Final report

Masterbeef App development to enable data integration into Red Meat processor systems

Project code: P.PSH.1362

Prepared by: Darren Hamblin
                        Masterbeef Pty Ltd

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Abstract

Over the last 10 years Masterbeef has developed a technically able and cost effective product to standardise, digitise and store carcase grading information. Continuous trial work under the supervision of MSA and AusMeat has ensured the device evolves and improves at the technical aspect of cut surface grading to meet Australian Standards. Whilst the device is progressing well in the accreditation process, the long term objective is to use digital devices in a commercial environment. This project was designed to emulate the real time use of the Masterbeef grading camera in a commercial environment and assess its suitability and understand the benefits and challenges for the commercial operator to consider for adoption of the next generation of carcass grading technologies.

Executive summary

Background

The purpose of the Masterbeef App development project for data integration into Red Meat processor systems is to evaluate the benefits of introduction of new digital grading technologies into our current systems. Along with introducing new technologies comes the challenges of changes to management, training in new processes, data integration into current systems and acceptance of the technology as being accurate for all stakeholders in the beef supply chain.

Objectives

Prior to starting physical trial work, the project management team identified and documented the key objectives of the trial. These are summarised as below

- Consistent and uniform grading results across all sites
- Ability to grade more carcasses more efficiently with less labour and less cost
- Improve the transparency of the grading process to the producer
- Improve livestock selection to better meet brand and/or product specification
- Improved data analysis
- The ability to deliver accurate and consistent feedback on carcase traits back to the producer.
- Accurate, consistent and "equal" assessment of both full ribbing and spencer roll rib eye sites by the Masterbeef camera
- Accurate and consistent assessment of the complete marble score range

Methodology

The concept of the trial is to run the analysis in parallel with the current JBS systems in place for grading and data management. The data collected from the Masterbeef camera can then be correlated to the information collected in the normal processes at the JBS sites. With two data sets collected on the same carcases in a controlled environment a solid analysis can be derived. The analysis can be used to identify the positives and deficiencies of either systems. Furthermore, it will create a solid basis of information and learnings for a full working integration model to be designed and implemented. During this process and potential changes required by either the Masterbeef system or the JBS system can be identified and addressed.

Results/key findings

The project revealed several key issues and positive findings that can be categorised into 3 groups.

1. Immediate work completed to allow the project to proceed effectively
    a. Changes to the Masterbeef App to assist graders and speed up time per carcase
    b. Camera shroud re-design to suit new spencer roll grading
2. Future changes for commercial implementation
    a. Consideration of abattoir IT system security and ability to operate with active 3rd party API's
    b. Graders should all be Ausmeat/MSA accredited graders who effectively oversea and overwrite the devices score if necessary, making the result Ausmeat/MSA approved by default

    c.   Voice activated controls were trialled in the APP to speed up grading and reduce manual keystrokes by user and further development will be worthwhile

3. Positive findings from introduction of the technology
    a. A new method was developed to grade spencer rolls effectively
    b. Full MSA grading is faster with the Masterbeef device than current system
    c. Ability to recall images for re-assessing if required
    d. Ability to share results including original and generated images with suppliers etc…
    e. The device's light weight and ergonomics were well received by users and allows ease of manoeuvring in tightly packed chillers
    f. The users expressed the ease of use of the device with little training required

Benefits to industry

The use of carcase grading devices allows image capture and storage. Supplier kill data will now have ability to include images in their feedback or on an online portal. This not only demystifies the grading results for cattle suppliers by allowing them to see their carcase, but our industry will gain a lift in cattle breeder and grower knowledge base and hence contribute massively to inform genetics that can be used with eating quality in mind. The device also collects additional information which is not yet recognised by Ausmeat or MSA standards, such as marble distribution and marble fineness. With these traits potentially creating better eating quality indicators over time they may become very useful tools to keep Australian beef ahead of our international competition.

Future research and recommendations

The Masterbeef App also has capabilities to connect other data sources and link them to the carcase grading data. These include data sets such as on farm data, other abattoir kill information and DNA genotype profiles. Masterbeef has an in built Artificial Intelligence module which has the ability to predict traits by training it with the traits required against 100,000 DNA markers.

Currently it is being used very successfully in Wagyu commercial beef operations and could be used in other breeds if the desire was there for cattle breeders to chase certain traits.

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1. Background

1.1.   Background

Masterbeef has developed a smartphone based image capture and analysis technology for assessing on the hook red meat cut surfaces. Whilst the technology has been adopted in many countries, take-up in Australia has been slow due to the fact that no digital technologies have attained full AUS-MEAT or MSA accreditation. Over time those accreditations will be achieved, however in the meantime this project objective is to move forward with the implementation of the technologies within the operating environments of meat processors. As the processors start to use the technologies they will be able to determine if the technologies are suitable or can be made suitable for their business to add value. Masterbeef understands the end to end meat processing dataflow and its real value due to their investors' long history of data management in the Wagyu supply chain in Australia.

The Masterbeef handheld camera device is significantly advanced in full validation and being presented in early 2022 for accreditation to measure ribeye grading characteristics in beef. Masterbeef has set up many of the building blocks to enable end to end secure data flow required in the beef supply chain, however more work will be required to ensure third party integrations are road tested and fit for commercial use.

This current project is to roll out the Masterbeef App for use in JBS Australia's Northern Division processing facilities with integration within their local and cloud based IT systems. Whilst many of the required database and API interface functions have been designed and built on the Masterbeef end it will still require more beta testing and tailored solutions for 3rd party first class integrations. There are other Digital Carcase assessment technologies in the marketplace however none of these fills the entire complement of carcase traits required nor the dataflow required to enable commercially viable, timely decision making ability.

This project will further develop the Masterbeef App and facilitate its integration into JBS northern operations local and cloud based IT systems. The App accompanies the handheld camera device and offers advantages over other OM devices including improved integration into existing processor systems, increased data collection efficiency, volume and integrity, the ability to 'deep dive' into historical big data and improved carcase data feedback to producers. The App will enhance the user interface and be validated with JBS feedback systems, including MSA.

The primary aim of this project is to finalise the design, implement and test the integration of the Masterbeef application (App) into JBS Northern division processing facilities and cloud based IT systems. There are currently no protocols for the adoption, implementation and integration of new objective measurement technologies into processor business operational and feedback systems. By further developing the Masterbeef App and integrating it into JBS processing facilities protocols, insights into system integration will be developed that will used to facilitate future implementation into other sites. This project aims to support the early adoption project (J21016) on Masterbeef integration at JBS.

1.2.   Project scope

This project's aim is to roll out the Masterbeef App and Grading camera solution with integration into JBS's northern operations' workflows and business data management systems within their local and cloud based IT systems. Whilst many of the required database and API interface functions have been designed and built on the Masterbeef solution, this project will require additional beta testing and

tailored solutions for 3rd party first class integrations to deliver a commercial grading application solution. The outcomes of the project will be critical for the concurrent JBS northern early adoption project. This project was a successful application from the 2021 Objective Measurement open call for proposals targeting the increased adoption of OM technologies. By further developing the Masterbeef App and integrating it into JBS processing facilities protocols, insights into system integration will be developed that will be used to facilitate future implementation into other sites. The App accompanies the handheld camera device and offers advantages over other OM devices including improved integration into existing processor systems, increased data collection efficiency, volume and integrity, the ability to 'deep dive' into historical big data and improved carcase data feedback to producers. This project aims to support the early adoption project (J21016) on Masterbeef integration at JBS.

1.3.   Expected outcomes

Currently the Masterbeef grading systems are not sufficient to efficiently enable full use of the MSA MEQ models already developed to differentiate high value carcases and hence promote higher returns on those cuts or carcases. Additional value add at a retail meat level can be calculated by using a cut by cut value model across a kill with the MSA model as the price differentiator. Supplier feedback to their breeding systems is a much slower feedback loop to calculate, however in certain high value beef systems such as Grainfed Angus and Wagyu carcase data feedback of this level can increase profit yields up to $500 per carcase average over one generation of breeding with suitable sires identified using the full Masterbeef suit of functions.

The outcomes of the project include:

- Consistent and uniform grading results across all sites

- Ability to grade more carcasses more efficiently with less labour and less cost

- Improve the transparency of the grading process to the producer

- Improve livestock selection to better meet brand and/or product specification

- Improved Data analysis

- The ability to deliver accurate and consistent feedback on carcase traits back to the producer.

- Accurate, consistent and "equal" assessment of both full ribbing and spencer roll rib eye sites by the Masterbeef camera

- Accurate and consistent assessment of the complete marble score range

The primary aim of this project is to finalise the design, implement and test the integration of the Masterbeef application (App) into JBS Northern division processing facilities and cloud-based IT systems. By further developing the Masterbeef App and integrating it into JBS processing facilities protocols, insights into system integration will be developed that will used to facilitate future implementation into other sites. The App accompanies the handheld camera device and offers advantages over other OM devices including improved integration into existing processor systems, increased data collection efficiency, volume and integrity, the ability to 'deep dive' into historical big data and improved carcase data feedback to producers. This project aims to support the early adoption project (J21016) on Masterbeef integration at JBS.

2. Objectives

The primary aim of this project is to finalise the design, implement and test the integration of the Masterbeef App into the JBS Northern division processing facilities local and cloud based IT systems.

The specific objectives of the project are:

- Ascertain the suitability of the technology to the style of processor
- Evaluation of the technology's ability to
  - increase the data collection in volume and integrity
  - increase the efficiency of data collection
  - allow more 'deep dive' into historical big data ie. AI on data files
  - add on other technologies in the industry efficiently ie. BT pH readers
- Evaluation of database integration and sharing models rather than data transfer and duplication
- Feedback from cattle suppliers to gain insights into their desire for the additional data that can be provided and the feedback platforms suitability to them to for use in their business
- Test and trial integration of developing equipment and integration of software into feedback systems including MSA grading outputs (across multiple JBS sites)
- Evaluate the integration of the Masterbeef camera solution into JBS's northern operations' workflows and business data management systems, including feedback to producers
- Evaluate device grading capabilities across multiple classes of animals and sites

3. Methodology

Masterbeef will partner with MLA and JBS to trial and validate the Masterbeef grading camera across all of JBS' northern sites.

- Trials will be conducted at five (5) JBS northern sites over the trial period. Initial focus will be on Dinmore and Beef City to develop data integration requirements.
- Integration of Masterbeef data to JBS systems will be conducted.
- Data will be collected, validated and analysed on a daily, weekly and monthly basis to assess performance of the Masterbeef grading solution
- User experience with the device, timesaving's and efficiencies will be measured
- An internal working group will be developed to review the technology. This group will consist of: MSA, Sales, Business analysts, plant operation and existing graders

3.1 Project planning and design [Milestone 1]

The following method and process steps were applied in project planning and design phase, including:

- Conduct start up meeting with JBS project team, Masterbeef and MLA
- Form steering project group

- Trial plans
- Design & integration requirements for hardware and software for customised (JBS) application

The progress report, including trial plans, design and integration requirements will be submitted to MLA for approval.

3.2 Device supply and commission [Milestone 2]

The following method and process steps were applied in the device supply and commission (i.e. Milestone 2), including:

- Supply & commission trial ready Masterbeef device(s) & software
- Review data integration protocols
- Device training & technical support.
- API design
- Device training of personnel
- Initiate testing protocols
- Conduct initial device test at JBS pilot (1) site

The progress report, including commission devices, API design training and testing protocols will be submitted to MLA for approval.

3.3 Device and API rollout across multi sites [Milestone 3]

The following method and process steps were applied in device and API rollout across multi sites (i.e. Milestone 3), including:

- Set up a 'real life' data collection trial on a full day of production
- Review device performance and usability
- Post trial analysis to assess successes, failures and remedies
- Device & API rollout to multiple JBS sites

The progress report, including equipment order and commission will be submitted to MLA for approval.

Go/No Go decision Point: Trial-ready Masterbeef devices commissioned, initiated training and testing protocols, and trial plan approved as scheduled.

3.4 Conduct device trials across JBS sites as per trial plan [Milestone 4]

Conduct device trials across JBS sites as per trial plan, including:

- Review multi-site rollout
- Collection and data integration
- Review device performance and usability
- Feedback to selected beef producers via a customer portal

- Technical support
- Finalise commercialisation plan

The progress report, including conduct device trials across JBS sites as per trial plan will be submitted to MLA for approval.

3.5 Final report [Milestone 5]

Confidential report of commissioned, training and testing protocols, data collection, integration systems, and trial results. Public case study of lessons learnt for early adoption of OM devices. Final reports (confidential & public) submitted & approved by MLA.

4. Results

4.1 Project planning and design [Milestone 1]

The initial planning and design phase was delivered by:

- Conduct start-up meeting with JBS project team, Masterbeef and MLA
- Form steering project group
- Trial plans
- Design and integration requirements

4.1.1. Conduct start-up meeting

MLA, JBS & Masterbeef key personnel attended a meeting to understand all parties' roles in the project and select a steering committee with suitable personnel from each team.

Meetings were held on-site at JBS Dinmore initially with the core participants from both JBS and Masterbeef management. Key management from both teams were identified for participation in the project with project management, operations and IT being the three main categories to be addressed.

4.1.2. Form steering project group

The project steering group was formed, including JBS, Masterbeef and MLA participants:

JBS: Michael Finucan; Linden Cowper (Other JBS, as required)

Masterbeef: Darren Hamblin;

MLA: Jack Cook; Richard Apps; Dean Gutzke (Other MLA, as required)

4.1.3. Develop trial plans

Draft trial plans, including design and integration requirements, were developed with ongoing changes, as required. [Refer to Appendix, See Section 7.1 Trial plans, including design plans & integration requirements].

4.1.4. Design and integration requirements for hardware and software for customised (JBS) application

The device design will be reviewed to ensure it can accommodate all grading requirements for JBS across their plants. It was identified that device engineering changes may be required to gain suitable images from the Spencer Roll assessment sites as used at JBS Dinmore. Further to this App code changes will be required to train the device on assessment of the Spencer Roll Images.

The IT system integration will also bring challenges through data flow that must meet all JBS cybec security protocols. API and security access will be designed once JBS have decided how the dataflow will be best managed on their side.

4.2 Device supply and commission [Milestone 2]

The following method and process steps were applied in the device supply and commission (i.e. Milestone 2), including:

- Supply & commission trial ready Masterbeef device(s) & software
- Review data integration protocols
- Device training & technical support
- API design
- Device training of personnel
- Initiate testing protocols
- Conduct initial device test at JBS pilot (1) site

4.2.1. Supply & commission trial ready Masterbeef devices and systems

Two (2) devices were delivered to JBS Dinmore during the stage one planning stage. Two (2) additional devices were shipped to JBS and forwarded to the JBS Beef City plant at Oakey.

Four (4) devices complete with 3D printed plastic shrouds, Samsung Galaxy A72 phones & calibration sheets have been supplied to JBS.

Devices were delivered pre-commissioned and calibrated by Masterbeef.

All devices were used in the training sessions carried out at JBS Beef City and images of the device in use can be seen in figure 1 and 2.

Final commissioning including operator logins was carried out by trainee operators and all devices were calibrated and ready for use.

JBS expected that 10 devices will be required to facilitate a full device roll out to their Dinmore, Beef City and Rockhampton plants. The remaining 6 devices will continue to be rolled out during the project to allow for throughput to increase.

Figure 1: JBS grader using the Masterbeef device

Figure 2: Masterbeef device analysing rib eye imagine and outputting analysis data

4.2.2. Review data integration protocols

Data integration protocols were discussed on two levels.

Firstly, access to use the plant WiFi system for user login and authentication.

Data security and even more so hacking protection has become a serious IT issue for Agribusinesses internationally and particularly with JBS after a serious international hacking event. Initial login attempts were blocked due to un-known devices to the JBS system requesting WiFi access.

Data collected by the Masterbeef Carcass Assessment App is pushed to and hosted on the Masterbeef cloud platform. The data is transferred over a secure encrypted connection which implements industry standard OAuth2.0 security protocols. Masterbeef does not allow direct connection to its datastore and all interactions must occur via the Masterbeef secured API.

Masterbeef proposes to setup a B2B (server to server) connection between the JBS system and the Masterbeef API using OAuth2.0 Client Credentials Flow (or similar). This will facilitate the secure access of information between the 2 entities without the requirement for user interaction (this will be reviewed during implementation).

4.2.3. Device training and technical support

A Masterbeef trainer took seven JBS Beef City management and grading personnel through the general overview of the Masterbeef grading technology and the background systems including the data review website, data analytics software and data summary reporting.

The complete training presentation was also completed by all seven personnel present.

The project lead, Beef City operational management and graders then proceeded to the chillers for practical application of the classroom learnings.

Graders and management all had a chance to utilise the devices in real life application. The Masterbeef trainer was present to answer any question as and when they arose.

4.2.4. API design

Masterbeef stores all information and data collected by the Carcass Assessment App behind an industry standard secure Web API. Masterbeef can use the existing Data API and implement additional endpoints to provide the information JBS require to achieve the outcomes of the project. Masterbeef's preference is to encourage the use of the Masterbeef platform as the primary store of carcass assessments and leverage our data sharing capability to provide the information JBS require. This would present a closer integration between the two entities, remove data duplication and provide a superior outcome to JBS and Masterbeef customers

Masterbeef has designed and will implement the following protocol for the JBS integration. Note that there may be minor alternations to the design during the implementation process.

4.2.5. Device training of personnel

All devices were present at JBS Beef City during the training. All graders set themselves up as Masterbeef users with secure passwords. The user setup is completed by the user themselves by using the phone and APP. All devices were calibrated ready for use.

JBS Beef City has been set up as a tenant and all applicable users have been given access to the "JBS Beef City" tenant by the tenant administrator, Linden Cowper.

Push, Read & Edit restrictions to the "JBS Beef City" tenant have been set by the tenant administrator.

Graders are showing that the new technology is learned with ease.

Grader feedback has been forthcoming and honest as this was the environment set in the initial meetings.

4.2.6. Initiate testing protocols

Initial login attempts via the JBS Wi-Fi were not successful due to un-identified devices being blocked. Login with personal phone hotspot was interim measure used to allow training and testing however is not a long-term solution. As this data flow is a direct device to Masterbeef database connection only, no JBS security protocols were breached.

No Wi-Fi access is required after initial device login is complete. The device operated without issue in the chillers without any need for Wi-Fi access.

Discussion with JBS IT department is underway to plan the use of the Wi-Fi system safely.

Initial barcode reading was an issue due the barcode layout protocols being new to the App code.

Training continued without interruption as barcode use is an optional field. App changes were made immediately, and the next training session showed the changes were effective and barcode reading was carried out without issues.

All other testing was carried out without any technical difficulties.

Images and grading data was again pushed to the Masterbeef database after grading using personal hotspot internet connections.

4.2.7. Conduct initial device test at JBS pilot (1) site

Grading trials were carried out with Masterbeef trainers present in March 2022.

JBS plant graders then continued with testing and comparisons to their plant graders own records.

Approximately 300 carcases per session have been graded per day since the training day. Total images captured up until 10 April 2022 was 4560.

4.3 Device and API rollout across multi sites [Milestone 3]

The following method and process steps were applied in device and API rollout across multi sites (i.e. Milestone 3), including:

- Set up a 'Real Life' data collection trial on a full day of production
- Review device performance and usability
- Post trial project analysis to assess successes, failures and remedies
- Device & API rollout to multiple (JBS) sites

4.3.1. 'Real life' data collection trial on full production day

To date 10,673 images have been collected by multiple experienced Ausmeat & MSA accredited JBS graders at the JBS Beef City plant. Current device trials involve collecting camera images on a cross section of cattle with approximately 300-350 carcases per day for four days per week. These numbers involve a mix of cattle and carcase type – MSA and AUSMEAT and a cross section to include all types including Angus. All data from carcases graded have been collated and compared with the human grader scores.

4.3.2. Review device performance and usability

4.3.2.1. Ease of use

Graders' feedback was that the devices was easy to understand and use. Using control functions synonymous with generally excepted smartphone functions made the device easy to operate.

4.3.2.2. Ergonomics or comfort to operate

The lightweight of the device meant one handed operation was easily achievable for all operators regardless of their physical strength.

The device is designed predominantly for right handed use, however is quite suitable for left handers to use. The location that the camera on the shroud is the main dictator of the ability to change the design to make left handed.

Whilst it can be carried and placed on the cut surface with one hand, the user's other hand is required to touch the screen to operate the software functions.

4.3.2.3. Speed of data collection

The operators found that the speed in which the device can capture and process the images and calculate the grading outputs was quite fast and in line with or faster than current manual grading and data recording system. When all grading measurements and traits are required (eg. MSA grading), the device has proven faster than the manual human grading. The device can be sped up further if less traits are selected for grading (e.g. less processing required). It has been decided for the trial that all traits will continue to be calculated.

4.3.2.4. Ability to access correct grading site

Due to the light weight of the device, height of the carcase at the cut surface was not an issue in the chillers used. In fact, the Masterbeef device allowed for the cut surface to be captured and then viewed by the operator where normally a step or platform may have been needed to attain sufficient elevation to see down over the cut surface to allow a manual grade.

The carcases graded were opened via cutting through the spine between the 11th & 12th ribs.

On rare occasions the cut was not sufficient to open the ribs apart enough to allow the shroud to fit into the area. This can be remedied by either increasing the size of the cut through the spine to allow the opening to increase or grading the other side of the carcase.

4.3.2.5.   Grading results compared to human graders

Results showed that the JBS graders agreed with the higher marbled bodies, but the Masterbeef device over graded the lower marble score carcases. The issue has been identified as light reflection or glare that is present on the lower marble score carcases that is difficult for the technology to distinguish from marble. Software updates have been made to the Masterbeef device these are being tested by JBS currently.

The fat colour was generally consistent with the human graders opinions.

The meat colour was well over the human graders scores. This fact is acknowledged by Masterbeef and more development in this area was begun prior to the trials at JBS. Specifically new colour cards for meat colour have been introduced to the Masterbeef software which are hoped to rectify this.

The two upgrades to the lower marble score recognition and meat colour cards are currently being trialled and these developments will be reported on in the next milestone report.

4.3.2.6.   General opinion of the system

The general feedback from JBS graders was that the system;

- was easy to operate by all users
- needs more work in meat colour identification
- is not accurate on low marble scores
- is good for the fact that it keeps images for future use or customer feedback

4.3.3.   Post-trial analysis to assess successes, failures and remedies

After feedback from the graders and their managers it was found that the major success was the ability for graders with little digital technology knowledge to be able to use the device with simple training.

The feedback was also that it failed to assess correct meat colour. Colour cards for meat and fat colour have been introduced to the calibration process in the App to better standardise colour recognition between devices. This uses plastic credit card sized cards with Ausmeat and MSA meat and fat colours and a barcode for the App to recognise that the card is being used in the calibration of each cameras colour palette.

It was requested that when the manual grader disagreed with the cameras grade given for marble score, there was the ability to add user scores in single decimal increments. E.g. Marble score '2.3'. This would then allow a greater ability to assess the correlation between the Masterbeef device and the human grader's opinion. This functionality has been added to the App for the next version release.

It was also discussed that voice control may be a suitable option to speed up grading time and also allow true single handed operation. The first version of voice controlled Artificial Intelligence has been added to the App for the next version release.

A shroud design change has been introduced to slope the left side of the shroud from the camera lens area down to the left hand side of the open face that touches on the cut surface (figure 7.2). This change was implemented to allow the device to be rotated to get into small rib openings and particularly where the spine protrudes above the cut surface. The protruding bone impedes the

shroud from being pushed into the ribs enough to allow the image of the complete Eye Muscle Area to be captured. New generation shrouds have been produced for trial.
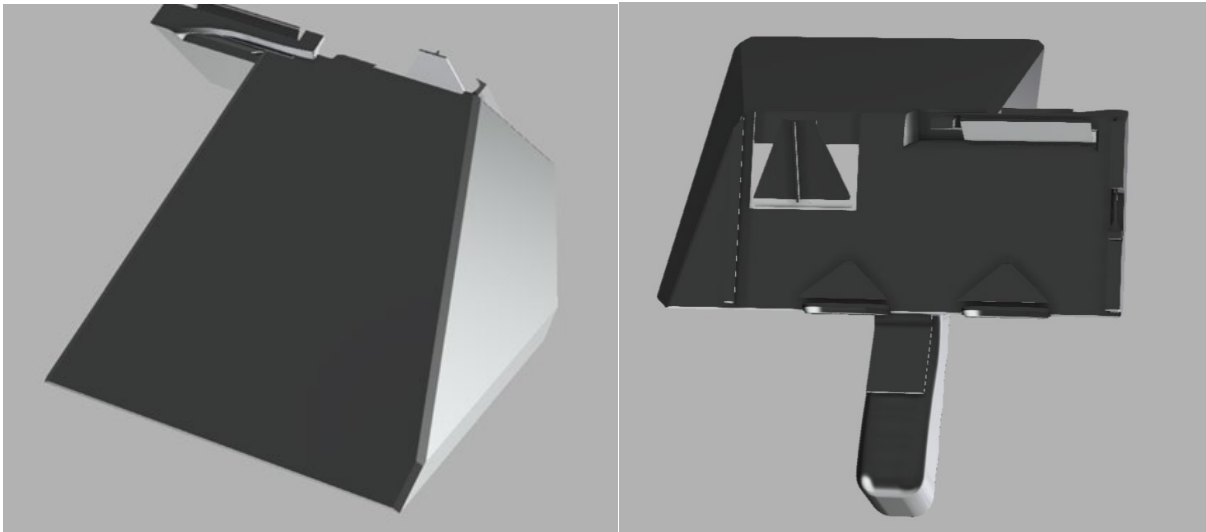

Figure 3: New shroud design

4.3.4. Device & API rollout to multiple JBS sites

Devices have been supplied to be used at other sites.

The Masterbeef database API details have supplied to the JBS IT Team for review.

Currently the API has only been used by Masterbeef to allow JBS to make data calls from the Masterbeef database. This approach has allowed the project to continue without need for JBS to create an API for data calls on their system.

Where simple JBS in-house grading is being carried out this data flow system will suffice. In cases where more data is required such as MSA grading a two-way data flow will be required.

Discussions with MSA technical team has assisted in understanding the data flow requirements to integrate the Masterbeef data into an MSA grading system. This system must be driven by the JBS database with Masterbeef as a data collector and supplier.

The Masterbeef Carcase Camera outputs make up around 60% of the data inputs required by the MSA grading model to calculate an MSA score.

The plant owner also has other facts that must be introduced to complete that data set. These facts include HSCW, dentition, etc... Other plant inputs required are less specific to the MSA score calculation but more related to –

- QA inputs required in the MSA grading system than just the carcase grading data. Eg. Supplier eligibility to the MSA system
- the number of MSA graded carcases required for sales.

The rollout across multiple sites has been delayed pending the JBS position on API integration being completed at Beef City.

4.4 Conduct device trials across JBS sites as per trial plan [Milestone 4]

4.4.1.   Review multi site roll out

4.4.1.1   Set up devices for Dinmore

It was agreed that after successful trial work at JBS Beef City Plant that the Masterbeef devices would be next trialled at JBS Dinmore plant. This plant was chosen for two main reasons, being that most management team involved in the trial were located at Dinmore and the Dinmore plant uses the Spencer Roll method of presenting Rib Eye muscles for grading.

4.4.1.2   Training of Dinmore Graders

With the Beef City graders already competent in the use of the Masterbeef devices it was our agenda to train the Dinmore graders to the same level of competence. The next plant to be trained was Riverina NSW.

4.4.1.3   Spencer Roll Grading

Spencer Roll grading has not been carried by Masterbeef in the past. Nearly all cut surface grading is traditionally carried out by cutting through the spine with a bone saw followed by a single knife slice in a plane perpendicular to the spine. The Spencer Roll method is achieved by leaving the spine complete and filleting the rib fillet from between the spine feather bones and the ribs for a distance of approximately 150mm. This allows the rib fillet to be pulled away from its in-situ location and 'rolled out' away from the spine so the grader can inspect the cut surface.

The Spencer Roll grading method is favoured in the Dinmore plant due to the long distances carcases are moved on the rails prior to boning. The traditional cut surface grading with the spinal bone cut sometimes leads to the forequarter of the carcase side tearing away from the hind quarter. This leads to the forequarter touching the floor in some cases and rendering the carcase as "contaminated". Therefore the Spencer Roll method has benefits in Dinmore and some other plants.

One negative point in grading using the Spencer Roll is that the Rib Eye Area can only be measured as an estimate. This 'estimated only' measure is due to the fact that the actual cut surface area of the rib fillet is distorted as the fillet is rolled out from its in-situ position in the spine and ribs. Whilst estimated rib eye areas are suitable for some grading systems it means other systems which require actual rib eye area are not able to be used.

The Masterbeef camera has been used in some cases using the camera facing up rather than down on a tradition cut surface grading. This method was adopted in situations where the forequarter (looking down) side of the cut surface was damaged by the bone saw or had water spoil. Trial work with Ausmeat and MSA in the past have indicated that looking up at the hindquarter (upward looking) side of the cut surface gives exactly the same result as the down looking view. The Masterbeef camera is simply flipped over and the same method of use is applied. The only difference visually noted is that the image is essentially mirrored so the image taken on the left side of the body appears like the right side of the body.

4.4.2.   Collection and data integration

Images were initially taken of the rolled out spencer for ease of access to the cut surface. The results of this trial were poor for a couple of reasons. The main reason is that the camera shroud is designed to keep the cut surface at a known distance from the camera lens and also to control the light for a clear and correct image. Without the rib and spine to rest the camera shroud on (as is done in the traditional grading cut surface) the image integrity is compromised. What is seen as an estimated measure of rib eye area already, only has become somewhat more variable without having a controlled focal distance from the camera.

It was decided that looking up at the other side of the cut surface would give a better representation of the rib eye. Not only would it be essentially looking at the same cut surface, it also meant that the rib eye area measure would be accurate as it was still in-situ in the spine and ribs.

The first trial of the up-facing image method was encouraging yet not successful. The biggest issue faced was the lights shining down from the chiller ceiling were in some cases shining directly into the open face of the camera shroud. The bright lights created too much reflection back to the cut surface which ultimately rendered the image not suitable for assessment. Another issued faced was that the access to get the shroud into the cut to get cut surface image meant the shroud had to approach the carcase from an angle at 90 degrees to the traditional orientation of the rib eye area. This can also be explained by thinking of the difference between a panoramic versus portrait photograph.

With the rib fillet still connected to the ribs at the cut surface and the ribs and spine still in place it also meant that the shroud was limited as to how its face it could be pushed into the carcase. The tip of the shroud was limited by touching on the rib bones. That ultimately lead to the rib eye area being at the furthest point from the camera lens. Whilst the camera technology corrects for focal length and keystone errors it still had a large part of the view area of the image wasted and only the very rear of the image with assessable meat area in it.

These realisations rapidly lead to the need for a camera App and shroud re-design.

4.4.3.   Review device performance and useability

Owing to the fact that no digital grading technologies have been used in the assessment of spencer rolled carcases to our knowledge we had to firstly assess if the images were suitable for assessment. The next stage was to collect images and assess data to determine if the camera data was in line with the JBS graders.

No MSA and Ausmeat trial work has been planned for industry to assess the suitability of Spencer Roll grading using digital technologies.

4.4.4.   Feedback to a selected beef producer via customer portal

The Masterbeef data has been supplied via an API for JBS IT Team to initiate data pulls from the Masterbeef database direct. It was the intention of JBS to incorporate the Masterbeef data into their customer feedback portal that was in development. It was agreed that the original and perhaps even the App created binary images would be of great value to the cattle vendors. Visual images would allow the producer to better understand their cattle and their performance on the hook.

4.4.5. Technical support

All trial work for the work in Milestone 4 was carried out by Masterbeef personnel with JBS graders and management present hence little technical support was required by the JBS personnel.

The App developers and shroud designers were present at the trails to gain first-hand knowledge of the requirements of the device which allowed rapid turnaround of designs

4.4.6. Finalise commercialisation plan

The final commercialisation plan would be discussed after a successful outcome in the quest to grade Spencer Rolls with the same level of confidence it has produced in standard cut surface grading. Full AusMeat and MSA accreditation was also sought for at least the marbling and meat and fat colour traits Less focus on the colours was required as they have less impact on product quality models.

5. Key considerations on adoption of OM [Masterbeef JBS Northern Case study]

5.1 Project brief [Snapshot]

The project set out to evaluate the potential to implement the Masterbeef Carcase grading device in the JBS production system and essentially replace the current data collection units as well as add more defined data such as images. In order for the device to be incorporated in the JBS systems it is necessary to firstly assess the devices ability to deliver on the key points below.

- Consistent and uniform grading results across all sites
- Ability to grade more carcasses more efficiently with less labour and less cost
- Improve the transparency of the grading process to the producer
- Improve livestock selection to better meet brand and/or product specification
- Improved data analysis
- The ability to deliver accurate and consistent feedback on carcase traits back to the producer.
- Accurate, consistent and "equal" assessment of both full ribbing and spencer roll rib eye sites by the Masterbeef camera
- Accurate and consistent assessment of the complete marble score range

5.2 Process of adoption

The Masterbeef device was essentially road tested in grading carcases prior to the JBS trial. Therefore, adopting the device in the JBS was not a huge task. The task of adopting to suit the JBS specific requirements was however a bigger task than first planned. Spencer roll grading was a new concept for Masterbeef as the device was design originally for cut surface grading at a site where the spine was sawn and the ribs opened.

The operator training side of the implementation went very smooth with all operators of any age learning the device controls very fast. The graders were very positive to the digital grading devices which made the training exercise very easy.

The Masterbeef package offers operators the ability to utilise the Masterbeef data portal to store and view their images and data. For those who would prefer to move that data to their own systems there are two options to do this dependant on the complexity of their own IT systems. A simple option is download an XLS file from the Masterbeef PC based carcase assessment web APP or for the more advanced systems there is a documented API process for automatic data transfer from database to database.

5.2.1   OM Technology install & evaluated for trial ready

The process of adoption of the Masterbeef technology has now been simplified based on learnings from the JBS project. This was mainly learned from understanding the client processes and IT security restrictions.

5.2.2   Data integration protocols

The data integration still remains the only in complete process that was not fully achieved. Data was successfully pulled from the Masterbeef database using the Masterbeef defined API process and stored in the JBS database. The next step of integrating the Masterbeef information in the JBS customer feedback portal was not fully implemented.

5.2.3   Training dedicated OM device

The device has been developed around the users needs from inception, hence useability and ergonomics was a top priority. Therefore the training time required to use the device is relatively short. An experienced grader is able to be trained in successful use of the device in less than 2 hours and be proficient in its use within one shift.

5.2.4   Data analysis and visualisation

The Masterbeef web portal allows the images and associated data to be searched and viewed easily. Previous grading results are accessible using date range filters. Images can be sorted by grade time/date, body number, marble score, marble fineness, marble distribution or plant.
The screenshot below shows a sample of the Masterbeef Carcase image portal.

Figure 4: Masterbeef Carcase image portal

Grading results can also be managed within the Masterbeef website or APP. For example, results can be shared to other Masterbeef users such as cattle suppliers. This allows the supplier or breeder to get firsthand data access to help them manage their business.

5.2.5 Review business rules to get the most out of Objective Measurement

The most important change of management consideration noticed during the JBS trial was to consider the data flow from an external data source (Masterbeef). The API allows for data to be pushed from the Masterbeef database or pulled out of the Masterbeef database to the abattoir database. There is first class security measures around the access to the Masterbeef database. The greater task is for the abattoir IT team to decide how their system will best deal with 3rd party data to be input into their system.

Another important consideration for users is to decide what Masterbeef data they plan to forward to their cattle suppliers. It may take time to manage the relationship between the abattoir and the untrained cattle supplier. Masterbeef's opinion is that all data should be available to the cattle producers.

5.2.6 External company support

Masterbeef Pty Ltd owners and staff are essentially IT consultants so no external IT support is required for implementation.

5.3 Key considerations, insights & lessons learnt

The Masterbeef carcase grading camera is a device designed to do a consistent task as it has been trained. Humans are able to make on the run decisions to change or alter outcomes based on personal preference. Devices can only be set up do this if the variables are clear and the decision making process can be set out clearly based on defined parameters.

Artificial intelligence (AI) is relied upon heavily in modern day life. Object detection has been very successfully carried out by AI particularly where consistency is present such as number plate and sign recognition, etc. Whilst Red meat grading may seem like a consistent article to train on, the intricacies of a cut surface vary extremely when they are examined in detail for subtle differences.

AI is very useful where a large set of training data (images) is aligned to accurate and precisely measured facts (grading data).

The Masterbeef camera is best implemented at plants by accredited graders. Fast collection of data should be the key objective. Current data collection units require either two operators and a clear communication between the grader and the data entering person or the grader to constantly remove focus from the assessment sight to manually enter data in the device. The Masterbeef camera can record images not only for the device to calculate grading data on immediately within the camera software but also to recall for review later if required.

The age of the grader was no barrier to use the Masterbeef camera. In fact, older graders appeared to grasp it's use faster due to their confidence and skill in manual grading. Younger graders grasped using the device quickly, however, were slower in deciding if it was aligned to their manual grade opinion.

User defined trait recording capabilities were built into the Masterbeef camera to allow experienced graders to record their opinion of a trait against the OM devices record. With both records stored together it enables a very solid data set of instances where the grader agrees or otherwise with the OM devices outputs.

Plant graders did not push back on these technologies as many may have anticipated. Masterbeef's experience was that all graders trained on the OM technology embraced it with enthusiasm and were positive about adoption of such technology in the future.

The project enabled more honest feedback from plant graders not only on the ability of the device to grade accurately but on its practical useability. The device software and hardware was developed rapidly during the process to keep the users engaged and reward their fast and honest feedback.

Understanding the needs and processes of the plant is the initial step for consideration. Even within a company different processing plants have evolved differently over time. Their age, layout and build style have required different processes to be implemented to operate them to their best efficiency over time. The OM technologies are the last kid on the block so they must adapt to suit the plants. Whilst logically it may seem obvious to change a plant to suit the rest of the industry, logistically and financially, modifications to a plant will be prohibitive.

5.4 Potential barriers to adoption

Table: Barriers to adoption

Barrier / challenge	Mitigation
Incumbent system change and supplier acceptance	Start cattle supplier feedback with images to educate the whole chain of supply on meat quality
Lack of confidence in the OM device's data	Understand the confidence level in the current system. Study accuracy and precision in current system versus OM Technology

Changing industry perception of beef breeders on what good quality carcases are	Start the conversation with cattle breeders. Show images and data from their supplied carcases. Show comparisons to higher and lower quality products
Human grader concern for job loss	Include and educate graders. They have always used technology and this is simply moving forward. (Note: there was no negative sentiment evident from any plant graders during this trial)
Human and financial capital requirements	OM software and hardware development will require industry support to continue
Full suite of grading measures not apparent	Meat and Fat Colour traits not accurate and require more R&D

5.5 Conclusion & Recommendations

5.5.1   Conclusion

From the perspective of the OM technology developer this commercialisation project was one of the most valuable periods of our development. With over 8 years of carcase image collection and calibration with various private operators and the AusMeat/MSA Accreditation trial work our product has evolved into a very stable industry tool. This project however allowed Masterbeef to gain some real insights into the commercialisation side with a better understanding of the abattoir's requirements and operating environment which will be invaluable in driving the wider adoption of the device.

5.5.2   Recommendations for future work

This project focused mainly of replacing current data collection and carcase grading systems.

The Masterbeef carcase grading App is only a part of the overall suite of genetic improvement tools. Future projects may be better served if one or more producers were involved from the start to understand the complete suite of tools from on farm data to carcase data with connection to Genomic profile and then prediction tools. If this work was to be showcased by known industry beef producers, the industry's understanding of the relevance and importance of using OM Technologies would be more easily expressed. When cattle (beef) producers can see a return on their money and time spent they are more likely to adopt better processes.

5.5.3   Commercialisation

Supplier feedback is a large part of our current carcase data collection system and change to the incumbent system may be painful. Having said that very few cattle breeders actually understand the current grading system. Their issue will be more about feeling they will be penalised for not producing good quality beef. If we use images as feedback, they will learn more about meat quality and the sooner this happens the faster payment grids can be linked to meat eating quality.
If all we gain initially is to replace our current manual data collecting units with modern operating systems with images that will be a huge first step. The whole supply chain has access to the images if required to take away the potential distrust that may sit within the current system.
Once we have smart devices in use, we can then create many more data linkages such as Bluetooth pH readers, live feeds to other plant systems for real time boning run decisions.

The speed of data collection will increase particularly when full data collection such as MSA grading is required.

With the Masterbeef device App when a grader does not agree with the devices score or grade they have the option to easily enter their own opinion. Both records are kept and the appropriate data is used in the commercial trade. With an Accredited grader using the device and overseeing the data, by default the recorded information should be classed as Accredited.

6. Conclusion

6.1 Key findings

- Current OM technologies have moved rapidly in the right direction
- Industry acceptance will be required for human and financial capital to continue to be invested in this area
- A controlled implementation combining incumbent and OM grading systems will be required
    - Integration of digital images into supplier feedback initially will assist them in understanding what OM devices are built on
- Consider those who will feel the changes the most
    - Beef producers may feel negative value changes in their product are eminent
    - Meat sellers may feel price downgrades are going to affect their profit
- Education of the whole supply chain will be required
    - What the OM devices are measuring?
    - Why are new technologies required?
    - Why is consistent feedback important to breeders feedback and genetic gain?
    - Why is meat quality important?
    - How do the OM technologies help understand meat quality?
    - Why do higher eating quality animals/cuts demand premium prices?

6.2 Benefits to industry

The red meat industry and more specifically the beef industry will feel more pressure from competing proteins as the global pressures change over the next few decades. Our goal must be to produce a better product rather than hope that our current standard of product will suffice. A volume article will only be useful if it is desired by consumers.

Our beef industry has numerous products and supporting technologies available to us to apply to our herds and processing systems to produce a compelling product for consumers into the future. If we do not start to utilise these technologies in the immediate future our industry will suffer long term pain. The beef industry has the slowest information feedback loop in all of the competing proteins due to the lifecycle and reproduction rate of cattle. In saying that, beef has the most volume and diverse range of products that we can harvest from one animal.

If we connect information feedback from consumers linked to OM technology data and genomic data we can rapidly increase the rate of genetic gain in beef.

Masterbeef has already utilised its technology coupled with world leading Artificial Intelligence software to create genomic predictors for meat eating quality traits for forward thinking cattle producers. Such state of the art initiatives can only be realised if we have solid data from our product to do so.

7. Future research and recommendations

The fineness and distribution of marble appear to be a variables that graders are subconsciously using to fine tune their marble scoring thought process. If OM devices can score these traits a more defined determination of their input into a marbling score may be achieved.

Currently no standard exists for fineness and distribution of intramuscular fat in the Australian red meat industry. OM devices would be required to measure such traits as they would be extremely hard to measure with standard human rated visual comparison cards or chips. Due to the huge variety of shapes, volume, quantity and location of intramuscular fat particles in the rib eye area, standard cards or chips would not be a viable way to measure these traits.

If marble is measure by IMF%, fineness and distribution then these facts can be used on studies where sensory taste tests are carried out and help build a better understanding of any relationships that may exist between them.