final report

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Frewstal Evaluation of cutting (Lamb)

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1. Abstract

The Australian Lamb industry continues on the path to improve its operating capability by structuring its processing rooms using newly developed equipment, and making better use of space and human resource. The use of new handling equipment and robotics or automated technologies, especially in the primary cutting has matured considerably in recent years, ready for wider adoption. Defining a cutting room with features that allow best performance to be achieved is fundamental to the competitiveness of the industry.

The report presents the strategies, opportunities and focuses on improvements in capability and capacity of cutting operation dealing with both the short and long term approaches. Cutting, boning, trimming, and where relevant, packing operations have been considered. Strategies in IT and automated have been considered. The concept for a performance Cutting Room (pCR) introduces new approaches for a modern plant capable of self-optimisation for maximum profitability. The short term emphasis for Frewstal has been concerned with the definition of a cutting room for better quality, minimum handling and optimised yield control in a safe working environment.

2. Executive summary

The cutting and boning plants of the future will need to provide performance that maximises profitability using human capability and automation. Skills in processes such as trimming and boning are complex as is the introduction of automation. In time, the only processes that would remain are those that involve human skills, beyond the capability of the smartest automation technologies and the researchers that generate their advancements. Automation technologies will advance, but the rate of change in using them will depend on the vision, the investment and the capacity as well as understanding of how new ideas may be introduced in meat plants.

Meat plants of the future will have a high degree of IT technology and automation with computer control for real time optimisation of efficacy in areas, such as the cutting rooms, that presently relying on ‘minute by minute’ management decision or intervention.

Robotic break up of carcasses using capabilities such as x-ray technology and machines that use sensors to adapt to cutting of variable primal pieces are now real options for meat processors. Use of IT for information handling and real time reporting of performance is in use already in some plants within and outside Australia. The next steps require better integration of technologies and human processes, with companies managing the change process to reach greater improvement of their business.

For the ‘performance’ Cutting Room (pCR) of the future, automation technology will bring the following possibilities:

- **3D scanning and quality measurement of whole carcasses at line speed**. This would give the inputs necessary for assessing and predicting the range of end products that may be achieved with best yield, quality, and efficiency, at minimum cost. The prediction requires a computer model of the processes, skills and equipment capabilities that can map carcass information to meet the sales, accounting for available carcasses with the characteristics matching customer orders at the time of break up. The target for such system of forecasting as part of the pCR of the future is for a computer program to anticipate trends in cutting or boning scenarios that takes any given carcass to the various possible end products, whilst meeting quality expectations against what could become a real customer order. Updating the scenarios in real time against uncommitted carcass stock would reveal planning strategies that supports sales opportunities for higher profit. The quality features from scanning each carcass need to provide estimations of tenderness, fat, bone content in sub-primal pieces, colour and other characteristics relevant in the process and necessary for profit optimisation.

- **Controlling and optimising the changes in the daily plan for carcass break up and cut recipe on a minute by minute and carcass by carcass basis.** A task that needs automation to achieve maximisation of performance in real time, as it requires significant status data from the stages of cutting for it to be performed manually or through supervision. The process would use carcass information, structured and controlled handling, where every item requiring manual processing would be delivered to the person or persons with the appropriate skills to achieve the resulting cuts against customer specifications. The system of handling also provides for performance monitoring with real time reporting to both individuals engaged in the cutting or boning tasks as well as those managing the operations.

- **Full control of flow and tracking products from the start of the process to the end of despatch.** With tracking and appropriate IT, a plant presents itself as one that is in control and open to accountability, crucial in the management of an enterprise. This needs to be complemented by an automatic assessment of historical data aiding the 'learning' process to support improvement decisions, facilitating management in exceptional situations that may go unnoticed with conventional monitoring, reporting or QA procedures.

- **The facility for forecasting equipment performance and automatically scheduling for preventative maintenance as well as dynamic reporting of faults.** This would also support the management of spares stock and other maintenance and repair related tasks.

Within the context of the above, this project has carried out an evaluation of the cutting operation at Frewstal during 2012/2013. The project has addressed the needs of Frewstal in respect of improvements in lamb cutting and requirement for a new layout giving efficient use of space, equipment and better flow, with consideration of future opportunity to introduce yield control and new automation. The results of the project have provided the approach for the short term implementation of the cutting room at Frewstal. The approach to the layout design and the considerations also support future developments towards the pCR of the future encompassing IT, automation and other technological advances becoming available.

Space constraints and the cost of technology continue to limit the expansion of capability and indeed capacity opportunities. Evaluations, in a qualitative form, of such aspects at Frewstal have been provided for an optimum solution within the anticipated investment capacity of the company. Operation drivers relating to yield and efficacy as well as safety have been considered and include:

- Improved quality and reduction of use of band-saws
- Increased throughput and reduced double handling
- Better flow and control with improved waste handling
- Automation and ROI in respect of new investment
- Yield monitoring and control options
- Grade based planning for improved yield against customer order
- Evaluation of cut process timing using an Excel model and simulation

The project has produced a mapping of requirements against processing capabilities expected and an 'ideal layout' for Frewstal evaluated using an Excel model. Future enhancements are planned in packaging, as a next step. The improvements beyond this project will be engaging World Class practices and automation, giving flexibility both in processing methods and responsive capabilities to meet different customer specification.

Table of contents

	Page
1. Abstract …………………………………………………………………	2
2. Executive summary ………….……………………………………...	3
3. Background …………………..……………………………………….	6
4. Project objectives ……….…………………………………………...	7
5. Methodology ………………..…………………………………………...	7
5.1 Definition of optimum cutting room layout ………..……………	8
5.2 Variability and impact ……………………………………………	9
5.3 Process for the definition of a layout …………………………..	10
5.4 Strategic considerations ………………………………………...	11
5.4.1 Efficiency, double handling and touch counts ………...	11
5.4.2 Yield and quality considerations ………………………..	12
5.4.3 electronic Cutting Room (eCR) …………………………	16
5.4.4 Consideration of hygiene, cleaning and QA procedures	18
5.4.5 Technology and automation …………………………….	20
6. Results and discussions …….……………………………………...	27
6.1 Changes to process for minimum handling …….……………..	29
6.2 Automation, skill development and management of change...	29
6.3 Assessment of priority and direction …………………………...	30
6.4 Consideration of technology and equipment ………………….	31
6.5 Evaluation of the cutting process ……………….……………..	33
6.6 Excel model for evaluation and simulation …………………...	35
6.7 Simulation for validity of layout ….……………………………..	37
6.8 Concluding remarks …….………………………………………	38
7. Web summary ………………………………..…………………..….	39
8. Web key words …………………………………………………….….	40

3. Background

Frewstal Pty Ltd have had a requirement to significantly improve their cutting room operation based on best practices in cutting, handling and packing solutions. Food safety, quality, efficiency, yield control and operational safety are key factors. This project, supported by MLA and AMPC and executed by BMC (Koorosh Khodabandehloo), UK with Frewstal PTY Ltd (Robert Frew), assesses the whole operation from carcass arrival in the boning room to the end of case packing. The target has been to create a high throughput, flexible and agile production solution with optimum efficiency.

The steps in the project were originally proposed to consider:

<u>Phase 1</u>

a) Process analysis: an evaluation of current process, quantifying the variability and impact of each step in the process,
b) Yield consideration, work practice and efficiency: current and future trends with respect to customer needs and market expectations,
c) Change process and product range: identification of changes to process for minimum handling and automation, skill development and management of change
d) Break up, band-saw and packaging stages
e) Design options for the cutting room improving food and operator safety
f) Evaluation of manning levels against required cuts using simulation

<u>Phase 2</u>

g) Evaluation of equipment including those in development for better packing, boning and cutting or break up efficiency.
h) Definition of final layout for evaluation and implementation
i) Consideration of market trends and influence of changes in customer specification for each product and the impact on the design in terms of flexibility and capability
j) Implementation of the best evaluated and validated option and experience with its operation over 12 months.

Phase 1 of the project has been completed under the current project contract and an overview of items (h) and (i), which were part of Phase 2 are also reported.

4. Project objectives

- To assess operating trends influencing the design for a cutting room
- To define alternative layouts for efficient processing of small stock taking into account staffing and fluctuations in products and cutting patterns for different customers or markets.
- To produce a report that presents options for a World Class cutting and packing room for lamb processing
- To formulate a plan of action with clearly defined steps to implement the boning room at Frewstal adopting best practice as well as appropriate technologies for cutting, handling and packing.

5. Methodology

An evaluation of the current operation has been made by observation and assessing current practice and products.

The proposed improvement stages have involved the use of an approach referred to as QFD (Quality Function Deployment), but only in relation to mapping the expectations with priorities in the short term. This has defined the decision process leading to an improved layout for cutting in the space available, as an immediate step, with appropriate links to packing stages.

https://www.google.com/#q=QFD gives a link for information on QFD, which is a process for mapping or assessing requirements to ranked solutions with the impressions or thinking of the working group that is tasked to deliver and manage the outcome of a given project.

Technology options have been considered and priority given to a selection of relevant equipment using a qualitative approach.

The evaluation of the layout has been reached using an Excel model simulating the manning levels against typical orders to validate the layout.

The methodology of the project has relevance to broader needs of the industry emphasising the basic assessment of current process and the way in which a layout may be established for further assessment and improvement by simulation. The main considerations need to include:

- the impact of new production demanded from existing and new customers,

- trend in markets especially with respect to MSA and other specialist cuts,

- cutting room layout that provides for changing requirements, whilst facilitating the necessary productivity and process improvements opportunities.

5.1 Definition of optimum cutting room layout

In the first Phase of this PIP project, consideration has been given to the following in respect of the approach:

1) Documentation of steps in the current process, including time standards. It is important to note that no clear time standards have been available, against which cutting room layouts can be defined. With BMC access to relevant timings for each task as nominal measures (see Appendix A) a first assessment has been possible resulting in the definition of the number of work stations that may be needed for the tasks intended. Note that these are compatible with volumes and customer requirements mapping also with Frewstal strategies for managing throughput increase.

2) Assessment of product mix based on current range of supply. The variability here is not only the different products, but also the volumes that have to be planned, on an hour by hour basis. Given the order book for the day, which may change to some degree during the working day, staffing levels need to be mapped against each task to meet the orders. Appendix B gives the current range of products that are to be produced on a daily basis at Frewstal. Note that the volume is generally determined on the number of carcasses to be processed, from which the order book in finished packs may be fulfilled. The constraint is to achieve a mapping of raw material (in the form of ready to cut lambs) to products, and human resource planning that minimises the production of 'uncommitted' meat separate from the orders that are to be met.

3) Market and sales variability has influences that may be considered random. In the consideration to define a cutting operation to meet current and future sales demands, different driving factors become more dominant. The factors include the size of the facility (available area for cutting, preparing and packing), the way in which flows in operation are structured and the influences of raw material variability: in volume, quality and type or composition. The variability in the daily orders is more specific to the type of cuts and meat specification as well as packaging formats. In so far as the cutting operations are concerned, the limiting factors are:
    i. Time to cut and prepare the specific products
    ii. Number of people to perform the task
    iii. Availability of work station space for all operations with the specific cuts that correspond to the new or changing order over a working shift.

The aspects of variability in relation to constraints to meet new markets or changing demands from existing markets have been evaluated using an Excel model for simulation. The approach is presented later in this report.

5.2 Variability and impact

A number of variable are considered important in the planning process of daily operation:

a) Carcass variability.

Weight: 14 Kg to 30 Kg, size-length: 1100 mm – 1400 mm and fat variation. The weight of the carcass has an impact on the staffing levels as smaller lambs require higher staffing to achieve a target weight output against a given order if the order is by weight. In contrast, heavier or fattier carcasses would demand more trimming. *It is envisaged that by having appropriate and relevant carcass information (weight, fat content, other features such as fat cover on specific primal pieces in advance of the start of the day); more accurate forecast of staffing levels may be made. Planning the operating day in a manner that reduces significant surprises is essential, for instance predicting the need for overtime.*

b) Product variability.

The range of products to be produced is generally known. To produce a single pack, a whole lamb needs to be cut (unless the cut required can be extracted and the rest of the carcass stored in chill rooms, subject to shelf life restrictions, which would involve double handling resulting in sub optimal efficiency). The main variability is the type of product to be produced, the specification being the key driver. If weight or fat (or indeed other quality factors like tenderness) are specified for a finished product, then the relationship between the corresponding carcass information becomes an important factor in the planning process. Other than the type specification, which is presented in Appendix B, Frewstal currently do not evaluate carcasses for such purpose except for MSA products. MSA products are sorted at carcass stage and the corresponding products are considered in the definition of the boning room requirements and the new layout.

c) Skill and processing time variability

The main considerations have been in respect of times to carry out specific operations. There is variability between operators and also between the times taken to produce different products from the same primal. The former is a variable that needs to be managed by adjusting manning levels to make the production throughput balanced, allowing for people variability that carry out the same task. The latter is important given that some products require significantly more time to produce, such as the MSA loin fillet from the loin primal. The influence here is of a magnitude that imposes significantly greater number of work stations being needed to compensate for the variability in time to produce the cuts.

5.3 Process for the definition of a layout

The process for defining a layout that allows for requirements of the markets currently served and planned for the future is summarised in Figure 5.1.

The considerations and management of change has been instigated through senior management under the direction of Robert Frew and the team responsible for Operations and Engineering. Figure 5.1 also shows the basic information that requires definition or quantification to meet the target products and cuts at a rate desired. This is an iterative process as shown in Figure 5.1.

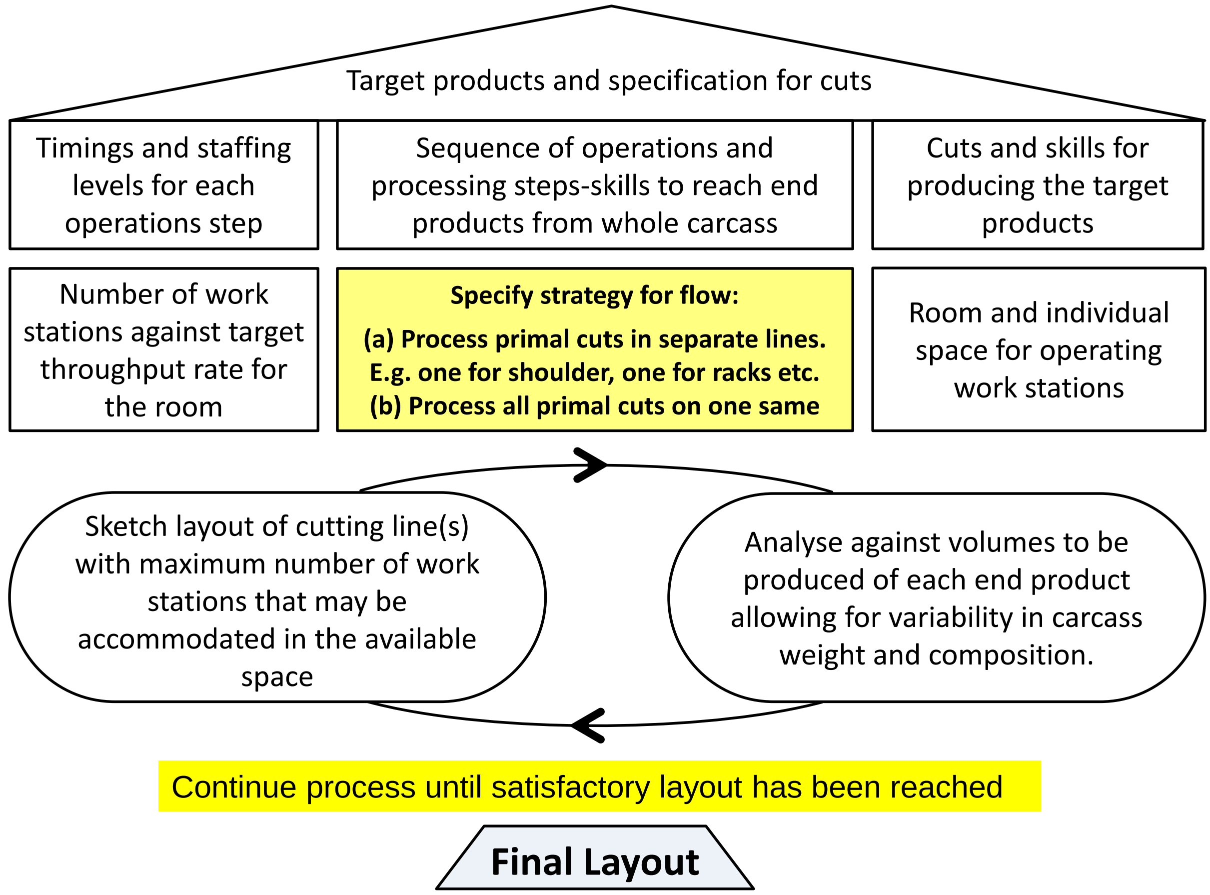


Figure 5.1: Process for defining a new layout as followed for Frewstal

In the process of defining the new cutting room for Frewstal, a number of strategic considerations have influenced the approach. These are presented in the following subsection.

5.4 Strategic considerations

During the course of the project specific considerations have been discussed and applied in an iterative process to define improvements to the cutting room at Frewstal. These are as follows and are relevant to the broader industry.

5.4.1 Efficiency, double handling and touch counts

Efficiency may be measures in terms of the least number of production hours used from operatives to process a specific target number of carcasses to meet the desired customer order, meeting product specification in terms of cost, quality and yield. Yield and quality are tightly coupled with efficiency and standards vary with “benchmarks” being specific to companies against customer specifications. An area of research is the understanding of this coupling which, although understood within specific companies and as is the case at Frewstal, requires broader industry wide examination. It is generally accepted that to produce to high customer specification, in say standard of trimming, requires time from operators. Similarly, in the processes of cutting increasing the speed, as is the case in deboning, compromises yield. The level of skill and capability of operators is yet, another variable. Such aspects, being matters for considerations by any company, require management information for “balancing” the use of skills to achieve specification in yield and quality output in an efficient manner. The coupling of quality, yield and processing speed is the most complex issue in managing and supervising a meat cutting facility to achieve high efficiency. The process by which a cutting room is configured in terms of equipment, flow design and operator positioning needs to consider such factors.

There are other factors that influence efficiency, which are less sensitive to the skills capability, decoupled from customer specifications or yield factors. To be specific, these are related to double handling and flow that reduces the number of “touches” a given end product experiences from the start of the break up process to point of despatch. The design and the layout of a cutting room must in the first instance eliminate the unnecessary handling and movement. A constraining factor is usually space and the lack of structure in existing facilities. At Frewstal the main effort has been to use the available space as effectively as possible achieving a balance between the many requirements that map the value adding steps into a workable layout that allowing for ease of access (operator and maintenance), and product flow in a logical and transparent manner. Many operations evolve over a period of time in a “compromising” manner responding to unplanned increase in production volume or range of cuts. At Frewstal a strategic decision has been to separate the break up process of lamb carcasses into three parallel lines, rather than a single line. This separation process has replaced the mixed production line where lamb shoulders, middles and legs were processed on workstations, either side of single conveyor. With no structure in the handling process, touch counts (the number of times a product is held and released) and product movements (say in plastic trays) from one area to another, result in efficiency being compromised. It may seem obvious that a “flow line” approach to an optimised layout would be the right approach. The task, which is not a trivial one, is the creation of a layout which meets all requirements. The design solution must accommodate all processes that can deliver the total range of products for current and future customers at a level of investment that is the lowest possible and within the available or affordable space. An overall efficiency gain is the main drivers that provides for the return on investment, with yield and quality control being important, but more difficult to quantify (or substantiate), given the reliance on operator skills, for ROI calculations.

5.4.2 Yield and quality considerations

A complex issue for any meat plant is yield, which needs to be measured in a manner that provides for better management of processes that could improve it.

Yield is generally a measure of the achieved final product weight, as a final product ready for despatch, meeting the exact customer quality specification. Compromises in quality can distort yield measures and processes that do not provide a fully conforming carcass, with at a true input weight, can give misleading calculations. So what can be done? The project considered yield issues and in particular what technologies may be used and more importantly what is of interest. The following presents an important summary:

a) End product yields against initial carcass weights are already measured and documented on a batch by batch basis. This currently meets expectations for customers at Frewstal. However it is important that the SLAUGHTER PROCESSES ensure that carcass quality is at its best for when its weight is registered into the boning room. Note that end of slaughter quality control is a key influencing matter in this respect.

b) The measurement of yield achieved by operators is important. The introduction of measurement at workstations should be provided for as part of the design. In particular the weight of sub-primal prices after carcass break-up is necessary if yield from butchers is to be calculated reflecting performance on a team or individual basis.

c) Measuring the yield of individual operators can be considered costly, but essential for a well-managed or to be managed process. To introduce measurement of weight of each piece of meat being processed by every operator and again the weight of cuts from the same operator on a piece by piece basis is revealing in terms of effectiveness of operations and assessment of training needs. Although individual operator yield performance may seem costly, there are considerable other advantages in using this approach as it provides intangible benefits such as understanding the requirements for improvement and indeed minute by minute action to maximise performance in real time. A major issue in using measurements systems for individual yield at each works station is the additional requirement for real time quality monitoring. Yield results are tightly coupled to quality performance and this remains a major limitation of the technologies available that track individual operators yield results. It would be important for the industry to consider the development of low cost semi-automated work stations that provide for both yield as well as quality performance information.

At Frewstal the need for introduction of individual operator yield measurements have been recognised for the long term. The industry, however, needs to consider the options carefully, as such implementations would result in more direct monitoring of performance. In particular systems of work that allow for instructions to and information from each workstation can provide considerable benefits in management of staff and their performance. A typical station that measures operator's performance would typically include the following:

i) Automatic delivery of a primal piece or sub-primal piece to the operator works station using "intelligent" conveying.

ii) Display of instruction for the cut recipe on an interactive display with instruction of specific recipe requirements matching customer order at the moment in time, when the piece to be worked on, arrives. This may be in a pictorial form for better communication of the requirements and the task to be performed.

iii) Structured interaction (with integrated links to high level planning and scheduling software) using the interactive operator display combined with handing of the cut pieces to facilitate automatic conveying, weighing and quality checking of the end product resulting from the operator work.

iv) The information from the workstation on a piece by piece basis to be used to provide a host of management information that allows for calculation of performance and capability.

The use of such systems has been attempted, however, the costs of implementation is not fully appreciated. There is also no clear data available to support return on investment. An important development consideration would be the implementation of a practical line, at small scale, as a pilot that combines all the measurement requirements, including automated quality evaluation, with respect to a select set of products. This may be a pilot project that also quantifies the benefits for the processors, where yield, quality as well as efficiency measures can be quantified in a small plant. To date there is no clear benchmark for the range of cuts: not even for the cuts considered conventional in lamb production, where few recipes are processed. Although the considerations of such aspects of cutting room improvement opportunities have been relevant in the Frewstal project, the scope of the implementation has needed to focus on immediate results with predictable benefits. The focused has allowed for the future extension of the approach to accommodate the concepts in respect of yield measurement, performance monitoring and IT for management.

Figure 5.2 presents the Intelligent Butchery Station (IBS) as a concept that would essentially provide for most, if not all, the requirements of the meat industry. The approach has been presented, in part, by several line builders such as Marel and ATTEC. If such a concept were to be designed into a complete line as relevant for Frewstal, the main stages process would be as follows:

a) Each meat primal or piece needing butchery operations prior to packaging would be conveyed and delivered an IBS as illustrated in Figure 5.2 at point A for a specific operator.

b) Once at entry point B, the primal or the meat piece would be weighed. Quality assessment by automation at point B, or manually at a previous IBS designed for this purpose, provides the 'intelligence' or information about the meat piece for operator performance calculations.

c) It would be a requirement of this system that the operator is identified on arrival and on every occasion. This identification may be based on personal tag or pass code using IBS operator interactive screen (Figure 5.2 D) combined with face recognition or verification in its ultimate form.

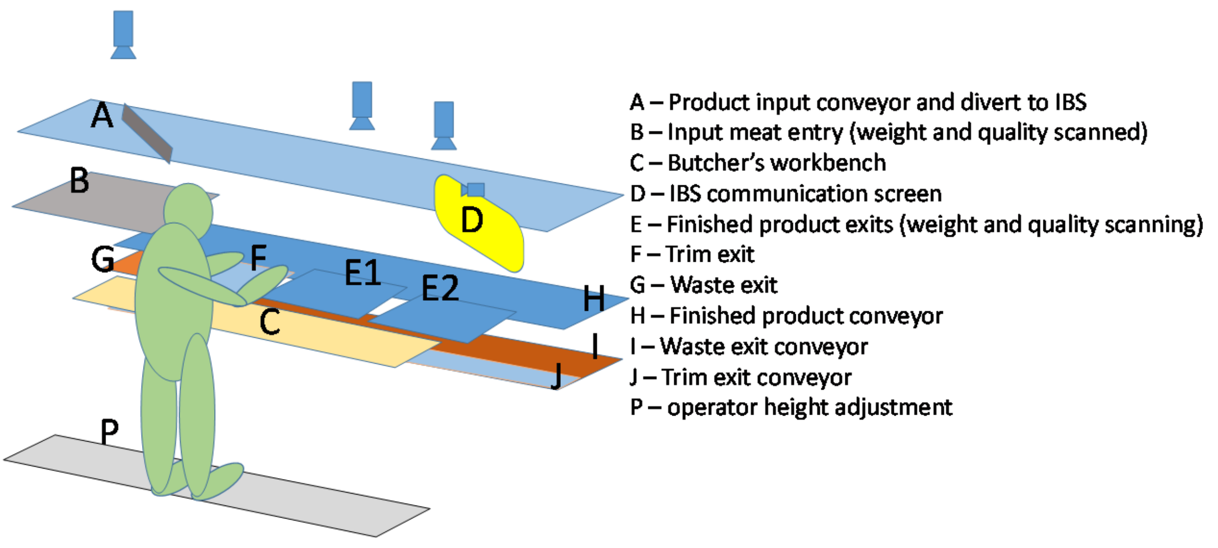


Figure 5.2 Intelligent Butchery Station (IBS) - Concept

The operator stand (Figure 5.2 P) with automatic adjustable height would set itself to the correct level using past setting once the identification has been reached. A feature that senses (based on weight or pressure) operator movement is important as this information would log the necessary data for measuring the duration of time work is executed by a butcher. The station would reset the platform and monitoring for anyone else that uses the same IBS at a different time. These features provide for assessment of operators' performance and records the specific work done. Many companies clock operators at entry to the plant or the cutting room. The movement monitoring process facilitated by a robust identification and operator presence sensing system as described here for the IBS, would be a more accurate process of determining hours of work done, individual movement as well as performance.

d) The IBS would include a butchery work bench (Figure 5.2 C), which may be equipped with knife holding, personalised wash station, chain glove wash or holder, sharpening tool and other features as used by butchers, but generally in a centralised location at existing plants.

e) The process of cutting generally produces single/multiple mid or end products, which need to exit the IBS. E1 and E2 in Figure 5.2 illustrate such exit points, which need to include weight and quality measurements if the IBS is to facilitate automatic yield monitoring and reporting on a realistic basis. The task of automatic quality assessment is essential on 100% of exit products. Without this feature, the IBS yield reporting process would be compromised, given the coupling between yield and quality. In certain recently implemented lines, tracking of the information provides for the inclusion of quality stations as part of the line for <u>sampling</u> quality performance. The sampling process is difficult to control automatically and leads to controversies or questionable performance reports. The concept of IBS calls for 100% automatic quality assessment both prior to entry and at or after exit of such a station for every product.

f) Trim and waste exits (Figure 5.2 F and G respectively) also feature in the IBS concept as separate elements. In particular it is important that all waste pass before a final check point: a separate station as part of the line, which may be assisted by automatic visual monitoring. Trim is often fat graded in bulk and this needs to have a separate exit. Reliable exit chutes for trim and waste that allow weights to be measured on a piece by piece basis are not justified easily. However, the challenge in innovation of developing such solutions need to provide for options at low cost in order for the IBS concept to be complete and robust in its use. The compromises made in existing equipment, provided by some manufacturers, result in poor operating capabilities and eventual discredit of the a process that needs to be robust in measuring efficiency and yield with quality conformation in real time on a piece by piece basis.

g) IBS interactive screen (Figure 5.2 D) is an important part the IBS, as it facilitates:

- The process of identification using pass code or tag scanning feature verified by video imaging face recognition, finger printing or any other identification medium that is not easily circumvented or abused..
- The process of communicating cut requirements (on a cut by cut basis) to each operator based on order book demands at the start

of and during a given production run. Note that the IBS needs to link in with a scheduling system that supports minute by minute instruction to IBS stations even if the same instruction is being displayed for the butcher repeatedly. In addition to work instruction the IBS screen would display important information relating to the performances achieved on a piece by piece and overall efficiencies, quality measures and yields over specific runs as appropriate.

- The process of information logging, operator skill monitoring and KPI reporting. In a modern meat plant having information is an important and essential aspect of plant management. Such information would also demonstrate diligence and competences that enhance customer or consumer confidence.

h) The exit process needs to support and maintain separation of product, waste and trim in a structured manner linking the IBS to processes of packing that follow. Exits H, I and J as in Figure 5.2 need to link with the next process steps. Note that efficient handling and packing stages that follow an IBS type line are coupled closely to the concept of separation and structured handling that feature in the concept of IBS. This is to be a subject of a follow up project, which is proposed under the AMPC-MLA PIP with Frewstal.

5.4.3 The electronic cutting room (eCR)

The concept of IBS may be chained to give a line, preceded by a carcass breakup process or, where appropriate, by a sub-primal break up process also. Maintaining flow and tracking is important. The integration of such a line with appropriate IT systems for control, monitoring and information reporting would result in the electronic Cutting Room (eCR).

The addition of automatic scheduling and real time planning software that predicts, monitors and controls the operations for best possible outcome, including computerised learning features, will provide processors with the performance Cutting Room (pCR) of the future.

A particular aspect of the IBS concept as presented is that the stations are independent and thus a failure at a given station should not affect the operation of other stations. Integrated correctly the process of break down and error recovery can be managed in a manner that provides for negligible production time losses using one or two spare IBS stations in the layout of an eCR.

It is necessary also for eCR in its concept, as an integrated layout, to allow for operators and maintenance staff access without the use of steps or platforms.

Features supporting cleaning and maintenance functions need to be part of the design process allowing efficient cleaning and responsiveness in maintenance.

The structure of the reporting process needs to accommodate the appropriate Quality Assurance (QA) procedures with automated features that support the QA tasks such as microbial swab testing.

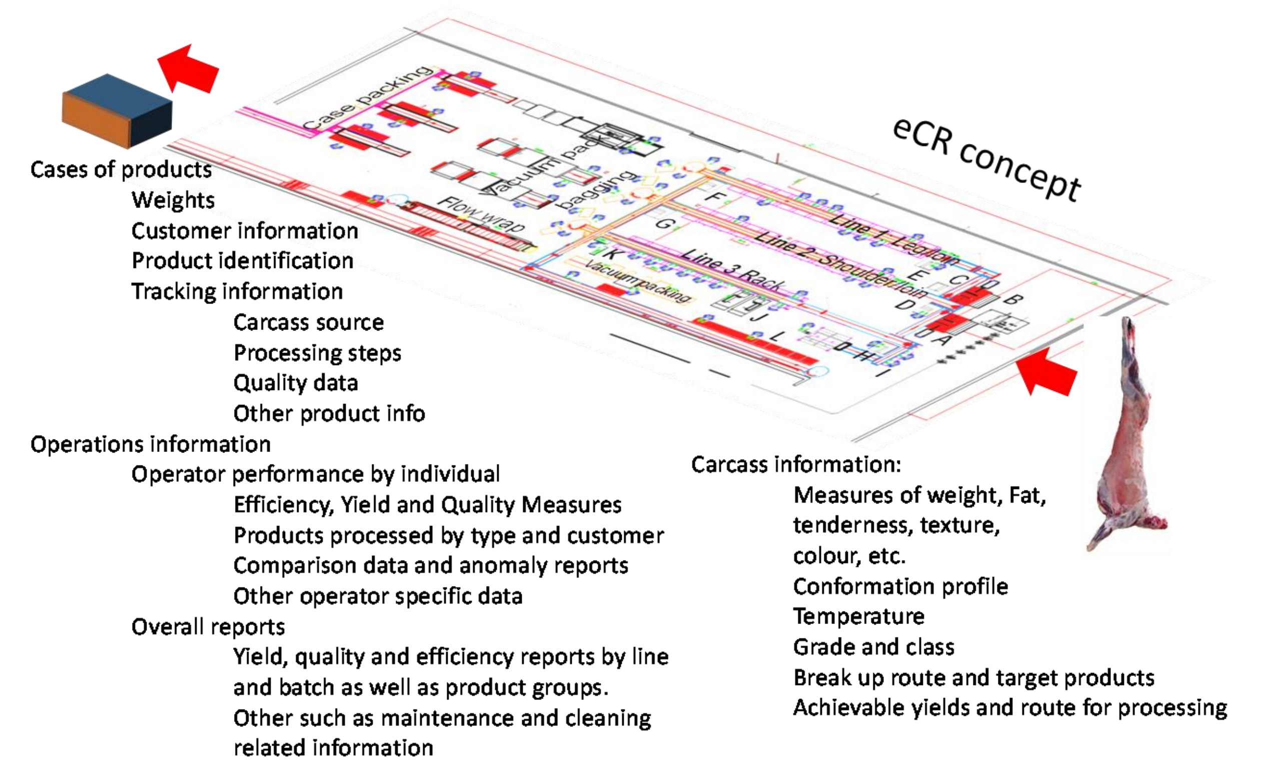


Figure 5.3 Integrating IBS information in an Electronic Cutting Room (eCR)

Figure 5.3 illustrated the approach to integrating the IBS in the eCR of the future. The availability of carcass information is an important aspect with respect to planning and optimising product yield as well as meat yield. Achieving the target volumes in terms of exact numbers of packs against customer orders without over or under production (Product yield) is as important as meat yield, which may be considered as the total saleable meat in weight from a carcass meeting customer specification. The process of planning using carcass information must aim to reach the highest meat yield at the correct specification (size, shape, weight, presentation and quality features such as tenderness, texture, colour, etc.) and also to achieve the exact pack count meeting the orders. It is clear that this easier said than done given the uncertainties in the ordering and picking processes, not to mention carcass variability. A subject for a future project. Nevertheless it is important that the layout of the cutting room accommodates for future changes to meet the more sophisticated demands of customers. The future needs the understanding of the process by which carcass information can link to processes of planning to achieve best production output against available carcasses in a manner that supports on-line, real time dynamic scheduling of production. The concepts of eCR and IBS need to be detailed further and specified for implementation using a pilot development approach with technologies available today and those that must be developed for the vision to be realised. The benefits and the approach to quantifying the benefits (ROI) also need defining by parallel research. The work of this project with Frewstal, having reviewed the future concept has focused on what is achievable today within the constraints of investment, management and technology. The layout design needs to incorporate the features capable of expansion to accommodate future developments in technology or practice.

5.4.4 Consideration of hygiene, cleaning and QA procedures

Maintaining the expected hygiene standards during the butchery process and having the procedures for monitoring it needs to become an integral part of the system of work.

The approaches that need to be appreciate and, when affordable, implemented, include the following:

- Operator access and hygienic wash at entry and exit that cannot be by passed
- Operations practice using periodic swabbing without the need for QA operatives
- In process cleaning and sanitisation, especially after a contamination release during cutting or handling.
- End of run, or end of day, washing of equipment using automated systems for hot and cold rinse, foam and final rinse and, if necessary, drying or sanitising.

The above approaches all require detailed specification and, in some cases, verification through R&D. The future methods need to be cost engineered to provide savings in terms of returns on investment in R&D as well as implementation for daily use. The main savings would come from significant reduction in labour for cleaning and QA monitoring as well as savings in water and use of cleaning material.

Operator access needs to ensure controlled entry into a cutting room encouraging or even forcing washing of hand and foot ware. Such technologies are important and a practice that may be introduces is as follows:

- Operator enters at a gate where access is only possible if the operator’s hands have soap dispensed on them automatically. The gate may be automatic or knee push operated, releasing to open only when soap dispensing has occurred.

- Operator is then to use automatic taps to wash and automatic dryer, to dry hands.

- After this a secondary gate would allow entry through an automatic walk in boot wash. The process is the same as the soap entry, but at the entry point the operator would receive sanitiser fluid on the hands whilst standing on cleaning brushes that automatically clean the sole of the foot ware, at and during the entry process. The access is gate operated to stop entry if operator fails to follow procedure to receive hand sanitiser.

- The final step is a complete boot wash (for long boots) and now the operator may enter the cutting room.

The procedure above is important, replacing the current entry practices that rely only on operator practice, diligence and awareness.

The design of the IBS needs to incorporate automatic cleaning, although the cutting room would still require some manual washing, especially the floor below the work stations, platforms and conveyors.

The QA practice for monitoring and in particular taking swabs may be assisted by the provision of swap pad dispensers at each IBS station, with the practice that requires butcher to take a swab of appropriate surfaces at the start of each period (the time for this being less than one minute). Note that the process of automatic cleaning and drying would have been operated at the IBS during the breaks as appropriate. Using a vacuum conveyor, the pads could be delivered to a centralised QA area for analysis. The saving would be the hours spent by QA operatives periodically walking through the cutting room performing such tests on equipment. This complements the automatic quality inspection system for product checks that also need to be done by QA operatives. The combined solution would add to the integrity of the process and the realisation of significant savings. The R&D towards such solutions needs to include cost engineering of the final equipment for a desired ROI.

Although, waste conveyors are generally used to carry bone and off cuts to waste bins, it is appropriate to consider such material as food. Earlier, it was mentioned that all waste may need to be inspected by an operative with respect to further meat recovery or indeed sorting for low value bone products as relevant. The reason for raising this in this section is that, by having this function included in the eCR and the layout of the room, a QA function that requires inspection of “dropped” or suspect meat may be integrated with the process of waste monitoring. In such situations the meat will be handled using the waste conveyor, with the waste inspection station dealing with suspect or dropped meat. An important feature of all conveying equipment would be constantly running, in-process automatic washing and drying in the return section of the belts in order to minimise or eliminate risk of cross contamination. This is especially relevant in relation to waste conveyors as these may carry contaminated or infected meat.

In the Frewstal process, the requirements have been kept to minimum to keep costs manageable, but the opportunity for adding the features as described have been accommodated in the design for future implementation.

5.4.5 Technology and automation

The operation at Frewstal and indeed most of the Australian industry rely heavily on manual break up of carcasses and the same in trimming, deboning, packing and palletising.

There is significant technology in the processes of packaging, and indeed automatic storage and retrieval as well as palletising and despatch.

The technology or automation considerations relevant under this project relate to the processes elaborated below:

a) Break up

The process of break up involves the separation of major primal cuts from the whole carcass and subsequent breakup of the primal pieces such as the whole shoulder, rack barrel, loin barrel, chump and whole leg into sub-primal or meat cuts as illustrated in Figure 5.4.

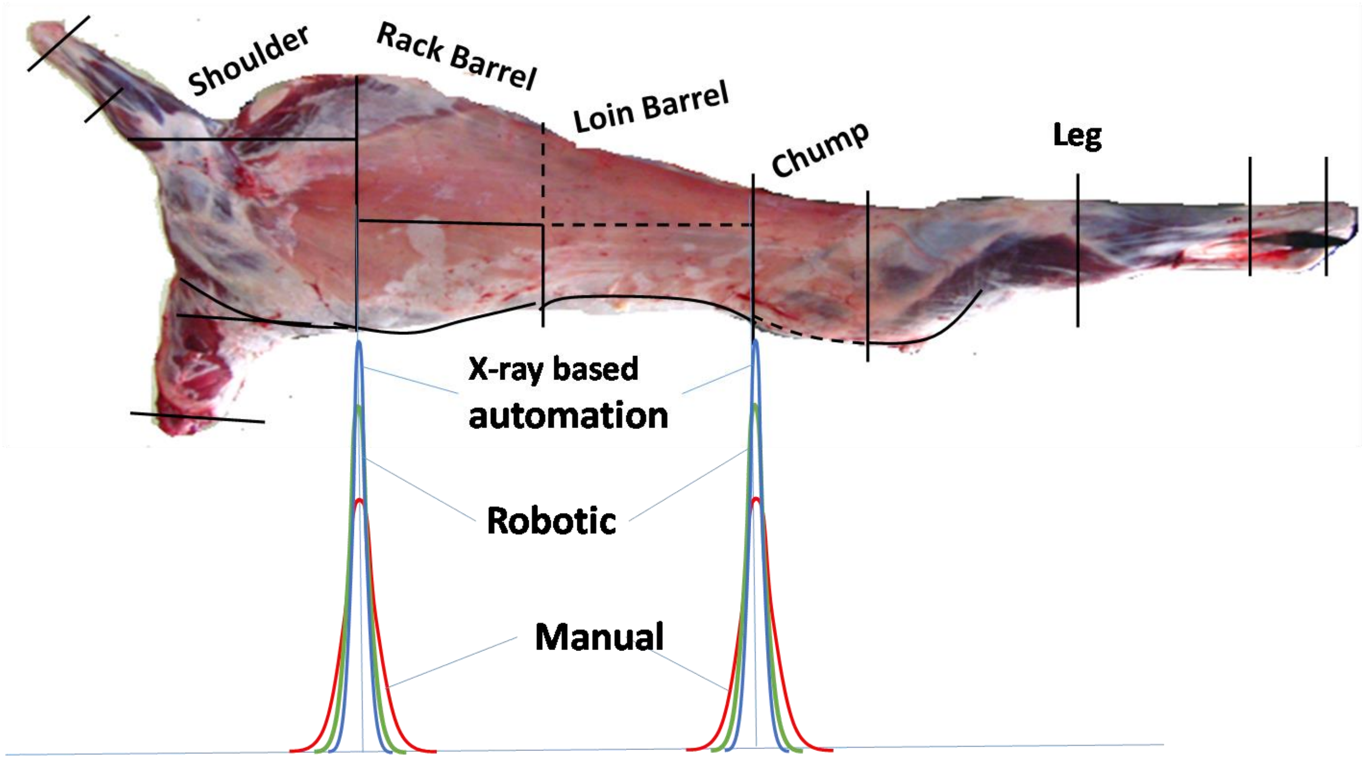


Figure 5.4 Primal cutting and cutting line considerations (yields may be changed by moving the bell curves)

The primal break up technologies in use include the following:

- Band-saws, operated manually (including those that feature blade stop for improved operator safety)

- Circular knife blades including guards operated manually similar to the band-saw, but with significantly reduced bone dust
- Vertical positioned set of knife blades with manual cut position defined by operator and automatic in-feed to perform cutting with operator kept at a distance from the cutters
- Robotic systems using also knife blades, or driving primal piece against band-saw or knife blade in various configurations using simple sensing or computer vision
- X-ray based system with automation for accurate cutting.

Figure 5.4 illustrates the cutting line consistency between manual, robotic and x-ray based system for leg and shoulder cuts on lamb. It is generally expected that the x-ray system gives the best accuracy and consistency with high throughput.

The manual process may be considered in two stages: (i) the judgement to recognise or define the cutting line and (ii) the physical action of cutting. In (i), skilled are capable of high accuracies recognition of the cut positioning, but in the execution (ii) of the cut, the manual process lacks consistency. It is also recognised that as the speed demand on a single operator increases, the cutting line accuracy is significantly compromised. Given enough time for a person to perform the cutting, highly accurate results can be expected, although this is not repeatable.

The results independently assessed and reported to the Meat Livestock Australia (MLA) places the x-ray as the highest accuracy system as one would expect (see MLA reports for detailed description and assessment of benefits).

It is relevant to state that the cutting optimisation requires the positioning of the cutting lines away from the high value primal pieces towards the lower value ones, without compromising quality or customer specification.

Each plant is different given the operational constraints, training or skills levels, rate of operation and the ergonomics of cutting.

At Frewstal, the practice of carcass cutting has involved highly skilled butchers using circular knife blades at a rate compatible with the desired accuracy performance. This has been the process before the start of the project, where significant cut accuracy performance is observed.

Although at Frewstal automatic operations were given lower priority, focussing the project towards improved flows, it is important to note that every plant considering change in the cutting room needs to review the technologies available, benchmarking the options against specific requirements.

In the work conducted with Frewstal, the options considered included:

- the MAR Robotic Ovine Cutter (ROC),
- the Scott Technology x-ray system (Leap),

- the ATTEC and Freund Circular knife cutting stations and variations of the same offered by various other suppliers
- The ATTEC vertical cutter with manual cut position definition
- Various machines, including BLM, ATTEC rack machine, Shoulder machine and leg machine for sub-primal break up

In the definition of the layout of the cutting room at Frewstal installations of the above, especially where the technology is yet to mature, has been the reviewed. The next section elaborates on the resulting approach for the short term, whilst keeping long term options open.

b) De-boning

Deboning operations have been attempted by automation in pork processing and chicken operations. In particular the widely publicised work of DMRI with SFK, Stork, Marel, MPS, BLM and Scott Technology may be referenced.

The requirements in lamb include Leg de-boning, H-boning (Scott Technology solution for vertical H-boning of whole legs is commended), shoulder de-boning, loin de-boning and de-boning of shanks. With respect to the process at Frewstal and many similar plants, the processes remain largely manual. There is considerable need for research in this area. New innovations in developing semi-automatic or fully automatic machines may benefit from technology transfers from the pork and chicken industries.

c) Trimming

Trimming automation has been considered, however, the requirements are diverse and due the high levels of skill and dexterity in the manual processes involved, the matter continues to be the subject for long term research. In fat trimming, the process that is the closest to realisation would ‘uniform fat trimming similar to that in pork (3D fat trimmer for pork loin from ATTEC). Trimming requires great skill and judgement, where a butcher needs to manipulate both meat and a cutting tool to achieve incisions and separation of one type of meat tissue from another or bone/cartilage from meat.

Another trimming process is the separation of cap from loin and rack pieces causing repetitive strain and an obvious next step for machine development.

d) Quality measurement

Measurement of quality and use of quality information for planning and sorting applies to all stages of operation, from whole carcass to the end product. Again these remain largely the subject for research. Vision systems of the type offered by E+V or Caromatic would be important technology transfer options. In particular the use of ultrasonics for measuring fat and indeed x-ray (Smiths Industries or Marel) or Q-Vision based on Near Infra-red technology for CL can lead to improvements in process to meet customer specification.

CT scan of the whole carcass with full traceability using RFID tagging can provide information for break up, grading and subsequent process optimisation to meet specific product results. Indeed, this can provide input for definition of cuts to IBS stations (see section 5.3). The topic of carcass quality and composition measurements is an important one for research: in time the integration with the concept of eCR will provide opportunities for real time or intelligent optimisation of the total process from carcass to the pack, maximising performance and profitability in operations (pCR).

Although Frewstal has the infrastructure to accommodate the ideas, it has been beyond the scope of this project to expand further on the opportunities to generate detailed specifications or designs. The coupling of quality with pick and pack however will be a subject of a PIP project already proposed on the subject of packaging.

e) Tracking and sorting

The structured handling and transfer of meat from one stage of cutting or process to another is most efficient when product identification is maintained avoiding the requirement for repeated identification or double handling. This becomes particularly relevant when automation is desired for picking and packing. Several existing systems, where traceability is the feature of the line, meat transfer is automatic to packing stations and the process is generally efficient. Automatic handling for packaging is however a separate and complex subject in its own right.

In the Frewstal, packaging automation has been considered outside the scope of the study. However, by considering a free flow conveying, separating shelf ready products from bulk pack at the point of cutting. This helps packing operators perform their task more efficiently, whilst identifying the products at the time of picking from a moving conveyor. The approach provides a lower cost option without the need for traceability or electronic tracking. The free flow feature may be seen in the layout design presented later in this report.

f) Cleaning

The subject of automatic cleaning is an important subject for a cutting room. In this study the options for CIP, using piping with appropriate spray nozzles have been considered. The automation process needs to auto-rinse (initially cold water then hot),foam and then hot wash and sanitise spray as appropriate, to clean every piece of conveyor, work table and machinery.

Given that cleaning automation is potentially possible at a cost and it will result in improved efficiency for a plant, there is a need for a detailed study defining the technical solutions, scope for R&D and the cost benefits. It is relevant to note that the cleaning of the processing equipment, although a major part of the operation, leaves the cleaning of the room to be done manually. Total solutions in cleaning automation is a much neglected area of research deserving greater attention increasing standards of hygiene with greater consumer assurance.

At Frewtal, the necessary and available solutions for equipment wash have been included, simplifying, but not eliminating manual control.

g) Quality measurements and fat analysis

Measuring quality for sorting, separates meat that may be supplied at higher price. The important meat quality characteristics that may be considered relevant for sorting, requiring online measurement include:

- Fatness
- Tenderness
- Texture
- Colour
- Piece weight, shape or size

Solutions for measuring quality by automation has been based on computer vision, x-ray, near infrared, optical probes and other specialised devices such as ultrasonic devices or CT scanners. Many of the technology options continue to be the subject for research with respect to effectiveness, added value and cost engineering. Aspects of user-consumer requirements also need greater definition as do the aspects of change management and acceptance, where such technologies are concerned.

The measurements at carcass level are more readily available, as are solutions for assessing bulk trim for CL based on x-ray. Use of vision for determining fat on high value meat slices may also be mentioned.

Online solutions for assessment of tenderness is also a subject for research.

It is generally the case that there is limited understanding of, not just how to measure quality features in the total process of carcass break up to packaging, but how the information may be used for optimising profitability.

The work undertaken here has only considered the use of available information in a manner that maps existing process to manual planning. The layout consideration for the Frewstal cutting room has allowed features for future integration of technologies as well as practices in online quality measurements that may emerge and become commercially available.

Software tools, such as Innova from Marel, for registering QC parameters have been available for some time in the industry. The process of specification and integration for daily use of such software need to be simple if the industry is to take advantage of them. There is significant effort in R&D as well as training before such simplifications are implemented in a manner that supports adoption or widespread use by the industry. The cost of implementation is also prohibitive as returns on investment are once again difficult to define.

h) Meat recovery

Mechanically recovered meat, especially from lamb shoulder rib cage after the whole shoulder is deboned and the H-Bone from a deboned chump or leg has been considered. The recovered meat may be considered for added value in sausage meat, sausage burger, or ready meals among others. The process of recovery may use trimming knives and an operator. Automatic processes recover meat with much lower potential for higher added value.

The Frewstal lay out, as defined and presented in the next section of this report, allows for work stations that may be used for meat recovery. The option for using standard machines for meat recovery have also been considered, but not pursued given the space constraints. Nevertheless there are a number of technologies available from several companies for meat recovery, including FPE in Australia.

i) Planning production and responsive scheduling

The process of production planning is generally performed at a high level in a typical lamb plant with the detailed production runs managed by supervisors in the cutting room. In a dynamic environment, where the order book may change during a given run, or multiple products are to be simultaneously processed, the task of replanning needs to be fast. There is a need for an automatic and responsive scheduling capability. Software for planning and scheduling in the manufacturing industry is widely available (e.g. MRP II or SAP), however many meat companies use a spreadsheet. The practice is an interactive one using an Excel sheet or similar, assuming it is correctly set up for all possibilities, to perform planning or re-planning manually. Standard software packages require adaptation for the specific needs of the meat industry as the process involves break up and disassembly rather than assembly or fabrication, which standard packages are generally designed for.

The project has considered a simulation process in a simple form for evaluation of a new layout at Frewstal. There is a need for consideration of a more specific project developing software for planning, scheduling and production control with wider applicability.

j) IT and Management information

In the meat industry use of IT and management information systems has been evolutionary. There is a need for generic specification of the requirements with appropriate definition of structures that can be readily put to use at low cost.

The approach for eCR and IBS can facilitate a structure that can provide the basis for such systems to be implemented in the longer term. The industry requires readymade packages that suite any operational design both modern and established. Packages like INNOVA are a step in the right direction, but they need to be tailored to the available skills of the general meat company that has scarce IT staff resource and limited possibility to give time for training to sustain the use of such systems on the daily basis. Generic software with simple interfaces are needed, where little or no skill is required for the daily plan to be formulated against the order book, whilst the software monitors and measures production parameters for reporting or control. A follow up study should aim to expand on this subject leading to the definition of generic IT system for the meat sector, continuing towards the development of user friendly software that can be integrated into an existing operation

k) Real time control, reliability forecasting and maintenance management

Following on from above, meat companies are generally limited in their resource for maintenance and the facilities do not have on-line monitoring or reporting systems to support control functions, fault monitoring and reporting or maintenance planning. Task such as spare parts inventory management and control, fault and failure analysis or forecasting, preventative maintenance and other related plant monitoring processes are rarely seen. Skills at management level are essential if such systems are to be specified and indeed implemented. Such aspects need further study with a review of the status play in the Australian meat industry. To date levels of practice observed, supporting such aspects of operation have been limited. There is a need for simplifying operations design and introducing IT integration to a level that includes real time response to faults and maintenance, supported by an effective communication network which for example automatically issues a message (say on a mobile phone) for the appropriate person who needs to take action or who needs to order a part to stock. Such systems have been tested and are in existence, but they need to become tailored to the needs of the meat sector and easily introducible for day to day use in any plant. Uptake of such technologies depends largely on how easily they can be introduced in a given plant at minimum cost. R&D needs to consider such aspects also.

6. Results and discussions

The assessment of the changes in operations and work practices and consideration with respect to variability of production, efficiency and flows has led to the formulation of a series of layouts for the boning room. These layouts have been iteratively reviewed by the Frewstal operations team. Use of automation and planning for the future has been a point of attention. Figure 6.1 presents the overall solution which has been the result of weeks of deliberations and analysis of options. Note video material has been analysed and aspects of yield and efficiency have been incorporated in the approach based on detailed analysis of practices and flow of products from primal cutting to the end of packing.

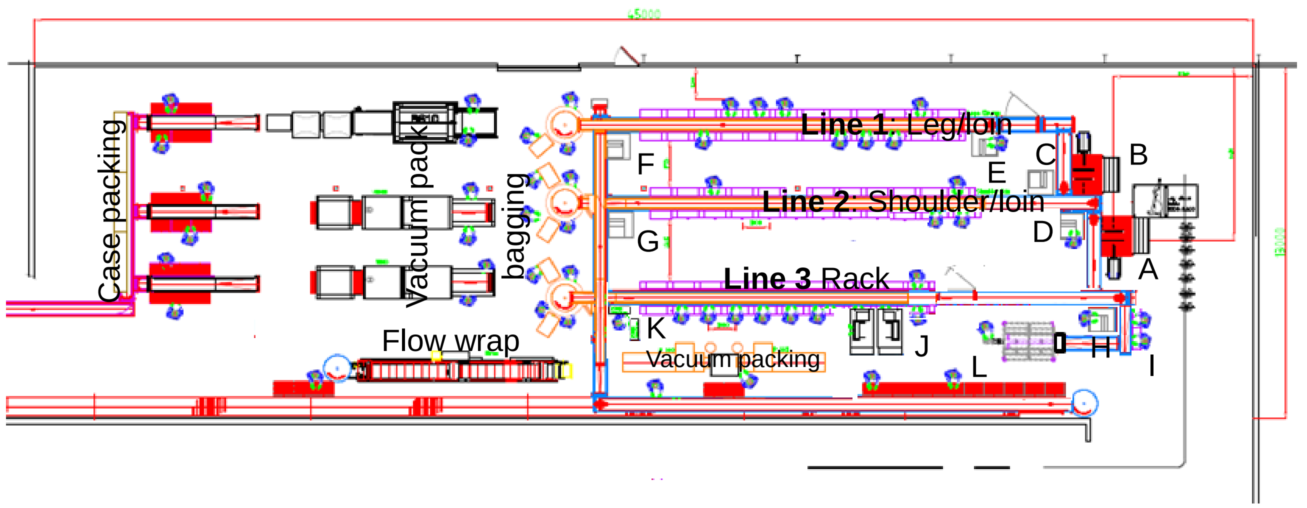


Figure 6.1: Overall solution to Frewstal

The latest proposed cutting room break up operation is to start at an existing circular saw blade, where a whole carcass is delivered after trimming and placement horizontally on an in-feed conveyor as shown in Figure 6.1 position (A). Adjacent to this area the room has space and there is possibility for building extension for new cutting equipment such as the automation for primal cutting referenced in section 5.4.5. At the first circular saw at position A, the shoulder and rack primal pieces are separated. The remaining leg primal with lion attached is to move to location B, where a new second circular saw blade is to be used to separate the lion and, if required the chump primal pieces. The resulting cuts from this arrangement onwards will be as follows:

- Line 1 is dedicated to Leg products where the long leg, the short leg or the chump are to travel to work stations on both sides of the line. On this line, at position C and E specific band-saw operations may be performed in the case of split bone-in-loin or tipping the leg for specific MSA leg products. Note at position F leg shank tipping and cracking may be performed when producing these products. Line 1 has a number of trim and boning stations with waste exit chutes and a waste conveyor below for any waste generated during the boning/trimming operations. A top conveyor is to deliver the product to bagging/packing locations at the end of Line 1. Bulk pack products are to be placed on the same conveyor that delivered the primal pieces from the cutting positions at the start of the line to the boning stations along the length of the line. The conveyor network is to deliver the bulk pack products to packing stations at (L) for case packing.

- Line 2 is for operations on the shoulder line and in the event that line 1 is required for higher than normal de-boned products, this line may be used for loin products also. The band-saw at D is to be used for square cut shoulder or neck separation when de-boning. The flow and operation of this line is the same as line 1, but producing shoulder products, including deboning of the whole shoulder, where a significant number of stations would be needed to meet the required throughput. At (G) a band-saw position provides for shoulder shanks to be tipped and cracked.

- Line 3 is dedicated to racks, although it may be used to process loin products also. The band-saw and the rack machine at location (H) are to break up the rack barrel as specification demands. Two stations immediately after an incline conveyor, delivering meat from the rack machine, are intended for rack cap removal when Frenching. As in lines 1 and 2, the bulk pack products travel on the same conveyor to delivers the pieces for boning/trimming, and a top conveyor to deliver the finished products for bagging/packing, with a low level conveyor for waste from all station.

At (K) products that need to be strung are processed and a high level conveyor is to carry the strung items to a designated bagging/station. A divert arm is to guide the strung pieces to the bagging location designate.

At D, provision is made for addition of a shoulder machine and the gap between lines 2 and 4 provides the space for future machines such as shank tipping-cracking machine.

Note that the design approach does not map fully with the IBS concept (section 5.4.2), but accommodates for the efficiency required in a batch traceable system of work.

The overall approach to avoid use of band-saws in the longer term has been accommodated.

6.1 Changes to process for minimum handling

The processes of primal cutting, boning, trimming and handling to the point of packing have been assessed. Figure 6.2 gives the outline of the process as follows:

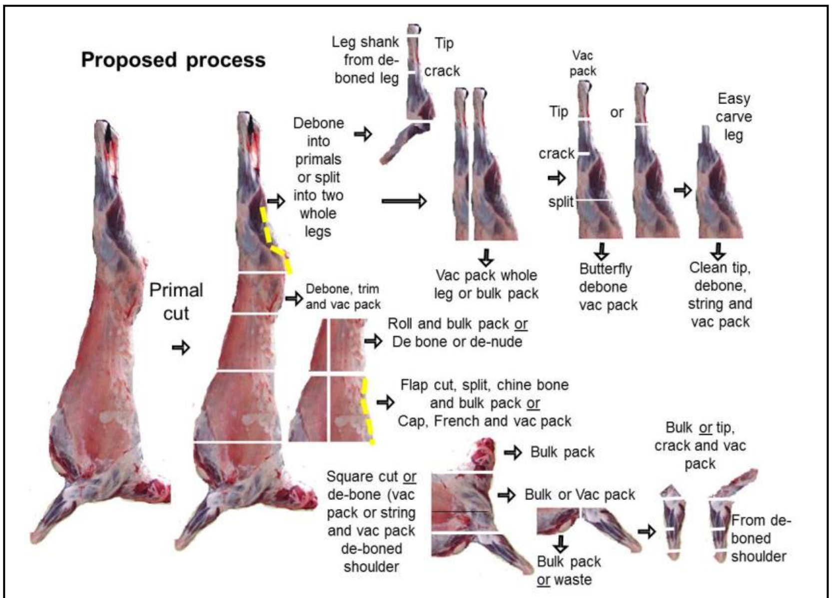


Figure 6.2: Changes to process of break up

1. Pre-trim whole lamb carcasses and break up into main primal pieces – shoulder, rack barrel, loin barrel, chump and whole leg,

2. Shoulder primal is to have neck cut (to be bulk packed), shank and brisket cut (shank to be vac packed) and after splitting the square cut to be vac packed,

3. The shoulder may be deboned and vac packed with option to string. The shank from deboned shoulder to be cut before vac packing. The shoulder carcass and tips to go to waste. Option to cut neck off square cut shoulder and slice for bulk or vac pack.

4. The rack barrel to be cut on rack machine. Chine bone to be bulk packed, flap to be bulk packed and bone in rack to be vac packed. Option to tip rack (on Fenching Machine) and trim for vac pack as French rack.

5. The loin barrel to be split and rolled with flap trimmed for bulk pack and the rolled loin to be vac packed.

6. The leg to be split and vac packed whole, or tipped and deboned or cut as leg roast for vac packing. Option would be to debone leg into primal cuts vertically; sort and vac pack primal cuts and tip leg shanks for vac packing. Another alternative is to cut legs and butterfly for vac packing.

6.2 Automation, skill development and management of change

During the period of the project, consideration has been given to automatic primal cutting as well as the practices in packaging, changes in processes of packing and impact on skills and the management of change.

The main consideration in respect of automation has been for primal break-up and in this respect it was decided that the capital locked into such systems, though considered to have good returns, would be a constraining factor in the business. A secondary constraint has been the availability of space, resulting in the primal cutting automation to be left for a future project. It is recognised that cutting lines at primal cutting stage set the yields and the consistency of cutting speed defines the pace of the room; both critical to the performance of the room and high priorities for automation. Given that the pace of the cutting room is defined by the rate at which primal cutting takes place, the task of primary break up (three way cut) is allocated two operators, to ensure throughput. This is a key factor in overall utilisation of resources from this point on.

Quality of cuts using band-saws and control of primal piece yield have been assessed and the key consideration has been the use of circular cutters at the primal break up stage and balancing the manning levels to ensure accuracy and consistency in the way manual work is done. Giving time to each operator to perform the primal cutting operation at a consistent rate produces the best outcome for minimum investment. Frewstal already used a circular blade and the introduction of a second unit has provided for a short to medium solution without tying up significant capital. Automation of the primary stage of cutting is to be visited once other priority areas have been developed.

Post break up, an important change to the practice is to be the separation of the lines into the Shoulder, Rack and Leg/Loin primal cut processing. The introduction of the 3 lines would facilitate skill specialisation with expected impact that improves both yield and efficiency. The separation also creates alignment to bagging and packaging lines where throughput, volume (weights) and yields can be assessed against staffing capabilities (skills) and efficiencies on a line by line basis. This is a compromise from the individual performance monitoring process of IBS (see section 5.4.1), but considered acceptable against current requirements from the market view point.

The opportunity and the challenge has been to reach a solution that meets with higher throughputs (10 carcasses per minute compared to 8) whilst allowing for the product mix and changes in order processing maximising the use of space.

In total 6 iterations have been applied to form a basic layout.

6.3 Assessment of priority and direction

A top level QFD as in Figure 6.3 presents the ranking of importance of the key drivers and also points to the directions to be considered resulting in a decision for a next action.

The operation QFD has been summarised in a structured form, with the ranking of important requirements (on the left of the chart in Figure 6.3) and the processes relevant to the plant (along the top of the chart in Figure 6.3). The importance column is the reflection of the views held and the scores against each process or technology, an indication of ranking against requirements. The right column indicates a first approach to the action.

It is worth emphasising that the QFD provides a means for structured assessment and, in the case under consideration, the results portray the outcome against Frewstal priorities. The results may lead to different conclusions for other processors or with a different management team.

FREWS (boning room) Ops QFD		X/10	Robotics and automation	Circular knives	Band-saw	Flow line design layout	Traceability (automatic)	Quality grading (auto)	Yield monitoring	Yield prediction	CIP	
No			1	2	3	4	6	7	9	10	8	Requirements
	Whats (Operations)	Importance	104	116	91	112	84	60	48	53	52	Assessment
1	Cut quality	14	9	9	3	1	7	10	1	1	1	important to customer
2	Accuracy of cut	12	8	10	10	1	1	8	1	1	1	needs to be to spec
3	Hygiene	13	7	8	5	5	7	8	1	1	9	needs to comply
4	Efficiency	11	10	5	5	10	8	5	8	5	9	needs to improve
5	Yield result	10	9	9	5	5	9	1	8	9	1	needs to improve
6	On time delivery	9	7	7	7	9	10	1	1	6	1	needs to be kept
7	Meeting order volume	8	8	8	8	9	10	4	8	1	1	needs t be kept
8	Space use	6	5	10	10	9	1	1	1	1	6	to be improved
9	Material flow	7	9	9	9	10	1	1	1	7	1	to be better
10	Cleaning ops	5	7	10	5	7	6	1	1	1	10	to be managed
11	Maintenance skill	4	6	10	9	7	9	8	5	8	1	to remain unchanged
12	Safety at work	15	10	9	5	9	1	1	1	1	8	to be improved
13	Access to workstations	1	5	8	8	10	1	1	1	1	1	to be improved
14	Waste handling	2	2	2	1	10	6	1	5	5	1	avoid double handling
15	Trim handling	3	2	2	1	10	7	9	5	5	1	avoid double handling

Figure 6.3: Focus on priorities based on QFD

From the assessment here, Frewstal priorities may be summarised as follows:

- Circular saws remain the main piece of cutting equipment in respect of primal cutting and the ranking reflects this for the short term.
- The re-arrangement of the cutting room is considered to provide the benefits reflected by the scores.

6.4 Consideration of technology and equipment

Figure 6.4 presents an overview assessment in respect of the considerations for equipment. Although this was to be a subject for phase 2 of the project, it has been necessary to reach a view on the direction for Frewstal in particular with respect to specific investments of high priority for the business of the company.

The chart (Figure 6.4) lists the available options against processes of interest. Considerable technology is available and in particular, it is relevant to highlight that it is the view of the processer in this project that fully automatic operations are costly and the ROI is notionally too long in proportion to the level of investment. The cut line accuracy in primal cutting is considered high when using skilled operators and semi-automated machines compared with robotics given the range of products and carcasses. However, manual process is not repeatable or consistent and automation provides better results. Circular knife blades achieve the quality of finish and eliminate bone dust, which is high priority for Frewstal. Based on such consideration and investment constraints, the short term decisions to proceed with the options included in Figure 6.1 have emerged. The gradual changes with standalone options provide a stage by stage implementation, overcoming the 'fears' in respect of sudden transition that often create 'resistance' to change or adoption of automation technology.

Frewstal evaluation of cutting (Lamb)									
No	Cut(s) - process	Technology or Equipment	Capacity	Staffing	Cost	Running cost	Sensing	ROI rank	Frews decision
1	Prmary (shoulder, leg)	Scotts	600/hour	1	High	High	X-ray	High (Labour-yield)	To review at later date
		MAR	600/hour	1	Average	Average	Vision	High (Labour-yield)	To review at later date
		ATTEC	600/hour	2	Low	Low	Operator	Saving on bone dust	Already in use
		Freund	600/hour	2	Low	Low	Operator	Saving on bone dust	ATTEC alternative
2	Primary (Rack - Chump)	Scotts	600/hour	in 1	High	in 1	X-ray	High (Labour-yield)	To review at later date
		MAR	600/hour	in 1	Average	in 1	Vision	High (Labour-yield)	To review at later date
		ATTEC	600/hour	1	Low	Low	Operator	Saving on bone dust	Already in use
		Freund	600/hour	1	Low	Low	Operator	Saving on bone dust	ATTEC alternative
3	Rack-barrel break up	Scotts	600/hour	in 1	High	in 1	X-ray	as 1	already have ATTEC
		ATTEC	>600/hour	1	Average	Average	N/A	Saving on bone dust	Already in use
4	Loin splitting	Scotts	600/hour	in 1	High	in 1	X-ray	as 1	To review at later date
		ATTEC	600/hour	1	Low	Low	Operator	Saving on bone dust	To review at later date
		Freund	600/hour	1	Low	Low	Operator	Saving on bone dust	To review at later date
5	H-boning	Scotts	600/hour	in 1	High	High	X-ray	High (Labour-yield)	To review at later date
6	Shoulder break up	Scotts	600/hour	in 1	High	High	Laser	High (Labour-yield)	To review at later date
		ATTEC	600/hour	1	Average	Average	Laser	High (Labour-yield)	In development
7	Leg and tipping	ATTEC	600/hour	1	TBC	TBC	TBC	High (Labour-yield)	At proposal stage
8	Boning operations	Not vailable	N/A	N/A	N/A	N/A	N/A	N/A	Use new workstations
9	Trimming operations	Not vailable	N/A	N/A	N/A	N/A	N/A	N/A	Use new workstations
10	Stringing	Use exisiting	N/A	N/A	N/A	N/A	N/A	N/A	Use exisiting
11	Bagging	Cryovac	30/min	1	Average	Average	Various	High (Labour)	To review at later date
12	Case packing	Not vailable	30/min	N/A	N/A	N/A	N/A	N/A	Use new work station

Figure 6.4: Consideration of technology against process

Automation technologies developed have demonstrated clear benefits in several plants in Australia. In some cases, for example carcass break up or sub-primal break up using robotics or standalone machines, payback is 12 to 24 months. Technologies such as those offered by Scott Technology (https://www.youtube.com/watch?v=MZIv6WtSF9I), MAR (http://www.machineryautomation.com.au/) and ATTEC (http://www.attec.dk/) are among those that were considered. Primal cutting by automation is considered important at Frewstal and a potential future project.

In the assessment of cost, the step by step investment is preferred and standalone options facilitate this, especially in the case of the small processor. The Frewstal strategy supports this view.

Skills development in engineering and maintenance of the plant, particularly in Australia is crucial as it is costly to rely on the support of providers and perhaps impossible in an emergency, given the distances involved. The approach to employing or training existing staff to cope with high level technologies is also a constraint, and costly. A parallel step is the approach to simplify proven advance technologies to be capable of being used and maintained by the already available skills within processing plants.

The work of this project has been expanded to implement the layout and to enhance current cutting processes at break up stages and by improving handling: flow processes, where knife operations are used to add value to the product.

6.5 Evaluation of the cutting process

The evaluation of cutting process has had two specific targets, both of which have been reached:

1. Production of a layout with generic applicability to plants producing similar products to Frewstal, but also tailored to fit within the space and environment of Frewstal plant. The focus of work has been to define a layout that allows the breakup of whole lambs into primal, sub-primal and portions to the point of packing, but including case packing of shelf ready and bulk packed products, but excluding pick and pack, order picking and bag loading and packaging processed.

2. To produce a model that simulates the constraints as a way of assessing the validity of the design layout for flow and operational requirement from the point of whole carcass break up to the point of packing, but excluding packing operations. The focus being:

    a) Assessment of the number of work stations as a maximum for a 7.5 hour operation at different throughputs

    b) Facilitation of the process of planning manning levels in the break up and boning areas.

The validation of the layout against operating parameters matching demands of order variations reflecting customer requirements is necessary as a task for the project.

To this end, for the validation of the layout the project has defined an Excel model that may be used to assess the layout by simulation. The main objectives of the simulation model have been as follows:

- To assess that the number of stations in the design meet with requirements. The model has been based on the layout of Figure 6.5 relating to knife stations for slicing, deboning, trimming and other such processing tasks. The stations occupy the space available to the maximum footprint possible, without compromising the potential for future additions based on selection of options in equipment under development. The key question is whether the number of stations available as a maximum can provide for the increased throughput of 10 lambs per minute or changes in future customer specifications or order volume, needing higher staffing levels and thus additional stations.

- To check that time intensive operations can be accommodated in the day to day operation without exceeding number of stations available.
- To provide a means for balancing the line.
- To check that capacity can be managed before start of operation after the new line has been implemented.

The Excel model uses time standards from the current operation benchmarks determined by the project. The model shows that the layout does not have constraints and meets with the full requirements of Frewstal.

The final layout which became operation in October 2013 (see Figure 6.5) uses an existing circular saw blade, where a whole carcass is delivered, trimmed and horizontally located on an in-feed conveyor as shown (A). This cutting step separates the shoulder and rack primal pieces, conveyed as shown to lines 2 and 3 respectively.

The remaining leg primal with lion attached is to move to location B, where a second circular saw blade is used to separate the lion and, if required the chump primal pieces.

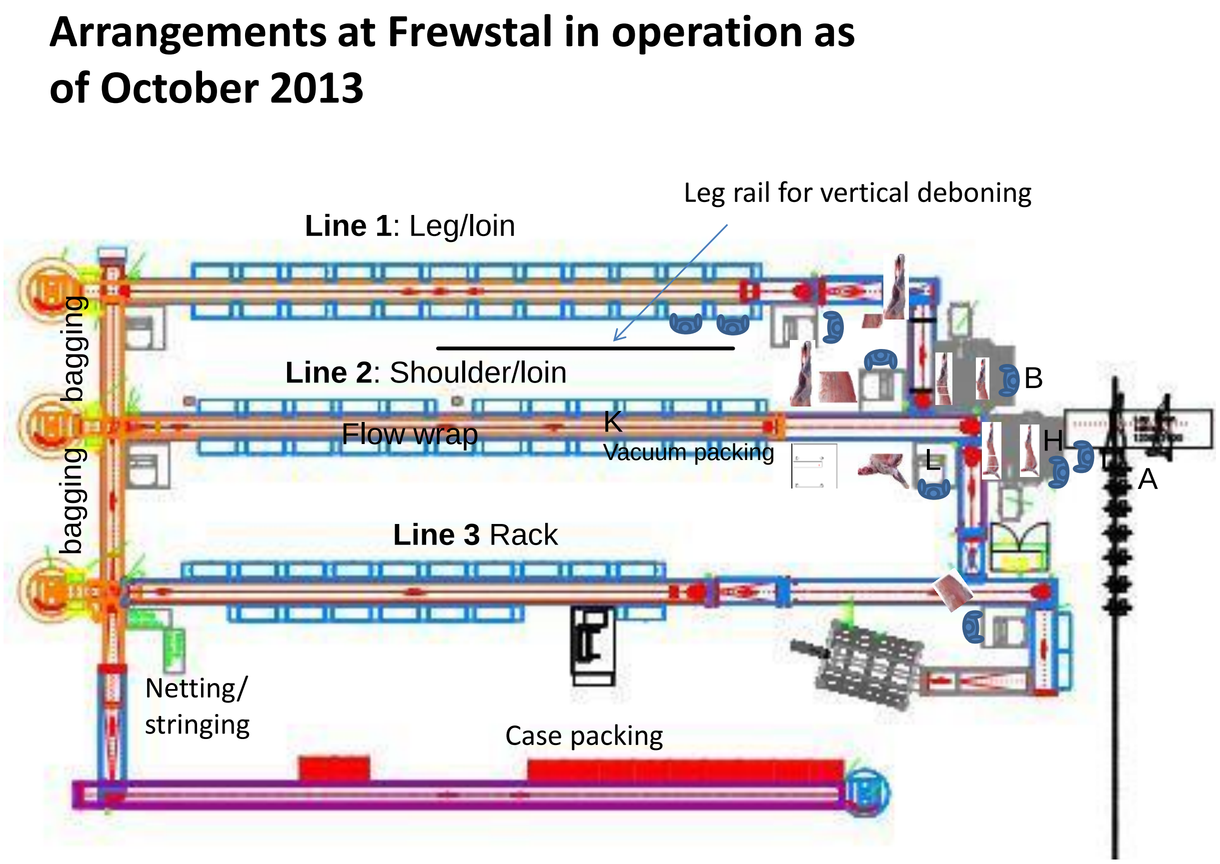


Figure 6.5: Frewstal implemented layout for break up and cutting assessed by Excel simulation.

The leg pieces proceed to Line 1, whilst the loin primal is to have two routes for processing (lines 1 or 2), depending on the loading on the leg and shoulder lines. The resulting cuts from this arrangement will be made on band-saws or the rack machine and continue on along the respective lines for trimming. Vac pack products are to proceed to the end of each line on separate conveyors positioned above the primal cut conveyor, at the working table height. There is a waste conveyor below the butchery benchers.

A dedicated area is allocated for stringing, which also links to the bagging stations. A bulk packing area is situated parallel to the trimming lines for fresh product case packing and packing trim (see Figure 6.5).

6.6 Excel model for evaluation and simulation

To assess the validity of the design in Figure 6.5, an Excel model has been produced and used for simulation.

The model has three main sections:

1. Data section where the times for the steps in the production of a given product is entered
2. A production input section (Figure 6.6)
3. A results section were the loading on the band-saws as well as the boning and trim lines may be observed (Figure 6.7)

The data section defines the task timings observed and analysed by time and motion in respect of the specific products. The data set is specific to the range of products, but there are variations for different customers that have not been included.

Figure 6.6 gives the section of the Excel sheet for the definition of the products to be processed over the shift of interest. This is the input section of the sheet that changes with customer orders.

The user of the model can simulate different mixes of products and determine if the layout of Figure 6.5 is likely to be limited in the number of work stations or if there are other constraints such as the loading on operators, especially those working the band-saws.

Figure 6.7 gives the results based on the timings and the selection of the range of cuts.

The results give the hours, specific band-saws need to be operated as well as the stations that would be occupied or needed to meet the cutting operations for boning or trimming.

Production input section

The number of carcasses per minute and the hours of work per shift may be modified by the user and here 7.5 hours and 10 carcasses per minute are entered.

The Quantity/day in red may be changed by the user to reflect the numbers required or being used for assessment.

The model adjust the quantity for items in black accordingly

Simulation by excel - analysis of cutting				
10	Rate per minuts			
7.5	hours per day			
4500	Rate per day			
Position	**Description**	**Quantity/day**	**Staffing**	**Hours**
Line 1	**Station committed**		15	
Band saw 3	Split leg with chump on (pairs)	1000	0.5	1.7
Band saw 3	Butterfly leg	500	0.3	0.8
Trim station	De-bone butterfly leg (pairs)	500	0.9	7.5
Band saw 2	Leg shank (pairs)	500	0.7	0.8
Band saw 2	Tip easy carve leg	1000	0.3	1.7
Trim station	Easy carve leg de-bone (pairs)	1000	3.3	7.5
Trim station	Rump (pairs)	2000	10.4	7.5
Band saw 3	Split short leg (pairs)	2000	0.5	3.3
Line 2	**Station committed**		20	
Band saw 1	Sqaure cut shoulder primal	3900	1.0	6.5
	Neck piece	3900	inc in A	inc in A
Trim station	Square cut trim (pairs)	3900	2.0	6.5
Band saw 2	Shank flap & crack (pairs)	3900	1.0	6.5
Band saw 1	Neck piece only for pre bone	600	1.0	1.0
	Deboned shoulder shank on	600	3.6	7.5
Band saw 3	Band saw split loin barrel	4500	0.5	7.5
	Loin trim flap (pairs)	3600	5.0	6.0
	Loin trim for chop (pairs)	300	0.4	7.5
	Loin smart heart (pairs)	600	5.3	7.5
Line 3	**Station committed**		9	
band saw/LRBM	Bone in rack (pairs)	1300	1.0	2.2
	Rack flap (pairs)	1300	inc in B	inc in B
Cap off	Cap off rack (pairs)	300	0.6	7.5
	Tipped cap off rack (pairs)	500	0.6	7.5
	Full French rack (pairs)	2400	8.0	7.5

Figure 6.6: The selection of products to be processed is mapped by the model to number of stations to be occupied based on the timings.

Results section

This section provides the key results once the timings for each operation against each product have been entered and the quantity of the products to be produced have been set.

The hours on the band saw is an indicator of any problems that may need to be managed.

The number of stations requiring manning are also given.

		Loading	
	Band-saw	(Hours)	
	1	7.50	
	2	7.61	
	3	6.53	
Stations		**Stations**	Total stations
not used		Needed	Available
9	**Line 1**	15	24
3	**Line 2**	20	23
10	**Line 3**	9	19
must be positive			
23	Total station	43	66

Figure 6.7: Loading on the lines and operators working the band-saws.

6.7 Simulation for validity of layout

The Excel model provides a tool for assessing the capacity of the arrangement and validation of the layout. Figure 6.8 provides the simulation template where changing the products to be packed, numbers in red, automatically determines the number of stations on each line that need to be occupied for knife operations. The number of stations (or staff) is given as a total for each line (Figure 6.8 bottom right).

Assessment of number of stations in the design meeting requirement

Simulation by excel - analysis of cutting	
10	Rate per minuts
7.5	hours per day
4500	Rate per day

Position	Description	Quantity/day	Staffing	Hours
Line 1	**Station committed**		9	
Band saw 3	Split leg with chump on (pairs)	**2000**	0.5	3.3
Band saw 3	Butterfly leg	500	0.3	0.8
Trim station	De-bone butterfly leg (pairs)	500	0.9	7.5
Band saw 2	Leg shank (pairs)	500	0.7	0.8
Band saw 2	Tip easy carve leg	1000	0.3	1.7
Trim station	Easy carve leg de-bone (pairs)	1000	3.3	7.5
Trim station	Rump (pairs)	1000	5.2	7.5
Band saw 3	Split short leg (pairs)	**1000**	0.5	1.7
Line 2	**Station committed**		18	
Band saw 1	Sqaure cut shoulder primal	3700	1.0	6.2
	Neck piece	**3700**	inc in A	inc in A
Trim station	Square cut trim (pairs)	**3700**	2.0	6.2
Band saw 2	Shank tip & crack (pairs)	**3700**	1.0	6.2
Band saw 1	Neck piece only for pre bone	**800**	1.0	1.3
	Deboned shoulder shank on	800	4.7	7.5
Band saw 3	Band saw split loin barrel	4500	0.5	7.5
	Loin trim flap (pairs)	**3900**	5.0	6.5
	Loin trim for chop (pairs)	300	0.4	7.5
	Loin smart heart (pairs)	300	2.7	7.5
Line 3	**Station committed**		2	
band saw/LRBM	Bone in rack (pairs)	**3200**	1.0	5.3
	Rack flap (pairs)	3200	inc in B	inc in B
Cap off	Cap off rack (pairs)	300	0.2	7.5
	Tipped cap off rack (pairs)	500	0.6	7.5
	Full French rack (pairs)	500	1.7	7.5

		Loading	
	Band-saw	(Hours)	
	1	*7.50*	
	2	*7.28*	
	3	*6.53*	
Stations		**Stations**	Total stations
not used		Needed	Available
15	**Line 1**	9	24
5	**Line 2**	18	23
17	**Line 3**	2	19
must be positive			
36	Total station	30	66

Figure 6.8: Template for simulation using the Excel model defined by the project.

The assessment for typical volumes for a typical production day at Frewstal, where the inputs have been entered and the results as in Figure 6.8 (right) suggest that the layout provides for far greater number of stations than needed and the loading on band-saws is balanced. The inputs in red are to the left of the sheet (Figure 6.8) and the results on the right. The results show the band-saw loading for 3 stations and the number of station occupied and also the spare stations, which may be used if necessary for higher specification products requiring further trimming. This is important as the Excel model may be modified in the Data section to allow for addition of steps in production with corresponding timing, which then automatically update the results to reflect any issues or constraints.

6.8 Concluding remarks

The future competitiveness of a meat company relies on its ability to maintain a commitment to achieving the highest performance and profitability. Operational performance is a large contributor to the business of a meat processor. The desire to achieve the highest performance can be validated only by information that proves this is being achieved. The uncertainty is that no one really knows, unless there are systems, for processing by automation and computer monitoring or reporting, in place. Indeed, such systems need to go beyond reporting, but achieving the highest possible performance using human and machine resource; self-optimising the process of production using the complement of data on carcasses, skills and customer behaviour. This report has highlighted the key aspects and considerations that can lead to a system of production based on concepts of IBS (intelligent butchery station), eCR (electronic cutting room) and pCR (performance cutting room). Automation technology in development will have a big part to play. The path to reaching the pCR of the future requires persistence, focus and drive, delivering the vision with a committed management team. Understanding change management and actually delivering the future by the management of change is fundamental in the process of advancement towards the plants of the future. It is important to use the best available technology as possible within the investment constraints. It is necessary to be pursuing R&D that supports innovations in production. The work of this project, based on the considerations at Frewstal, present many of the approaches that need attention in the path to creating new and modern cutting rooms of future.

The specifics of this project at Frewstal has evaluated the cutting operation for production of lamb, concentrating on the definition of a layout that may be used for best use of space allowing expansion of operation for higher throughput and wider range of products.

The report has presented the approaches and methodologies as well as systematic assessments towards the next steps for a meat cutting room. The validation of the layout for Frewstal by simulation using an Excel model has been reached. The new validated layout allows for the possibilities of including further automation currently ready for adoption or in development. Detailed overview assessment of the equipment or technologies is to be a future steps with the focus on case ready packaging.

The design solution for the layout proposed by this project for Frewstal commenced production in October 2013. It is intended that future projects provide for automation options presented in this report.

7. Web summary

The Australian Lamb industry needs to continue on the path to improve its operating capability by structuring its processing rooms using newly developed equipment, rationalising the use of space and making better use of human resource. The use of new handling equipment and robotics or automated technologies, especially in the primary cutting is of considerable interest. Space constraints and the cost of technology continue to limit the expansion of capability and indeed capacity opportunities. BMC (Koorosh Khodabandehloo), Frewstal PTY Ltd with support of Australian Meat Processors Corporation (AMPC) and the Meat and Livestock Australia (MLA) have evaluated such aspects in this project. The evaluation has been focused on improvements in capability and capacity, also assessing the scope for implementing more effective break up and cutting processes, boning and trimming, as well as packing operation. Emphasis of the evaluation has been on minimum handling and optimised yield control in a safe working environment.

The project has addressed the needs of Frewstal in respect of improvements in lamb cutting and requirement for a new layout giving efficient use of space, equipment and better flow, with future opportunity to introduce yield control and new automation. Much of what is considered establishes approaches for the Australian Lamb industry and more broadly the meet industry, which needs to continue on the path to improve its operating capability. Space constraints and the cost of technology continue to limit the expansion of capability and indeed capacity opportunities. Evaluations of such aspects at Frewstal have been an important part of the business of the company in Stawell Victoria and the findings have relevance to lamb processes with intent to improve cutting.

Aspects considered include:

- Improved quality and reduction of use of band-saws
- Room layout for increased throughput and reduced double handling
- Better flow and control with improved waste handling
- Automation and consideration of ROI in respect of new investment
- Yield monitoring and control
- Grade based planning for improved mapping of stock against customer order
- Evaluation of cut process timing using an Excel model to determine by simulation the manning levels needed for execution of a given order over a production shift.

The project has produced the following results:

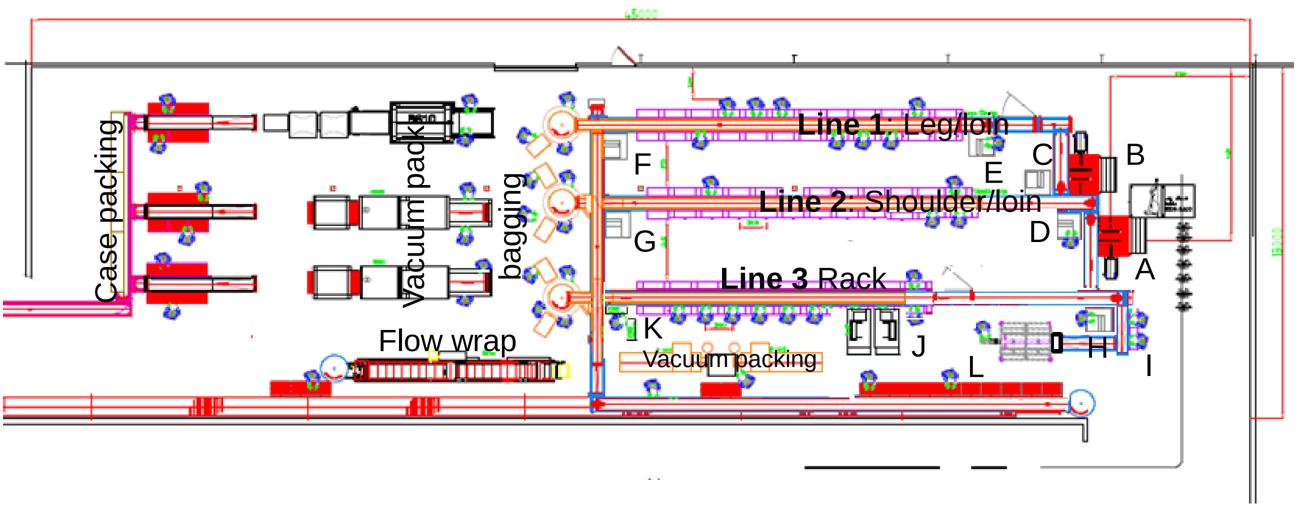
- A mapping of requirements against processing capabilities expected
- An ‘ideal layout’ for Frewstal with a corresponding evaluation model using Excel for simulation.

- A validated approach for the consideration of future cutting rooms with better layout and flow.

The project has provided a structured methodology for evaluation of boning room operation mapping important priorities to requirements. Focus has been on the changes of layout utilising human resource as well as appropriate technology within existing space to improve operational drivers relating to safety and efficacy.

The excel model from the project may be used and refined by production team at Frewstal as a planning and estimating tool.

The system in the Figure below was installed at Frewstal and commenced production in October 2013 using much of the evaluation results and work from this project with the new layout defined by the project and equipment from ATTEC



Layout operating at Frewstal in October 2013

8. Web key words

Lamb cutting, boning room layout, cutting room modelling, operation simulation, automation feasibility