final report

Project Code: P.PSH.0482

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Date published: April 2008

PUBLISHED BY
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Pre-rigor stretching using Boa Technology

This is an MLA Donor Company funded project.

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

Table of Contents

1. Executive Summary – a situation analysis

The Boa Technology aims to deliver a process intervention for i) abattoir pre-rigor manipulation, and ii) a meat process for portioning and shaping. The benefit of this technology is enhanced profitability by i) value-added/portion controlled cold-boned cuts, ii) processing efficiencies, accelerated tenderness, and/or the ability to bind hot-boned primal and sub-primals.

This business opportunity brief has been prepared for potential technology providers (The Commercialiser) of the Boa Technology.

It is intended that the Commercialiser will sign an exclusive licensing agreement to commercialise the Boa technology in Australia and New Zealand. It is expected that further work is required to bring this technology to a commercial reality. However, a potential in-plant prototype design has been proposed based on the current prototype (See section on Boa technology description and background) a patent has also been lodged.

The business opportunity outlined in this brief has been compiled with the assistance of Meat & Livestock Australia (MLA) and Meat & Wool New Zealand (MWNZ). The purpose of this business case is to identify a suitable partner to commercialise this technology in Australia and New Zealand.

1.1 Business Opportunity Description

Stretching primals prior to rigor is a well known means of decreasing the amount of contraction by sarcomeres; therefore, an improved eating quality is possible. Past work has demonstrated significant improvements in tenderness during the early stages of maturation, reducing the variability between animals and generating a 2-3kgf improvement, evident in the early post-rigor period. There is historical evidence that the stretching process also results in reductions in purge loss and improvements in colour stability. In addition to the marked meat quality improvements, stretching and reforming the product into a consistent log shape provides obvious portion control opportunities, such as moulding primal or individual muscles into consistent log-shaped products. Other benefits that have been identified include upgrading lower value cuts by virtue of both improved meat quality and improved shape.

MLA and M&WNZ have been funding research into technologies to stretch meat for some time now. Most recently, a prototype machine has been developed and trialled both on cold- and hot-boned beef applications over the past 12 months with encouraging results and positive processor feedback from initial pilot trials. This is referred to as Boa technology, based on the way it stretches and massages the meat along the length of its fibres.

The design of the Boa is based on air being forced into an outer sleeve of stretching cylinders with the meat cut encased in flexible food-grade based silicon. As air is forced in, the inner sleeve decreases in diameter and increases in length, thereby stretching the meat within. Once the dimensions of the meat have reached the desired level, the active sleeve is squeezed together at one end, expelling the meat cut upwards into the packaging sleeve. The Boa is a compact unit that could be easily applied in most boning rooms. It is totally encased in a stainless steel cabinet and can be readily cleaned as part of the standard clean-down procedure.

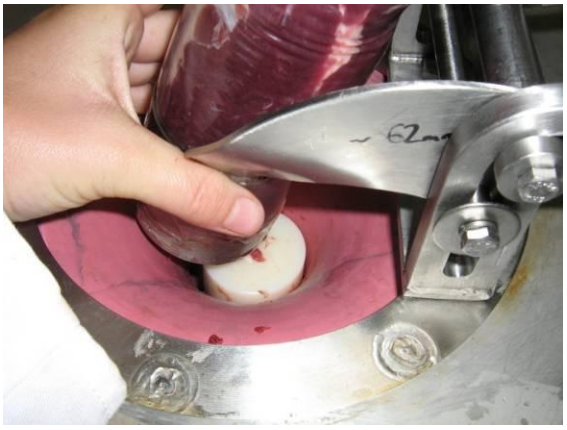
There are two alpha-prototype machines available one in Australia and one in New Zealand. They are currently being used for a scheduled series of cold- and hot-boned beef and sheep meat trials. The results to date from preliminary commercial trials demonstrate that the Boa Technology provides an efficient and effective means of stretching and shaping the product ready for filling into a film. The technology concept of stretching and shaping has been proven in commercial applications and is now ready to be commercialised in the market place.

The basic steps in the Boa Technology operation are:

1. Trim the muscle or muscles

2. Load into the Boa (from the top) and stretch

3. Using peristaltic action and the pneumatic ram, fill into the packaging



4. Remove and clip/seal packaging

5. Chill and store

6. Remove packaging and portion slice

The Boa is able to stretch meat up to 40% (hot boned) and under certain conditions may bind pieces of meat together without the use of meat binders. Benefits to existing cold- and hot-boned meat plants are proposed using Boa technology.

Hot-boned meat advantages:

- Increased tenderness,
- Increased water holding capacity,
- Increased colour stability, and
- Overall up graded low value cuts through improved meat quality.

Cold boned meat advantages:

- Reformed Meat - Up graded low value cuts through binding frozen muscles together,
- Reshaped Meat - Producing a uniform-sized primal with one muscle, resulting in a consistent cooking time and consistent weights.
- Immediate target is a retail ‘roast beef’ similar to the roast chicken.

Meat processing advantages:

- Increased yield with potential labour (up to 25%) and power (up to 20%) savings if applied to hot-boning applications,
- Increased profit from decreased aging required,
- Increased profit from increasing the value of low value cuts, and

- Increased demand due to new products.

1.2 Market Size

The market segments for BOA technology are Australian and New Zealand meat processing plants, both hot- and cold-boned meat. Processing plants that adopt the BOA technology will be able to develop new meat product offerings to a range of resellers and users such as:

- Supermarkets (upgraded meat cut, uniform size and thin sliced product), as well as 'roast beef' rotisserie product that can be purchased and is ready to carve;
- Institutional organisations (anticipated as the first market to take up new products due to uniform shape);
- Middle range restaurants (upgraded meat cut, uniform size);
- Food service trade (upgraded meat cut, uniform size and thin sliced product for fast cooking);
- Average quality butcher (upgraded meat cut, uniform size and thin sliced product); and
- Fast food chains may promote a 'healthy' range of products from reformed or reshaped meat over a hamburger with mince.

It is expected domestically, opportunity exists to market the Boa technology to niche small operators, and medium and large secondary hot- and cold-boned processors of red meat both in Australia and New Zealand. As part of an agreement with MLA and M&WNZ, the Commercialiser would agree to meet the immediate industry need for the Boa technology as a priority, then after a medium to long exclusivity period, be in a position to expand commercialisation into overseas markets such as the United States.

1.3 Intellectual Property

A provisional patent has been filed for a "Meat stretching device and method" in the United States: Patent Application 60/910,018. A full specification will be submitted in April 2008.

Background knowledge has been developed through several years of R&D involvement by MLA and M&WNZ. There is no similar equipment in existence at this time.

The IP is available for licensing and/or sale based on the expressions of interest proposals received.

1.4 Competition

Hand wrapping using standard "Bazooka" filling equipment has been done on cold based product for many years, but this process is non-viable commercially for large volume production. Commercial applications for hand wrapping of primals exists only for premium valued products where the high labour costs and time required to complete the process, makes it still profitable. Often several layers of film are required to provide the necessary tension on the product, and this causes colour problems and inconsistent & uneven stretching of product due to varying degrees of manual pressure being applied right across the primal. The film is later removed and the muscle is often re-packaged again for sale, making the cost of packaging and double-handling quite expensive.

Experience has shown that when the meat is forced along a tube either by compressed air, vacuum or pneumatically driven rams, the muscle is not given time to elongate and re-align and hence widespread tearing between bundles can occur. Often meat folds over on itself making it difficult to control fibre direction. With normal variation in muscle cuts, current commercial stuffers are not able to apply pushing pressure or the stretch, which is achievable with the Boa. The Boa provides unique

stretching with fibre alignment across the entire cut and provides the distinct advantage of control over stretching and shaping.

To our knowledge, there are no known commercial technologies that can deliver the same level of control for stretching and shaping evenly across the primal. However, there are two other commercial technologies that are targeting similar principles and a third based upon a meat strip alignment process, all of which aim to improve tenderness and eating quality. Currently available systems are not widely used in Australia. The reasons are not fully known.

1) Whole Muscle Stuffer

The Hamax 800 was developed for stuffing larger muscles (such as loins) directly into artificial casings. The Hamax offers a fast and efficient operating procedure, which until now has been very labour intense and time consuming. It becomes even more efficient when working with pre-shirred casing and combined with a double clipping system, to eliminate pre-clipped individual casings.

Hamax 800 - A commercial meat stuffer by Wolf-tec (Source: http://www.wolf-tec.com/268.0.html)

The basic method for operation is the whole muscle is loaded into the pressing chamber. The chamber “mould” is fitted to products allowing them to be compressed and formed in shape. It is then stuffed through the horn assembly and pushed into the casings. If connected to a double clipper, a position sensor signals that the proper length has been met before clipping the product and retracting the hydraulic piston for the next cycle. If fitted with the optional “cut-off” knife, whole muscle product can still maintain exact length requirements.

The advantages as outlined by the manufacturer (Wolf-tec) include:

- Fast and efficient operation
- Capacity up to 2,600 lbs/hr.
- Only one person needed to operate
- Caliber precise filling with perfectly defined length
- Pre-forming
- Direct connection to an automatic double clipper
- Reductions of product loss up to 50%
- Reductions in casing loss up to 30%

The disadvantages of the Hamax 800 is that it is manually hand loaded and ideally only suited to larger muscles (such as loins) that are stuffed directly into a one-size fits all artificial casing. These bigger cuts have a tendency to tear, while smaller cuts are at risk of folding over.

In comparison to the Boa technology, Hamax 800 is used on post-rigor meat, therefore, there is the potential for significant shape deterioration (dependent on the storage time) once the product is unpacked, subsequent cutting and also during cooking.

2) Pi-Vac system

The Pi-Vac packaging system, also known as elasto-pack, exerts pressure on all surfaces of the meat throughout its entire shelf life. The agent in Australia was Lesnies
http://www.bunzl.com.au/Lesnies/Home.htm

Briefly, a permanently elastic gas barrier film is expanded in the packaging machine to allow the packing of fresh meat, with attractive presentation. In contrast to conventional vacuum packaging systems, with the Pi-Vac packaging system it is no longer necessary, to evacuate air out of the package.

The disadvantage of this system is that the pressure is not applied evenly and the packaging rounds off each end (i.e. pillow packs), resulting in inconsistent and uncontrolled stretching across the primal. Consequently, there is uneven portion control during slicing.

Teagasc, in Ireland, was assisting in the development of the Pi-Vac system as a “novel hot-boning and chilling procedure for the processing of beef cuts”. The cited potential benefits to the industry, included increased meat yield, reduced energy costs resulting from less chiller space and a saving of refrigeration input, quicker throughput of meat in the packaging plant and a reduction in transport costs and labour.

In this system, the carcass is hot-boned and the hot meat is tightly packaged in elasticated film using a “PI-VAC” machine. Teagasc claimed the new system overcame two major disadvantages associated with hot-boning: the toughening which is caused by muscle contraction during chilling of hot-boned meat, and shape distortion of the hot-cut meat. PI-VAC operates by stretching tubes of elastic film to the inside wall of the packaging chamber. The hot muscle is inserted into the chamber, pressure is released and the film returns to its original dimensions. The meat forms into the shape of its constraining pack and the muscle shape is not distorted. The restraining force of the film hinders muscle contraction and thereby prevents toughening. Using this new system hot-boned meat packed in PI-VAC can be chilled quickly producing beef of consistent tender eating quality. Using this system variability of tenderness will be reduced as individual muscles can be treated optimally.

3) Meat strip alignment technology

This is a novel and new technology currently in final stages of development and is awaiting initial commercial evaluation. Products produced using Meat Strip Alignment technology (MSAT) depend on brining with salt and phosphate and cooking for binding. The end product requires ingredient declaration in certain markets and takes on the shape of the casing that the product is cooked in.

The benefits of Boa product over MSAT are numerous. Firstly, accelerated tenderization and binding is achieved if hot boned raw materials are used, without the need for binding or tenderizing ingredients. Secondly, there are multiple applications for end products either cooked from fresh, or frozen.

1.5 Adoption Barriers

Relative to the rest of the food processing industry, the red meat processing sector has generally been slow to take advantage of commercial opportunities offered by modern packaging technologies. Despite the development of a highly successful vacuum pack export trade, which is arguably the single most significant example of new technology by the industry, with the notable exception of the HRI (Hospitality, Restaurant, Institution) trade there has only been limited adoption of latest packing technologies at the retail level. The most valid reason for this slow rate of adoption is the conflicting commercial interests along the domestic meat supply chain. The five key actors in this story are the domestic service abattoirs, the independent wholesalers, HRI trade, supermarkets and chain stores, and butcher shops.

The service abattoirs produce carcase meat for wholesalers, supermarkets and butchers. These entities generally specialise in production of carcase meat and rendering of inedible materials. The typical wholesaler buys livestock, has them killed at a service works and then delivers these bodies, sides or primals to the HRI trade, retail butcher or supermarket trade. The HRI trade tends to experience peak demand periods for labour, therefore provision of meat in a form that is ready-to-use is the preferred form.

The HRI trade was the first segment of the domestic market to embrace vacuum packing technology, and we believe that they will readily adopt the Boa technology also.

However, the limitations of this technology that may result in an initially slow up-take in some markets include:

- Premium cuts markets with established high demand in retail and butchery.
- High end food markets would refrain from using anything that could be perceived as a reconstituted product; though Boa certainly is not reconstituted;
- Low-end food service trade will continue to purchase traditional primals
- Some customers may not recognise muscle shape

1.6 Proposed Path to Market

The pre-production prototype has a small foot print (size is similar to a stand-alone vacuum packaging machine) that would be compatible with any cold- or hot-boned process without any modifications to existing processes. Up to two operators would be required to conduct pilot testing (a single operator can work in a product development capacity if required). The proposed design of the commercial prototype is outlined further in this business opportunity brief.

An innovative hand wrapping technique to produce similar samples could well see this process piloted in plants prior to arrival of the new machine which will enable plants to cost effectively access the commercial potential of this new process.

The long term goals:

- Maximum benefits and impacts are expected if the industry was to make a full transition to hot-boning. Accelerated tenderness of hot-boned primals and sub-primals would be possible by totally replacing vacuum packaging with Boa for fresh chilled markets.
- New premium frozen products would also be possible by stretching hot-boned meat with controlled aged-in-the-bag prior to freezing (estimated 5-7 days only).
- Assuming the modern industrial process for meat in the future requires precise control and intervention, primal and sub-primal may be an important strategy for many domestic and export controlled operations.

- Ongoing new products would be engineered to meet new consumer needs. Value enhancement, processing efficiencies, and labour and energy savings are expected by integrating Boa into hot-boning operations in the future.
- Funding strategies are to be developed between Commercialiser and MLA/MWNZ to progress the implementation of the technology.
- Strategies to commercialise the Boa will be developed with industry and commercial partners.
- Incorporate accelerated tenderness of primals in MSA (Meat Standards Australia) model.

2. BOA Technology Description and background

2.1 Vision

The immediate opportunity to be captured by the implementation of the Boa technology will be for innovative value-adders to produce new shaped and portioned cold-boned product. There has been a lot of interest from Australian beef and sheep meat companies prepared to trial the prototype technology with the view to testing markets straight away. Enhanced awareness and increased applications into cold- and hot-bone products will see the technology base broaden widely throughout low- to high-volume abattoirs and value adders.

2.2 The Boa Technology concept

Stretching primals prior to rigor is a well known means of decreasing the amount of contraction by sarcomeres; therefore improving eating quality. There is a wealth of research confirming this; however, little has been done in Australia to develop technology that can capitalize on this effect due to the limited amount of hot carcass boning plants.

MLA in collaboration with Meat & Wool New Zealand are coordinating further research on this and developing prototype equipment to automate the process. The research to-date has demonstrated immediate market appeal in the HRI (Hospitality, Restaurant, and Institution) businesses, as the technology process produces perfectly formed logs of whole muscle meat primal. The potential to service rotisserie roast beef markets with tight weight tolerance single muscle primals is now closer than ever to becoming a feasible practice that could see elements of this technology spill over into traditional cold boning plants.

Research is being initiated into trialing the removal of the m. gluteo bicep muscle, and the m. *tensor fascia latea* from the kill floor and processing using the Boa technology. The potential of a fully portion controlled mini roast products from these undervalued muscle's could revolutionize the hot deli roast meat market segment with the added benefit of carcasses going into chillers 7% lighter around the leg area which will assist the whole chilling process.

2.2.1 Current Design Status of Boa

Effective procedures for packaging meat stretched in the Boa have undergone an evolution in concept with design and operational changes to the Boa itself. Critical to defining a commercial packaging system is identifying the best procedure for loading the Boa then removing the stretched meat from the Boa before transferring the product to the packaging system. The requirement is that this transfer from the Boa to the packaging be simple, reliable, require minimum time and be flexible enough to allow a range of product diameters to be accommodated.

The procedure for extracting the stretched meat from the Boa has undergone a number of changes. The first approach was based on a 'flow through' design, where the meat was introduced into the Boa from above, stretched in the elastic sleeve and removed into the packaging from below the sleeve. The main difficulty with this design was accommodating different product lengths.

The process was then modified so that the meat was introduced and removed from above the Boa. After stretching the product and reducing its diameter, a metal tube was inserted into the Boa to fully envelop the stretched product and extract it after it was confined in the stretched state, within the tube. The product could then be pressed out of the tube directly into a packaging system. Different product diameters could be accommodated by using different diameter tubes.

This approach worked effectively and remains a viable option for the Boa operation under some circumstances. However, it had two limitations: first, multiple steps were required, which slowed the process down and added to its complexity. Second, there was some concern that the introduction of a metal tube into the elastic sleeve of the Boa may contribute to sleeve damage and reduce its lifespan.

During trials with this system, it became evident that it was not always necessary to lower the metal tube fully into the Boa in order to recover the product. If the product did not fully extend to the bottom of the elastic sleeve, the external gas pressure used to compress and stretch the meat also collapsed the sleeve compartment below the meat and this generated an upward force that could expel the meat from the Boa. This peristaltic type action was able, under the right circumstances, to fully transfer the stretched product into the collection tube with only minimal insertion of the tube into the Boa.

Exploiting the peristaltic effect seemed to offer a significant advantage to packaging the stretched meat. Because it is no longer necessary to insert a collection system into the Boa to recover the meat, it becomes possible to transfer the stretched meat directly from the Boa into the packaging system, given an appropriate mechanism to hold the packaging in place. This approach simplifies and speeds the process of packaging the stretched meat.

To accomplish this, a frame was constructed to hold the packaging at the mouth of the Boa (Figure 1). The first design for this was trialed during the M&WNZ / MLA visit in April 2007 but proved to be insufficiently robust. The design of the frame was improved and made more robust and this new system was trialed. While these trials were largely successful, it became clear that two aspects of the process require further consideration:

1. The initiation of the peristalsis/ejection process needs to be controlled. In the initial configuration, the peristalsis began as soon as the sleeve below the product collapsed under the applied gas pressure. In circumstances where the pressure required to collapse the sleeve was also sufficient to reduce the diameter of the product to fit within the packaging, the process worked very effectively. However, for larger samples that needed high pressures to ensure the necessary reduction in diameter, the peristalsis began to eject the product before the necessary squeeze had occurred and the product would not enter successfully into the packaging. Hence, a mechanism to initiate the peristalsis only when the appropriate product diameter (and therefore stretch) had been achieved was required. The photograph left shows the packaging sleeve within the lip of the Boa and meat being expelled by the peristaltic action
2. The peristaltic action becomes weakest when most of the product has been ejected into the packaging and only the tail end of product remains at the interface of the Boa and the packaging. In most cases, the residual product could be pulled through manually to complete the packaging, but a backup mechanism is needed to ensure that product does not get jammed at this point.

Figure 1. Boa with the packaging sleeve attached from above.

Process description

As a solution to these issues, an additional pneumatic ram is mounted below the boa, which extends into the product compartment of the sleeve (Figure 2). When product is stretched, the ram is passively pushed downward by the product but remains in contact with it: as a result, the necessary void in the product compartment below the product cannot form and the peristalsis cannot begin. To initiate peristalsis, the ram is simply pulled downward to produce the required void below the product, the sleeve collapses and the product is pushed upward into the packaging.

The ram can also act as a backup for product that fails to transfer fully into the packaging by extending it upwards to push the product into the package. Our expectation at this stage is that the design of the package holder and fine tuning of the Boa operation will reduce this use of the ram to a very occasional incidence. This latest modification will now be trialed extensively

Figure 2. Pneumatic ram has been inserted from below the boa, which extends into the product compartment of the sleeve

2.2.2 Proposed In-plant Prototype

The design of the commercial packaging system is shown in Figure 3. This system still incorporates components from the earlier concepts based on using a ram that descends into the Boa from above. The ram was used to attach the packaging frame, but we do not believe this is the optimum design for commercial operations.

Therefore, the current proposal is to anchor the package holder to the top surface of the Boa. The holder is little more than a collar which holds the opening of the packaging tube. The collar is mounted so as to hinge from the horizontal position –the position to accept the product from the Boa - to a vertical position, which allows the packaging to be mounted onto the collar.

Operationally, the collar is hinged out of the way to allow the meat to be inserted into the Boa, then hinged down to accept the stretched meat from the Boa. Once the meat is removed, the collar is hinged back to allow another length of packaging to be mounted, and the process is repeated.

A number of different size collars, with associated tubular packaging systems, will constitute the final commercial configuration for packaging the meat following stretching.

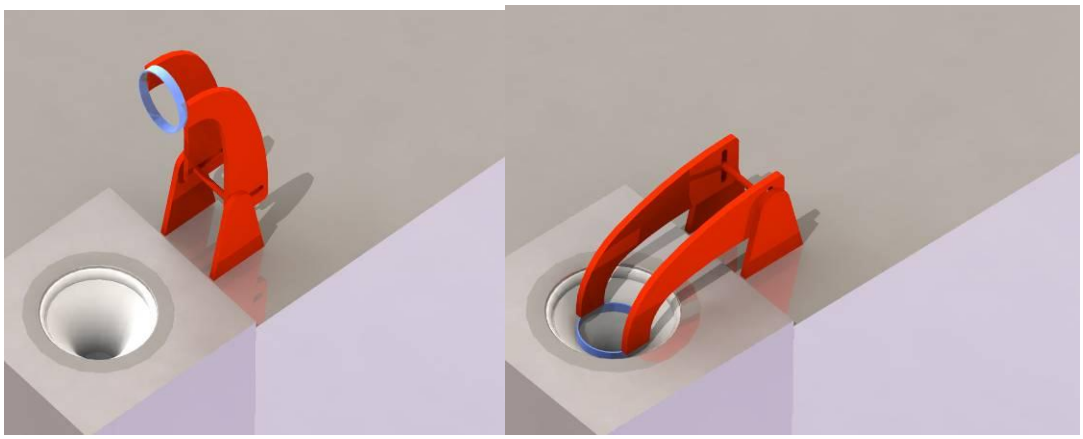


Figure 3: Drawings of the proposed package holder in the up and then inserted position.

3. The Business Model for the Potential Commercialiser

The Boa Technology has reached a point in its development where preliminary market feedback has been obtained, and indications are that the process and the technology are viable. However, in-plant trials in both hot and cold boning plants need to be conducted in-order to develop the technology to the next stage. Pre-production prototypes will be built and commissioned with input from a Commercialiser. Concurrently, market assessment in retail/food service will occur, through meat plants in both Australia and in New Zealand, trialing using a hand-filled prototype.

The HRI (Hospitality, Restaurant, and Institution) trade was the first segment of the domestic market to embrace vacuum packing technology, and may be significant players in the technology push, market pull for retail ready, portioned meat products.

Companies can create and capture value from their new technologies in three basic ways: through incorporating the technology in their current businesses, through licensing the technology to other firms or through launching new ventures that exploit the technology in new markets.

The functions of a business model are as follows:

1. Articulate the value proposition (the value created for users by the offering based on the technology)
2. Identify market segments. Users to whom the technology is useful and the purpose for which it will be used.
3. Define the structure of the company's value chain which is required to create and distribute the offering and determine the assets needed to support the firm's position in this chain.
4. Specify the revenue generation mechanism for the company
5. Describe the position of the company within the value network, linking suppliers and customers
6. Formulate the competitive strategy by which the company will gain and hold over rivals.
7. Assess capability required to achieve commercialisation.

With the BOA Opportunity there are a number of different perspectives for considering an appropriate business model. A meat processor will have a different business model to the technology Commercialiser due to their different positions in the value chain. This Business Opportunity Report only describes one business model. This business model is focused on Meat Processors because that is where the BOA will be sold and that is to whom the technology is useful and will generate an income.

The focus of this business opportunity is currently on beef meat; however, there is little difference in the business models between beef and sheep meat, it mainly differs in the value being captured.

3.1 The Value Proposition

Stretching primals prior to rigor is a well known means of decreasing the amount of contraction of sarcomeres. This has the effect of improving eating quality. Also, there is evidence that the stretching process results in reductions in purge loss and improvements in colour stability. In addition to the marked meat quality improvements, stretching and reforming the product into a consistent log shape provides obvious portion control opportunities, such as moulding primals or individual muscles into consistent log-shaped products. Other benefits that have been identified include upgrading lower

value cuts by virtue of both improved meat quality and improved shape – all leading to greater financial returns.

To capture this market value meat processors can sell retail-ready product direct to butchers and large retail chains without additional preparation and handling required (therefore, reducing labour costs and gaining greater control over food safety risks within the retail supply chain).

1. *Portioning and shaping*

Immediate opportunities exist for improving the value of cold-boned product by shaping and portion controlling for existing domestic & international markets. Almost all portioning is done manually, which is costly and time consuming. This is likely to be only viable for premium quality product where the market is able to carry high labour costs. A less costly process would enable lower-value cuts to be viably upgraded. Portioning provides opportunities for new products. For example, a premium retail rotisserie roast beef or lamb product with similar cooking protocols to the roast chicken depends on a consistent size to ensure consistent cooking times. Similarly, value added meats for the aged care market which often contain mixture of muscles often fail fully cooked specifications.

2. *Improved eating quality and tenderness.*

Mixed fibre direction and connective tissue contribute to toughness and bad eating experiences. Sub-primal muscle market provides the advantages of better definition of eating quality. Often when the subprimals are awkward shapes, unacceptable high yield losses are experienced, making them often non-viable.

3. *Reforming*

Poor plate appeal of premium cuts that have small product diameters (eg. lamb backstraps) can be value enhanced by reforming two or three primals to create a premium sized product. This has been of interest for Fletchers established export markets for some time now.

The Boa technology facilitates the binding of 2 or more hot-boned meat pieces, under pressure in the package. More technical work is required to determine optimal binding characteristics of hot-boned meat suitable for Boa processing.

4. *Processing efficiencies*

Hot-boning offers significant production efficiencies over cold-bone processing, specifically for yield benefits (< 1% hcwt compared to ≈2.5% hcwt for a chilled carcase) savings in energy (≈20%) and labour (≈25%) costs. Further efficiencies are expected for Boa when you consider up to 7 days of extra chiller ageing is required to achieve acceptable tenderness for normal warm-boned vacuum packaged product. This benefit applies to premium fresh-chilled and aged-frozen products. Chiller savings are also expected where tenderness of stretched hot-boned product is accelerated for domestic trade (ie. can save several days of chilling) for supermarket trade.

5. *Quality enhancement*

Preliminary results with earlier stretching prototypes have shown that it reduces drip losses and cooking losses with no adverse effects on shelf-life or display-life.

6. *Accelerated tenderness*

Hot boning is generally considered controversial in the industry due mainly to historical experiences; however, hot boning has significant benefits if a number of key disadvantages can be overcome.

7. *Enhanced chilling of leg cuts*

Selective harvesting of hot-boned surface leg cuts, like outside flat and tri-tip, allows enhanced cooling of deep cuts which would otherwise heat toughen and become pale and weepy.

3.2 Value Proposition for Hot Boning Processors

Initial trials using the Boa Technology demonstrated marked tenderness improvements at early post-rigor time points ie. 48 or 72 hours after kill. At this time, depending upon the cut, stretching tended to result in a 1 to 3 kgf improvement (when measured by Tenderometer). With longer periods of ageing, the advantage offered by stretching became less marked, and generally after a week (depending upon the processing prior to stretching), the effects did not differ from unstretched counterparts. Other meat quality evaluations such as purge loss and colour stability are improved by pre-rigor stretching although these effects are not always significantly different from unstretched controls (between different trials and different cuts). (Dr Nicola Simmons, Carne Technologies, personal communication).

Therefore, the commercial meat quality advantages of using this technology are most suited to product that is destined to be frozen within 1 or 2 days of slaughter, or product that is to be sold in the domestic market and will be consumed within 1 week. The meat quality of longer term chilled product i.e. 14 days plus will not benefit from pre-rigor stretching.

Feedback to-date from NZ processors is that they would like to use the stretching technology to generate a portion controlled product that could be frozen within 2 or 3 days of slaughter. Once frozen, they would then slice the rolls into portion controlled steaks and sell in a free-flow pack. In addition to the tenderness advantages, there is significant economical cost to some processors, in energy savings. This is targeted towards negating the need to have a re-freezing step after ageing, in order to get a cylindrical, portion control product,

Portion control of NZ cold-boned product is taking place in overseas markets e.g Taiwan, at a significant cost. The Boa allows meat processors to undertake the value-adding in New Zealand prior to export and enhance their cost margins.

3.3 Market Segments

The market segments for BOA technology are Australian and New Zealand meat processing plants, hot and cold boned meat. Processing plants that adopt the BOA technology will be able to develop new meat product offerings to a range of resellers and users:

- Institutional organisations (anticipated as the first market to take up new products due to uniform shape)
- Supermarkets (upgraded meat cut, uniform size and thin sliced product)
- Middle range restaurants (upgraded meat cut, uniform size)
- Food service trade (upgraded meat cut, uniform size and thin sliced product for fast cooking)
- Average quality butcher (upgraded meat cut, uniform size and thin sliced product)
- Fast food chains may promote a ‘healthy’ range of products from reformed or reshaped meat over a hamburger with mince

(i) I**mmediate opportunity** in both Australia and in New Zealand is in portion control. The Boa produced product would be frozen within 2-3 days of slaughter, then slice the rolls into portion controlled steaks and sell in a free-flow pack.

The market will continue to purchase the same product but would choose to look for Boa extruded products based on the innovation of shape according to the market. Boa meat is not considered reconstituted. It is understood that after cooking the meat shape will not stay in the exact original shape and will spread giving it a natural look and not similar to comminuted logs. The desired

outcome of using this technology is to increase total consumption of beef and sheep meat not steal market share from other categories, such as the highly valued minced meat markets.

Preliminary market review shows immediate opportunities for cold-boned product by providing significant benefits in process efficiencies for shaping & portioning, improved yields for sliced & diced products and improved profitability through significant reductions in product returns for those products not meeting specifications and market expectations. These shaped & portioned products will be taken up into well–established food-service market segments.

There is uncertainty about customer perceptions of shaped product, primarily for retail trade. There is increasing demand for portion controlling by the various food service market segments. While red meat still retails by cut, you can expect consumer resistance to a more uniform shape. But as some retail markets move towards selling meat by cooking method, you may expect shaping to become highly demanded.

Any product opportunities identified for domestic retail and food service markets and the export trade will need to be evaluated through pre-production prototype trial.

New market opportunities have been identified including:

Domestic Supermarket – Flavoured & non-flavoured beef and/or lamb rotisserie product consistent roasting portions requiring cooking protocols similar to roast chook (Personal communications David Carew);

Retail or foodservice – microwave beef product with consistent shape of selected sub-primals;

Aged care – value-added whole-tissue beef and lamb meeting fully cooked specification from lower value meats;

Premium foodservice – Tri-tip est. 95% VL is customarily removed as lower grade material from export carcasses. Reformed tri-tips (head to tail) to produce foodservice logs of 95% VL and high quality whole tissue meat with applications as premium steaks or roasts.

Clubs / pubs (local) – Representing 7% of carcase hcwt, outside flat (Gluteo biceps) is an immediate market opportunity as an everyday steak by cutting the primal into 3 portions to separate multiple fibre directions.

Export (China & Hong Kong) – Existing hot pots market for mutton flaps that is vacuum packaged and sent chilled to China. Chinese later value add using a specialised spring-load device used for shaping, sliced thinly, frozen and packaged ready for the Hong Kong market.

Export (Japan) – highly specialised diced meat produces 60%-65% in specification with 30% fines. The shape drives ability to meet this specification using selective muscles and squaring off in a square log template. Again Gluteo biceps representing around 7% of hcwt would be an ideal muscle selection for this market.

(ii) **Medium to long term opportunity**. The medium to longer term opportunity for Boa is to expand commercialisation into overseas markets such as the United States.

3.4 The Value Chain for the Commercialiser

The value chain is all the steps in the chain from the product to the consumer that can add value to the offering. Therefore, the value chain for the Commercialiser of the BOA technology is:

- Manufacturing capability for the construction of the BOA Meat Stretching Unit. That is, the Commercialiser may not have the capacity and capability to manufacture the equipment. In this situation, the Commercialiser may choose to outsource to an Engineering firm for the design and manufacture of the commercial prototypes.

- Packaging company. That is, the packaging may add value to the offering as it could extend the shelf life and it may improve the quality attributes (less weep in the pack) and presentation attributes (ie. Colour, print, shape, size of packaging).
- Sales and services. This would be ideally with-in the Commercialisers capability.

The Commercialiser of the BOA technology will develop a value network with equipment manufacturers and packaging companies to leverage the advantages of the partnership between these network participants For example the equipment manufacturer and the packaging company can make changes to the equipment design or the packaging to simplify the process and reduce the cost of the equipment.

3.5 Cost Structure and Margins

Initial trials on the commercial automated prototype used for stretching and tenderising hot-boned meat have been completed and have demonstrated both meat quality benefits and significant plant savings (related to a reduction in carcase shrink loss of better than 2%).

Hot-boning offers significant production efficiencies over cold-bone processing, specifically for yield benefits (< 1% hcwt compared to ≈2.5% hcwt for carcase chilled) and savings in energy (≈20%) and labour (≈25%) costs.

Being able to meet the premium markets for hot-boned product depends on some controlled ageing of vacuum packaged primals (approximately 7 days) before freezing and exporting. For these quality markets, Boa offers immediate additional benefits through further production efficiencies, improved energy savings through reduction in chilling time by several days in readiness for premium fresh chilled markets.

Even greater benefits and impacts are expected if the industry was to switch to partial hot-boning. Accelerated tenderness of hot-boned primals and sub-primals would be possible by replacing some vacuum packaging with Boa primarily for fresh chilled markets. A preliminary analysis of the benefit of Boa technology to the Australian beef industry for one cut only (ie. outside flat that was identified from preliminary market analyses as an immediate domestic and export food service opportunities) is approximately $6,000,000. Considering the benefit initial is only calculated on the value enhancement proposition for this one cut, it equates to approximately 5.6 cent per kg. When you consider the benefit of vacuum packaging to the industry was estimated to be 12 cents per kg, and this represent significant benefits at an early adoption stage (see Appendix 1 – impact analysis). Note this is a first run of the model, and we expect further calculations will be required shortly as companies start using the pre-production prototype and allow us to tighten our assumptions in the model.

It is expected that Boa stretching may be used also for selective hot-boned BI primals that currently are unable to meet the MSA grade, to be upgraded into higher value grilling products, potentially worth $7 to $10 extra per kg. Similarly, the cow and bull meat budget market also stands to benefit in value enhancement for selected domestic & export markets.

In the longer term, integration of hot-boning will open domestic & export markets right across all market segments.

Preliminary Impact Analysis (First year impact):

The initial market schedule is focused on the Biceps Femoris (outside flat). In the Australian domestic market the muscle is preferred in an oval form rather than its natural rectangle shape. The muscle is expected to be thin sliced for food service and institutional markets. It is expected that the oval shape will provide advantages with respect to cooking consistency and reduce variability in eating quality.

The attributes of tenderness, juiciness and flavour can be improved through portion control in commercial kitchens. Improving beef tenderness by one per cent can increase retail values by 20 cents per kilogram and improving juiciness and flavour by one per cent can result in an 8-cent increase per kilogram in the domestic market.

By reducing the eating quality variability by standardising muscle steaks or slices. The eating quality variability of the BF is high and a reduction in the variability due to shaping with Boa Technologies may be 20 per cent. This equates to a value of about 5.6 cents per kilogram.

The cost of Cyrovac bags and processing is approximately 12 cents per unit or 3 cents per kilogram on whole primal packs. The Cyrovac bag would be replaced by a latex wrap and the cost of the Boa technology would need to be less than 3+5.6=8.6 cents per kilogram to break-even. The net benefit above Cyrovac is the 5.6 cents per kilogram.

For the export market to Korea the benefit could amount to $4,472,400 in the first year for changes to the BF product destined for the United States, S. Korea, Chinese Taipai and Eastern Europe.

Assuming a 100 per cent change over in the first year for the BF in the Australian Domestic market the value in the first year is approximately $1,592,237. BASE = 12% of food service market value at the price increase of 5.6 cent per kilogram for BF steaks.

The combination of the export market and domestic market benefits equate to $6,064,637 in the first year. The export market values are shown below in detail.

Table – Preliminary impact analysis for Australian domestic and export markets

Aus $/kg		**Export Value Increase**	**New Value per kg**	**New Market Value**	**Difference Value $**
	Americas				
4.29	Canada				
3.74	United States	0.01	3.811427	145215360	2847360
	Asia				
4.89	Chinese Taipei	0.01	4.992277	18151920	355920
10.39	Hong Kong				
3.82	Indonesia	0.01	3.894545	4112640	80640
5.54	Japan				
4.65	Korea	0.01	4.743383	60563520	1187520
11.64	Malaysia				
1.97	Philippines				
	Europe				
8.74	Europe Union				
9.20	CIS				
4.00	Eastern Europe	0.01	4.08	48960	960
	Middle East				

Aus $/kg		Export Value Increase	New Value per kg	New Market Value	Difference Value $
5.00	Kuwait				
5.67	Saudi Arabia				
10.54	United Arab Emirates				
	Oceania				
4.40	New Zealand				
2.67	Pacific Islands				
1.95	Papua New Guinea				
4.78	**Total**				**4,472,400**

3.6 Competitive Strategy

The advantage that the BOA Technology is able to deliver to meat processors is a consistent and uniform, value-added product. Existing mechanical assistance technologies such as Pi-Vac and Hamax have been designed to specific meat processing applications and consequently have not readily been embraced by meat processors in Australia. The Hamax process is ideally suited to large muscles and the process uses one bag size for all size meat cuts. The disadvantage of the Pi-Vac is it produces inconsistent and uncontrolled stretching across the primal. This will produce uneven portions.

A competitive strategy for a potential Commercialiser is to establish an on-going development program jointly with MLA and M&WNZ. The strategy may include development of other components that build on to the existing stretching capability such as packaging, unique shaping, chilling etc. The development program would extend the technology to cater for other cuts from which value could be captured. This competitive strategy should include the development of handling automation for loading and unloading the BOA. The current focus is on beef; however, developmental trials with lamb muscles have sheep processors very keen to progress immediately

3.7 The Boa Technology Customer

The overall strategy is to maximize the technology's impact by growing demand and the competitive advantage of Australian beef and lamb. In order to maximise return for every carcase and grow demand, meat production from paddock to plate must become a modern industrial process where all raw material parameters are measured and controlled to produce a consistent output. A major source of variation comes from highly variable cooling rates across the deep and shallow parts of the carcase. The key factor to achieving a controlled process is precise intervention; primal and sub-primal processing is an important strategy for producing consistent eating quality across the carcase regardless of its position. Boa provides dose controlled treatment of individual cuts to ensure consistency.

Boa technology provides a platform to copy existing products in well established markets or engineer completely new products. Existing value-added markets can be serviced more cost effectively using Boa (eg. hot pot mutton breast and flap meat which are manually prepared for established markets in China and Hong Kong). Also new product opportunities exist in the short term in established retail

(eg. retail shaped rotisserie beef and lamb; microwaveable products) and foodservice (premium wet diced and sliced products). New premium frozen products would also be possible by stretching hot-boned meat with controlled aged in the bag prior to freezing (est. 5-7 days only). Further product developments are expected for selected hot-boned products. Value enhancement, processing efficiencies, and labour and energy savings are expected by integrating Boa into hot-boning operations in the future.

The benefits for cold-boned beef and sheep meat plants will flow almost immediately. The impact to the industry will be ramped sharply up over the next 5 years assuming combinations of cold- and selected hot-boning applications. While significant impacts will be achieved through portioning and shaping of cold-bone product, maximal impacts will be realised if the industry integrates hot boning partially or fully into their processes to capture the additional processing efficiencies and savings through hot-boning.

There is significant interest from cold- and hot-boning plants for the technology in both Australia and New Zealand. Existing cold- and hot-boning plants have been approached individually with positive responses and immediate market opportunities were identified for shaping and portioning of product. Initial interest has come primarily from cold-boning operations only.

3.7.1 Australia

There has been a lot of interest from Australian beef and sheep meat companies prepared to trial the prototype technology with the view to testing markets straight away. However, for much of the industry, the current stigma associated with quality hot-boned product will be a difficult hurdle to overcome, particularly for beef where all current warm- and hot-boners produce for either well-established frozen export markets and/or fresh chilled local budget markets. Of the approximately 8-10 hot-boners in Australia, key southern (Midfields) and northern (Teys) operations have been approached. While in principle support was given for cost-saving technologies, markets for lower value chilled budget and frozen cow and bull meat are well established, and it is unlikely further investment will be made in low value markets. Also being able to produce premium products from warm- and hot-boning was discredited by both processors. It is unlikely that this view will be changed amongst current hot-boners in Australia until the Boa can be trialed in each of the plants.

The three anticipated scenarios for Boa Technology Customers in Australia are:

1) Cold-bone shaping ie. into a roast beef roll/log.
2) Partial removal of some hot-bone muscle at a point in the processing chain that this is suitable. The remainder of the carcass will then be cold-boned.
3) Increasing the value form hot-boned meat.

3.7.2 New Zealand

In New Zealand, the response to the Boa technology has been overwhelmingly positive from several processors where production of hot-boned product has been practiced for some time. It should be noted the premium 2006 NZ beef award was produced from hot-boned product.

Frozen hot-boned product export marketers are unlikely to be swayed in the short term, but penetration is anticipated as value enhancement and production efficiencies which are realised in the medium term. There are well-established premium frozen markets available now, and New Zealand processors has been successfully supplying into this market for some time against other market competition.