their use. A first Workshop to be held in late June or early July 2013 is proposed.

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