Final report

Utilising the VIAscan OM grading solution to provide objective carcase measurement

Project code: P.PIP.0593

Prepared by: Allister Watson
Australian Meat Group
[Technical input provided by Craig Daff and Karl Mueller]

Date published: 2 June 2023

PUBLISHED BY
Meat and Livestock Australia Limited
PO Box 1961
NORTH SYDNEY NSW 2059

This is an MLA Donor Company funded project.

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

Abstract

This project aimed to deliver an early adoption and evaluation of the VIAscan grading device to measure ribeye grading characteristics in beef to improve accuracy and consistency compared to current manual grading systems. This project developed operating protocols to enable adoption of a grading solution using the VIAscan grading system for future adopters. Specifically, the project evaluated the integration of the VIAscan solution into a beef processor's workflows and business data management systems, including feedback to producers. General learnings from this project were used to develop generic guidelines for adoption and integration of new OM technologies.

The project was instrumental in facilitating a relationship between R&D, engineering and industry that is vital to ensure that the VIAscan CAS can perform in an actual production environment.

The key takeaway from the project was that objective measurement devices and associated solutions need to be very ergonomic even at the expense of robustness, otherwise it is very difficult to overcome apprehension and resistance to adoption.

Another very important insight that was learned through the partnership with industry was it is best to have a single device for the collection of all grading traits, even if those traits are not specifically predicted by the device as this reduces the amount of equipment that must be carried.

The realisation of these insights because of this project means these particular aspects will be able to be applied to future developments in the red meat industry and overcome these barriers to adoption more readily.

The results and key findings of the project were that cut surface cameras, such as the VIAscan camera used for predicting grading traits are an important technological advance in the red meat industry, but it is vital that these devices satisfy operator expectations with regards to functionality, portability, and usability otherwise uptake of this technology is hampered despite accuracy and repeatability of trait predictions.

To remain relevant as a reliable OM solution, it is also critical that the technology provider remains at the leading lead to ensure that the technology maintains its AUS-MEAT accreditation, and continuously seeks advancements on accreditation of new traits where applicable. To this end, it is recommended that ongoing work will continue improving the accuracy of the predictions and research and development of new technologies to support and enhance the prediction of meat grading traits.

Future developments for VIAscan CAS include but not limited to:

- Development of additional trait data entry fields in accordance with AMG recommendations during the project trial stages.
- Re-engineering of the VIAscan CAS to improve on the construction and physical design, in accordance with AMG recommendations that there were too many screws used in its construction.
- Addition of Artificial Intelligence and Machine Learning algorithms for supplementing the trait predictions. Presently several ML classification models have been trained for AUS-MEAT meat colour classification with the highest validation accuracy of 86%. Models are currently being developed and trained by Marel Cedar Creek engineers for rib eye detection, which will considerably enhance the entire image processing pipeline.

- Re-calibration or redevelopment of trait predictions of AUS-MEAT marbling and Meat Colour which were both very close to exceeding AMILSC minimum standards.
- Participation in more grading trials to test the system and collect additional calibration/training data.
- Continued engineering of the system to make it more ergonomic.
- Continued development of the system to make it more energy efficient.
- Subcutaneous fat measurement instead of rib fat
- Move to a machine learning model for meat colour prediction
- Lightening internals to use aluminium instead of stainless
- Engaging with the Marel innovation team for additional support with the project

Executive summary

Background

Carcase grading is currently done by trained and qualified graders in the plant. Whilst they are trained and have very good guidelines to follow, each grader can see different things and the consistency across the industry is not as good as it should be. By introducing an objective measuring tool such as the VIAscan, the accuracy and consistency can be achieved across many plants. The objective measures will then be able to be used in better grading of carcase's, more consistency for customers and better feedback to producers enabling them to produce animals for optimal results.

VIAscan measures four carcase traits of eye muscle area, both MSA and AUS-MEAT marbling, meat colour, and fat colour. With these objective measurements, AMG will have the ability to grade more accurately and both recognise and provide feedback to the producers that are consistently meeting their optimum carcase requirements.

Objectives

The overall project objective is to deliver an early adoption and evaluation of the VIAscan grading system to measure beef ribeye grading characteristics with improved accuracy and consistency compared to current manual grading systems.

The specific objectives of the project are:

- Test and trial integration of developing equipment and integration of software into feedback systems including MSA grading outputs (across multiple sites and animal types)
- Evaluate the integration of the VIAscan grading solution into AMG's operations' workflows and business data management systems, including feedback to producers
- Evaluate device grading capabilities across multiple classes of animals and sites
- Develop protocols on how to integrate new OM technologies including data captured into existing business systems
- Develop generic guidelines for adoption and integration of new OM technologies

Methodology

The methodology used for the pre-commercial trial and the Device Trial: Testing Phase 1, involved an on-site visit, training, and demonstrations by Marel Cedar Creek engineers over a period lasting several days each. After training and demonstrations were complete, the CAS unit was used by plant graders to grade the prescribed number of carcases, and feedback was provided. The results generated by the unit were analysed. At the end of the Testing Phase 1, the unit was left in the care of AMG for graders to complete Testing Phase 2.

Results/key findings

The primary results and key findings of the project were that cut surface cameras used for predicting grading traits are an important technological advance in the red meat industry, but it is vital that these devices satisfy operator expectations with regards to functionality, portability, and usability otherwise uptake of this technology is hampered despite accuracy and repeatability of trait predictions.

The key takeaway from the project was that objective measurement devices and associated solutions need to be very ergonomic even at the expense of robustness, otherwise it is very difficult to overcome apprehension and resistance to adoption.

Another very important insight that was learned through the partnership with industry was it is best to have a single device for the collection of all grading traits, even if those traits are not specifically predicted by the device as this reduces the amount of equipment that must be carried.

Benefits to industry

This project identifies insights and lessons that can be adopted by VIAscan CAS engineers and by any R&D project team creating devices for the red meat industry. The most important insight and lesson is that the technology needs to be as ergonomic as possible otherwise this alone will create substantial barriers to adoption regardless of any other feature or function of the technology. Another key insight and lesson were that the technology needs to be all-encompassing (i.e. a meat grading device that predicts a subset of meat grading traits) and should also be able to accept and store entry of all meat grading traits.

Future research and recommendations

Future research and development for VIAscan CAS should be aimed primarily at the ergonomic aspects and data entry aspects of the system as these were the key areas identified by AMG during the Pre-commercial and Testing Phase 1 trials as major barriers for adoption.

To remain relevant as a reliable OM solution, it is also critical that the technology provider remains at the leading edge to ensure that the technology maintains its AUS-MEAT accreditation, and continuously seeks advancements on accreditation of new traits where applicable. Work will also continue improving the accuracy of the predictions and research and development of new technologies to support and enhance the prediction of meat grading traits.

Table of contents

1. Background, scope and purpose

1.1 Background

Red meat traits are graded using manual and primarily visual subjective methods. Not only are these manual grading methods tedious, they are also open to inaccuracies in the data captured. Developing precise objective measurement methods is an industry strategic 2025 imperative to capture more accurate data to support alternative pricing methods for producers. There are a number of objective measurement technologies at various stages of validation and accreditation for grading red meat traits. This project was submitted in response to an open call for co-investment proposals from businesses seeking to trial and adopt emerging objective carcase and/or live animal assessment technologies. While some technologies may not yet have achieved AUS-MEAT accreditation, the opportunity was open to all technologies for businesses to test and trial integration of developing equipment, and, where applicable, integration of software to enable MSA grading outputs from these technologies to plant systems.

VIAscan measures four carcase traits of eye muscle area, both MSA and AUS-MEAT marbling, meat colour, and fat colour. With these objective measurements, AMG will have the ability to grade more accurately and both recognise and provide feedback to the producers that are consistently meeting their optimum carcase requirements.

Stage 1 of this project is to introduce the VIAscan into AMG Dandenong operations to replace the manual grading system currently being used, ensure that it is efficient and safe to use, determine what improvements need to be made to the system, and measure the gains made. It is envisaged that if Stage 1 is successful then a second project will be introduced (Stage 2), which will see the system introduced to the new AMG plant in Cootamundra and be linked to an RFID tracking system for carcases in the plant.

Carcase grading is currently done by trained and qualified graders in the plant. Whilst they are trained and have very good guidelines to follow, each grader can see different things and the consistency across the industry is not as good as it should be. By introducing an objective measuring tool such as the VIAscan, the accuracy and consistency can be achieved across many plants. The objective measures will then be able to be used in better grading of carcase’s, more consistency for customers and better feedback to producers enabling them to produce animals for optimal results.

A major concern in the processing industry is the shortage of labour and people interested in working in this sector. There is high turnover in all areas, and it is hard to retain staff. There is currently a large cost in training people to be qualified and certified carcase graders and it is ongoing. With a VIAscan system it is envisaged that the VIAscan itself will be certified and it won’t need a qualified grader to operate it in the future. This will give processing plants flexibility in who operates the scanner and will save ongoing training costs and time.

Previous scanners have been stationary and too large which have made them hard to use in confined chiller space. The more portable new VIAscan should be more flexible and easier to use. The current VIAscan system is not capable of completing all grading tasks required to grade a carcase. This creates the need to complete a second grade on each carcase which could prove costly and inefficient. By working with Marel/Cedar Creek on this project, it is anticipated that the VIAscan system will be improved to the point where only one grading will be required eliminating the requirement to perform a second grade improving the viability and performance of the system.

The value proposition for AMG is to use the VIAscan technology to determine more accurate carcase grading whilst being more efficient and less costly overall than the current manual grading system. The efficiency will be measured by using the existing cost of manual grading including all the training time and certification fees, and comparing that with the total cost of introducing a VIAscan into AMG's Dandenong plant.

The carcase grading will be measured by determining the grade mix over a six-month period using the VIAscan and comparing it to the same six month period in the previous year using a manual grading system. Whilst this will be dependent on cattle mix it will form a pattern to determine a grade shift and can be calculated to a cost/return difference. If the costs are less than the current manual grading system then there is an expectation that the processing industry will adopt this technology and introduce it to their plants.

If producers are getting valuable information from this technology and can make adjustments on farm for better return then it may encourage them to seek a processor that has a VIAscan that can provide better feedback. This project implemented the VIAscan grading solution which will provide an objective measurement of key carcase traits improving accuracy and consistency compared to the current manual grading system.

There are currently no protocols for the adoption, implementation and integration of new objective measurement technologies into processor business operational and feedback systems. This project was designed to develop operating protocols to enable adoption of a grading solution using VIAscan grading device for future adopters. Specifically, the project evaluated the integration of the VIAscan grading solution into AMG's operations' workflows and business data management systems, including feedback to producers.

1.2 Project scope

This project aimed to deliver an early adoption and evaluation of the VIAscan grading system to measure ribeye grading characteristics in beef to improve accuracy and consistency compared to current manual grading systems. This project developed operating protocols to enable adoption of a grading solution using the VIAscan grading device for future adopters. Specifically, the project evaluated the integration of the VIAscan solution into a beef processor's workflows and business data management systems, including feedback to producers. General learnings from this project will be used in consideration of other concurrent early adoption OM projects to develop generic guidelines for adoption and integration of new OM technologies.

1.3 Expected outcomes

The desired outcomes of the project included:

- VIAscan will be installed and commissioned at the AMG Dandenong plant
- VIAscan will be more accurate and consistent than the current manual grading system
- VIAscan unit will be approved to be used by a non certifies AUS-MEAT grader
- VIAscan unit will save AMG time and labour so it pays for itself
- VIAscan unit will incorporate all the grader functions and upload to myMSA in real time
- VIAscan unit will provide producers with more accurate information on their carcase grading so they can improve their cattle and returns
- VIAscan unit will be improved to allow the project to move to Stage 2 and allow it to be linked to a carcase RFID system at AMG's Cootamundra plant

This project will contribute to a series of case studies generated through concurrent early adoption projects of several objective measurement (OM) technologies that were identified through an Open Call process. General learnings from this project will be used to develop generic guidelines for adoption and integration of new OM technologies. The outcome will be a comprehensive final report that captures the lessons learnt, including challenges encountered and solutions identified to improve opportunities for future adopters.

2. Objectives

The overall project objective is to deliver an early adoption and evaluation of the VIAscan grading system to measure beef ribeye grading characteristics with improved accuracy and consistency compared to current manual grading systems. This project will contribute to a series of case studies generated through concurrent early adoption projects of several objective measurement (OM) technologies that were identified through an Open Call process. General learnings from this project will be used to develop generic guidelines.

The specific objectives of the project were:

- Test and trial integration of developing equipment and integration of software into feedback systems including MSA grading outputs (across multiple sites and animal types)
- Evaluate the integration of the VIAscan grading solution into AMG's operations' workflows and business data management systems, including feedback to producers
- Evaluate device grading capabilities across multiple classes of animals and sites
- Develop protocols on how to integrate new OM technologies including data captured into existing business systems
- Develop generic guidelines for adoption and integration of new OM technologies

Develop a case study of learnings of integration of VIAscan grading system into business workflows and operating systems used to develop generic guidelines for adoption and integration of new OM technologies.

3. Methodology

AMG partnered with MLA and Marel/Cedar Creek to trial and validate their VIAscan system across the pilot Dandenong site. The methodology involved using the Marel Cedar Creek extensive expertise to significantly advance the MLA objectives to drive the adoption of such solutions within the MSA and AUS-MEAT process, procedures and practices.

The phased process steps included:

- Marel/Cedar Creek provided AMG a proposal to supply one VIAscan unit to the Dandenong plant after the trials in Queensland have been completed and the unit is approved by AUS-MEAT and MSA.
- The VIAscan unit was installed in AMG Dandenong with operators trained and site certification to MSA standards achieved.

- AMG will measure the efficiency of using the VIAscan unit and accuracy of the unit compared with the manual grading system currently used. This measurement will determine the value proposition for AMG and what will make this project successful.
- AMG will work with Marel/Cedar Creek to provide feedback on the unit, what works and doesn't work, what improvements are required, and what the next steps are.
- A review of the VIAscan system and the value proposition will be reported 2 months after commissioning of the unit to determine if the project is on track and the next steps.
- The project will be reviewed at 6 months and 12 months from commissioning. If it is determined at these review period, that the proposed outcomes are not being achieved then the project can be put on hold until all parties determine the next steps.

The following method and process steps were applied:

i) Project planning and design [Milestone 1]
ii) Supply and commission equipment [Milestone 2]
iii) Conduct device trials as per trial plan [Milestone 3]
Go/No Go decision Point: Trial-ready VIAscan device commissioned, initiated training and testing protocols, and trial plan approved as scheduled.
iv) Conduct device trials as per trial plan [Milestone 4]
v) Final report [Milestone 5 – this report]

3.1 Project planning, design and equipment supplied [Milestone 1]

Conduct start-up meeting with AMG project team, Marel/Cedar Creek and MLA. Form steering project group. Trial plans. Design and integration requirements. The progress report, including trial plans, design and integration requirements will be submitted to MLA for approval. AMG sign subcontract with Marel/Cedar Creek once VIAscan approved.

3.2 Supply and commission equipment [Milestone 2]

Install, commission, training of dedicated personnel and pre-commercial test VIAscan in AMG Dandenong.

3.3 Conduct device trials as per trial plan – Phase 1 [Milestone 3]

Conduct device trials as per trial plan (Testing phase 1). Data collection and data integration. Review device performance and usability. AMG report on results vs expected outcomes for initial testing period. The progress report, including trial work submitted to MLA for approval.

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

3.4 Conduct device trials as per trial plan – Phase 2 [Milestone 4]

Data collection and data integration (Testing phase 2). Review device performance and usability. The progress report, including results of phase 2 trial work submitted to MLA for approval.

3.5 Final report [Milestone 5]

Confidential report of commissioned, training and testing protocols, data collection, integration systems, trial results and recommendations for next commercial R&D phase. 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, design and equipment supplied [Milestone 1]

4.1.1 Start-up meeting

The initial pre-project planning meeting with AMG and MLA was conducted on November 10, 2021. [Refer to Appendix, see Section 7.1 Initial AMG & MLA meeting & project planning: Brief notes and agreed actions].

Subsequently, the start-up meeting with the project steering group, including AMG, Marel/Cedar Creek and MLA was conducted. [Refer to Appendix, see Section 7.2 AMG VIAscan steering group meeting & project planning: Brief notes & agreed actions]. Ongoing engagement and project planning between AMG and Marel/Cedar Creek was conducted, as required.

4.1.2 Develop trial plans

[Refer to Appendix, See Section 7.4 Trial plans, including Design plans, design & integration requirements].

4.1.3 Design & integration requirements

Design plans, design & integration requirements, including the required components:

- Data collection and data integration
- Device performance and usability
- Optimisation & redesign
- Plant accessibility, livestock supply and available grading staff
- Availability of MSA graders for validation trials

[Refer to Appendix, See Section 7.4 Trial plans, including Design plans, design & integration requirements].

4.2 Supply and commission equipment [Milestone 2]

The supply and commission equipment phase included:

- Install and commission equipment
- Training of dedicated personnel
- Pre-commercial test VIAscan in AMG Dandenong

4.2.1 Install and commission equipment

Installation and commissioning of the VIAscan equipment was completed at AMG, Dandenong using a loan device until the new AMG device is assembled and delivered. Installation was originally based around using a 240v supply plugged into a standard GPO. However, given there were no GPO's close to the chillers the unit was installed using a temporary battery pack. Provider (Marel/CC) is currently working on a permanent battery pack solution for future use. [Refer to Figure 1].

Figure 1: VIAscan equipment similar to the loan equipment used in the pre-commercial commission trial.

4.2.2 Training of dedicated personnel

Initial training of dedicated personnel in using the VIAscan CAS unit has been completed at AMG. Operators were shown how to operate the software and locate the device over the eye muscle area and trigger the imaging process. Operators were also trained in the start-up and shutdown process and how to calibrate the system. Operators were shown the grading screen presented to the user once each carcase is graded to understand the results. [Refer to Figure 2].

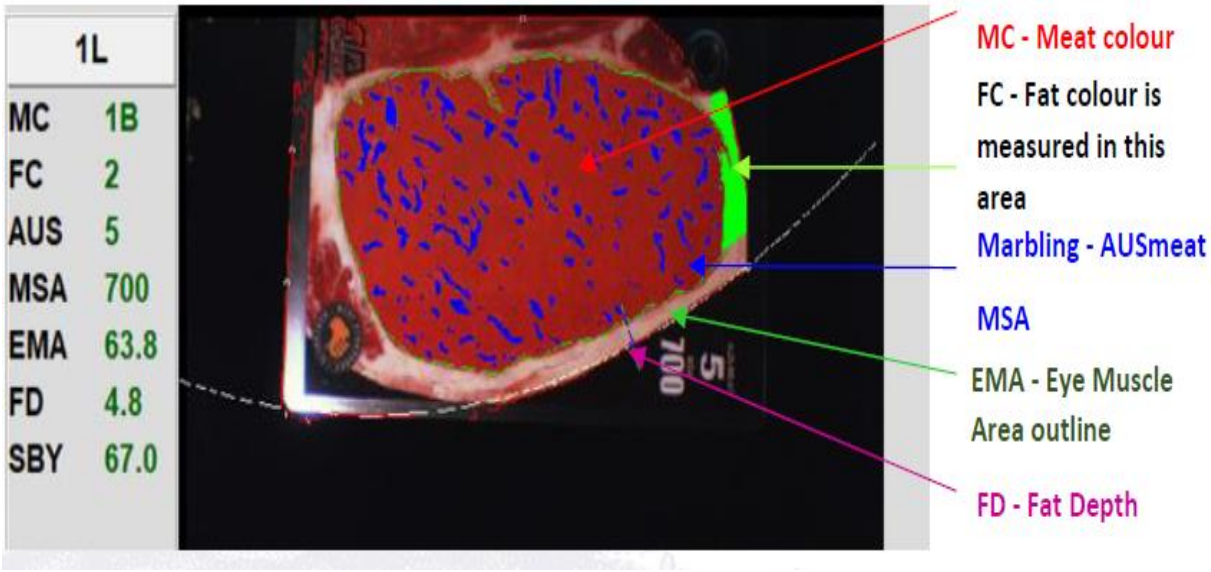


Figure 2: Grading screen used to train grading operators.

On-site training and demonstrations were provided for the operation of the VIAscan CAS system. The two graders participating in the trial were both shown how to use the system. The graders were able to quickly master the operation of the system. Throughout the trial Marel Cedar Creek technician was available on-site to assist with any operational problems. It is noted that there were not any operational issues experienced throughout the entire trial period.

4.2.3 External company support

External company support was provided by MLA for facilitation of the partnership between AMG Dandenong and Marel Cedar Creek.
The ongoing support of the AMILSC for conducting trials and developing standards in conjunction with MSA and AUS-MEAT for cutting-edge grading technology is vital for the VIAscan CAS technology development.

4.2.4 Pre-commercial test VIAscan in AMG Dandenong

An initial pre-commercial trial was performed at initial pilot AMG plant where 100+ bodies were graded across two days. Data from the trial will be extracted from the VIAscan unit once it arrives back in Brisbane and compared to the manual grade results. The trial was considered successful with no operational issues or equipment malfunctions. A further trial grade is planned where carcases will be graded across one week and compared to the manual grades. Dates for the next trial have not been confirmed as Marel Cedar Creek are building a new unit to be used in the trial.

The pre-commercial start-up trial identified a series of questions from AMG integration perspective. All major concerns from AMG about the unit were noted and will be actioned as best as possible before the commencement of the 1-week trial included in Milestone 3, with the view to addressing all major concerns by the time we commence Milestone 4, which includes the six-month trial period.

4.3 Conduct device trials as per trial plan (Phase 1-2) [Milestones 3-4]

Conduct device trials as per trial plan (Testing phase 1), included:

- Data collection and data integration
- Review device performance and usability
- AMG report on results vs expected outcomes for initial trial period

4.3.1 Data collection and data integration

As part of this project the VIAscan unit will be integrated into the plant inventory system where data can be reported on and analysed. Development work for the integration has commenced with Cedar Creek and will be deployed to AMG once complete.

4.3.2 Review device performance and usability

Some good feedback was provided during the pre-commercial trial which Marel Cedar Creek will take on board for potential future development. Other points noted during the trial were as follows:

- Together with the VIAscan unit the Graders need to carry their torch, PDA, meat colour grading chips and PH probe to measure the other traits that VIAscan does not calculate. For ease-of-use Marel Cedar Creek will look to add those additional traits to the VIAscan screen so Operators can enter these details manually on one device rather than 2 x separate devices. The unit will need to be verified and approved by AUS-MEAT in order to grade all aspects for MSA accreditation.
- Reducing the weight, and possibly the size, of the unit would be beneficial. Marel Cedar Creek have a prototype of a lighter hood design that will significantly decrease the weight of the unit which will be trialled and tested in the future. There is limited room in the chiller between rails and it is important that the unit is not cumbersome for the operator.
- The VIAscan unit is currently only designed to grade the left side of the carcase so this may need to be managed at AMG so that that left sides only are quartered when the VIAscan unit will be used. AMG will discuss this with the Operations team and report back at the next steering committee meeting if this change of process can be implemented.
- At times, the quartered side was not opened up enough for the VIAscan unit to image the eye muscle area. AMG may need to look at opening up sides more when the VIAscan is used. There needs to be a consistent standard that the VIAscan can work with as all quartering is done to meet the cut requirements in production irrespective of the scanning method being used.

The pre-commercial start-up trial identified a series of questions from AMG integration perspective. These will be addressed as part of the next ongoing testing and optimisation phase.

4.3.3 AMG report on results vs expected outcomes (for initial trial period)

Initial trial results appeared positive. For example, Meat Colour results were being calculated manually by the grader and then compared to the VIAscan unit and most of the time they were a match or very close. Once the complete data set has been extracted from the unit and analysed, Marel Cedar Creek will put together a report for submission to AMG comparing manually graded results with VIAscan.

4.3.4 Data analysis and visualisation

Data collected by the CAS unit during each of the trial sessions was analysed and compared to grader data. Discrepancies were noted.

The outcomes of analyses of data captured in the initial test phase 1 at the pilot AMG Dandenong plant from the commencement of the project until 12/01/2023 are shown below in Figures 3-6.

It is important to note with these statistics that at the time of Testing Phase 1, VIAscan CAS had passed AMILSC minimum standards for prediction of MSA marbling scores, and had also achieved very good results with meat colour and AUS-MEAT marbling predictions.

4.3.5 AUS-MEAT accreditation status

VIAScan CAS performed successfully in the November 2022 grading trials to exceed minimum Australian Meat Industry Language and Standards Committee (AMILSC) performance benchmarks for MSA marbling and has received conditional approval for prediction of this trait. The calibration parameters used for this trial were identical to the ones developed for the AMG unit. AMG Unit Calibration data was collected September 2022 at ACC abattoir and calibrated against three expert AUSMEAT/MSA graders. Accuracy results are calculated based on first image only.

CAS exceeded AMILSC accuracy standards for MSA marbling and AUSMEAT high marbling. [Refer to Figures 3 & 4].

Table 1: VIASscan CAS November 2022 MSA Marbling results

MSA Marbling	**=+/-50**	**0 - 100**	**0 - 200**	**201 +**	**N**
VIAScan	70.3%	90.3%	99.2%	0.8%	637
AMILSC Standard	>=49%	>=79	>=97%	<3%	NA

VIAscan CAS has participated in the March 2023 grading trial at ACC plant, Cannon Hill and exceeded minimum AMILSC benchmarks for MSA grading once again. At this stage a submission for full accreditation for this trait has not been submitted to AMILSC.

Figure 3: VIAscan CAS November 2022 MSA Marbling analysis.

Further, in December 2022, Cedar Creek provided an update on the calibration and accreditation outcomes as a result of the November 2022 AMILSC accuracy trials, conducted at the Australian Country Choice [ACC] plant at Cannon Hill.

Note the calibration parameters used for this trial were identical to the ones developed for the AMG unit. AMG Unit Calibration data was collected in September 2022 at ACC abattoir and calibrated against 3 expert AUSMEAT/MSA graders. [Note accuracy results are calculated based on first image only].

After the accuracy trial, the traits of meat colour were compared to AMILSC specification (as at March 2021). The results showed that the meat colour grade recorded by the cut surface camera was ~4% away from matching the expert graders' result. Refer to Figure 9.

In addition, the traits of MSA Marbling and AUS-MEAT Marbling were compared to AMILSC specification (as at November 2022). The results showed that the meat colour grade recorded by the cut surface camera was ~4% off the corresponding matching the expert graders' result. Refer to Figures 4 & 5.

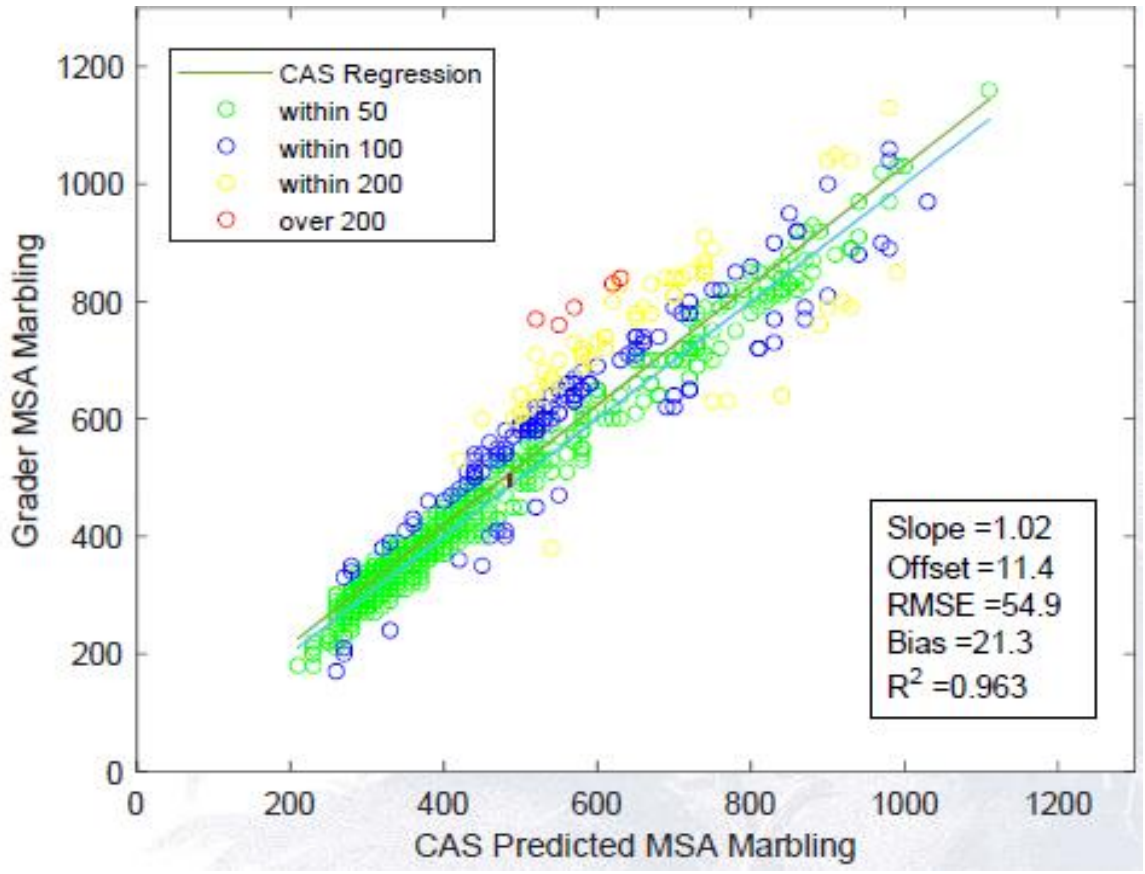


Figure 4: VIAscan CAS March 2021 for MSA Marbling.

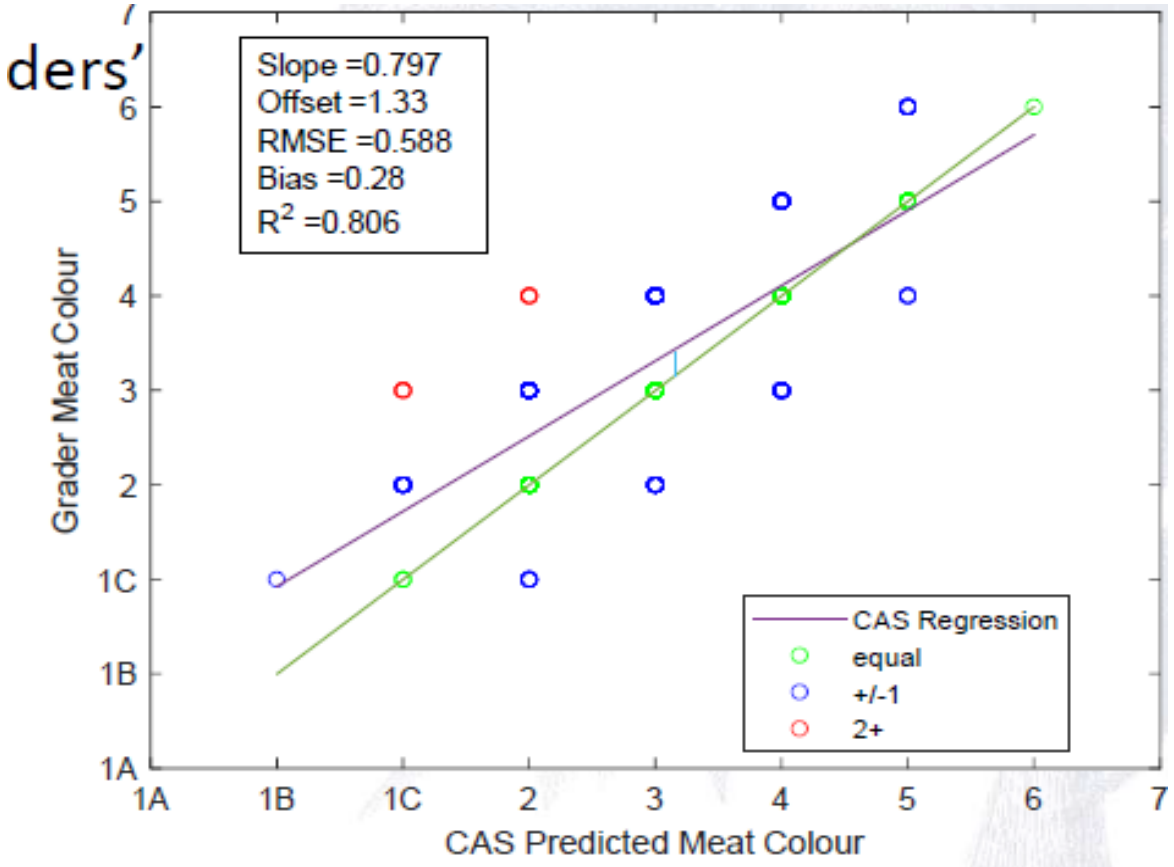


Figure 5: VIAscan CAS March 2021 for Meat Colour analysis.

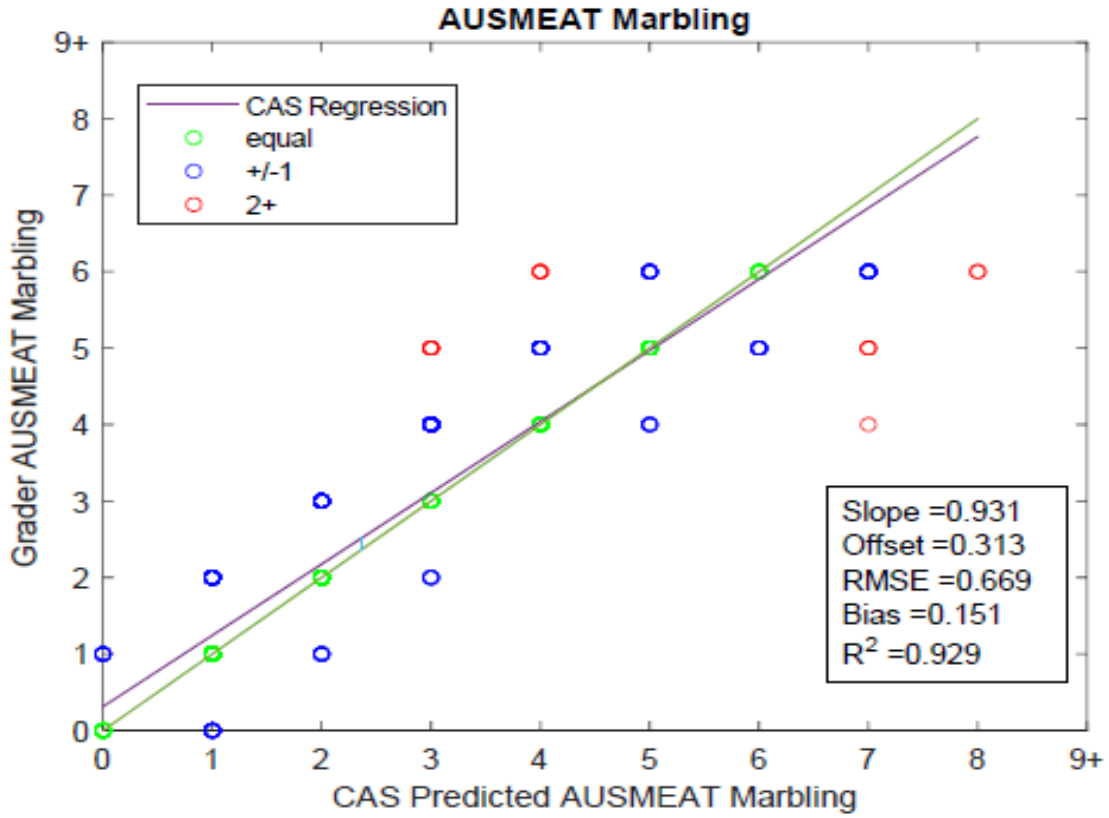


Figure 6: VIAscan CAS accuracy trial in November 2022 for AUS-MEAT Marbling.

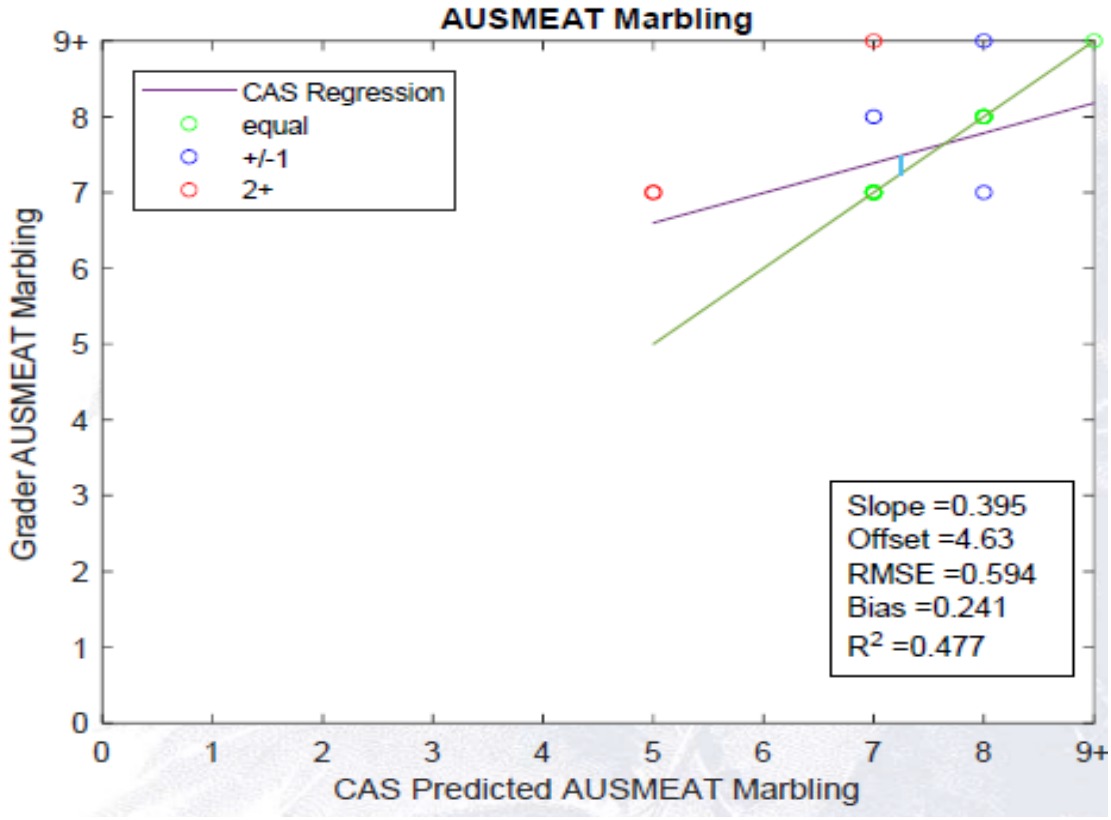


Figure 7: VIAscan CAS accuracy trial in November 2022 for AUS-MEAT high marbling.

Furthermore, additional validation trials were used to compare fat colour with corresponding grader's score. Fat colour was not primarily focused on during previous trials. While results were promising, further work was required. Refer to Figure 8.

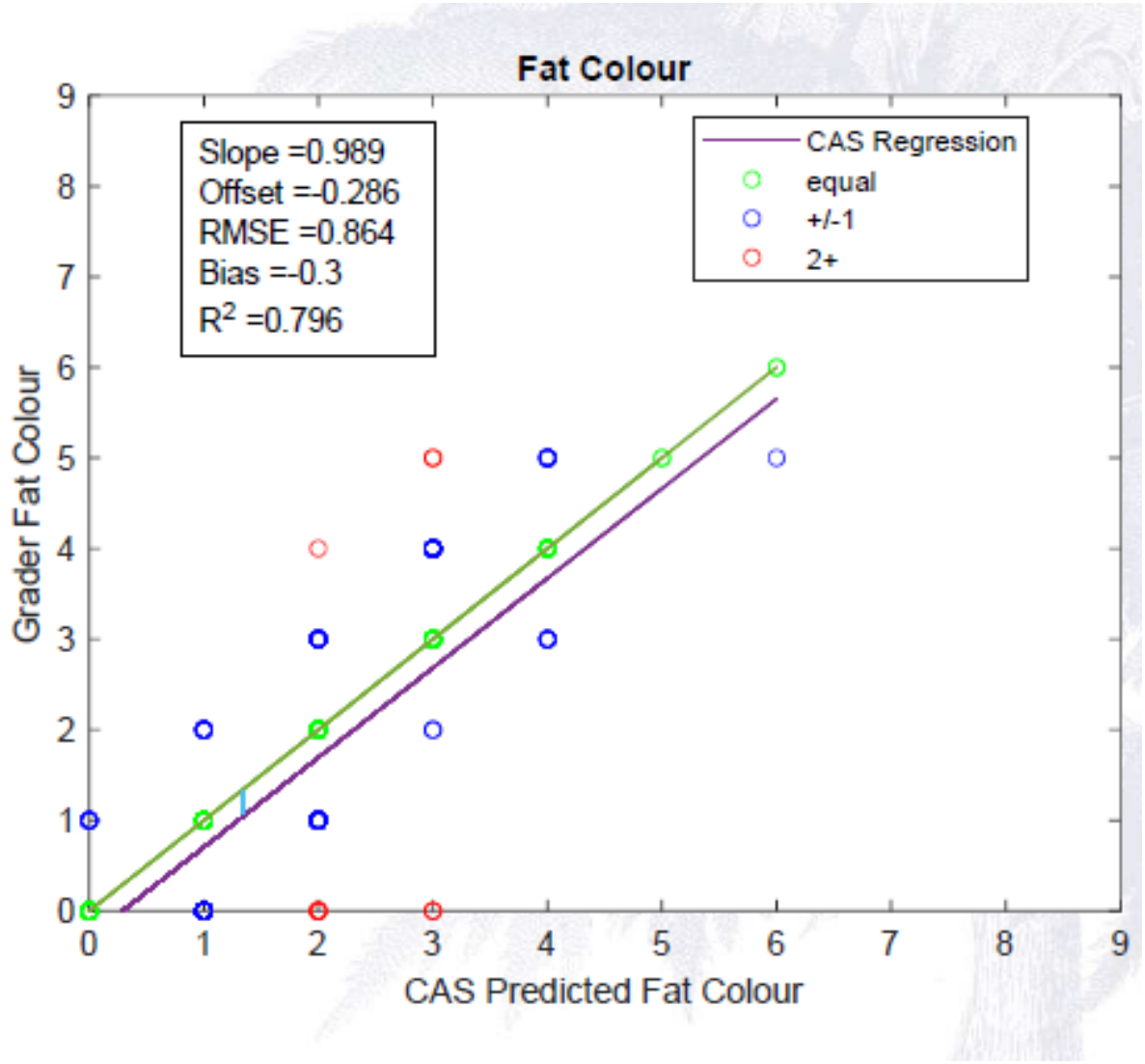


Figure 8: VIAscan CAS accuracy trial in November 2022 for Fat Colour.

AUS-MEAT has indicated that VIAscan has passed accreditation on a full range of MSA and AUS-MEAT marbling, pending the collection and analysis of data from some additional carcases. Specifically, AUS-MEAT requires data from 600 carcases for accreditation and Cedar Creek collected data from approximately 560 carcases in the November 2021 trial. Results were sent to AUS-MEAT / AMILSC to be included in their scheduled May 2022 meeting.

Overall, the current capabilities of VIAscan include:

- Prediction for MSA Marbling (full range, increments of 10)
- AUS-MEAT Marbling [Low (0-6) and high (6-9+)
- Meat colour (1A-7)
- Fat colour (0-11)
- Eye Muscle Area
- [Rib Fat]

It is noted that predictions are made in real-time, at approximately 2-5 seconds per carcase for the full range of predictions. Finally, predictions are shown on the screen and able to be over-ridden if required, with the provision that all overrides are logged into the system to monitor grader changes.

It was a recommendation that the 3D printed shroud be used and has been successful, and field tested during two AMILSC trials. This is included on the AMG camera solution.

Repeatability trials are being scheduled for early January so this data can be included in the future AUS-Meat accreditation trial submission.

4.4 Future developments

VIAscan CAS Future Developments include:

i) VIAscan CAS is in active development
   - Many new capabilities to be added
   - Modifications to existing capabilities and functions

ii) LED Lighting
   - Will significantly increase unit runtime (presently 3 to 4 hours with 18aH battery)
   - Standards for LED lights are available from AUSMEAT

iii) Wearable LiFePO4 battery pack
   - Will increase unit runtime, extending total battery capacity to over 20aH
   - Development has been put on hold at the moment

iv) Hardware pushbutton trigger

v) Subcutaneous fat measurement instead of rib fat

vi) Move to a machine learning model for meat colour prediction
   - Collecting image colour data for training a neural network instead of the current method
   - Possible problems of overfitting with some of the calibrations which this would also address

vii) Lightening internals to use aluminium instead of stainless

viii) Engaging with the Marel innovation team for additional support with the project

To remain relevant as a reliable OM solution, it is also critical that the technology provider remains at the leading lead to ensure that the technology maintains its AUS-MEAT accreditation, and continuously seeks advancements on accreditation of new traits where applicable. To this end, it is recommended that ongoing work will continue improving the accuracy of the predictions and research and development of new technologies to support and enhance the prediction of meat grading traits.

Future developments for VIAscan CAS include but not limited to:

- Development of additional trait data entry fields in accordance with AMG recommendations during the project trial stages.
- Re-engineering of the VIAscan CAS to improve on the construction and physical design, in accordance with AMG recommendations that there were too many screws used in its construction.

- Addition of Artificial Intelligence and Machine Learning algorithms for supplementing the trait predictions. Presently several ML classification models have been trained for AUS-MEAT meat colour classification with the highest validation accuracy of 86%. Models are currently being developed and trained by Marel Cedar Creek engineers for rib eye detection, which will considerably enhance the entire image processing pipeline.
- Re-calibration or redevelopment of trait predictions of AUS-MEAT marbling and Meat Colour which were both very close to exceeding AMILSC minimum standards.
- Participation in more grading trials to test the system and collect additional calibration/training data.
- Continued engineering of the system to make it more ergonomic.
- Continued development of the system to make it more energy efficient.
- Subcutaneous fat measurement instead of rib fat
- Move to a machine learning model for meat colour prediction
- Lightening internals to use aluminium instead of stainless
- Engaging with the Marel innovation team for additional support with the project

The pre-commercial start-up trial identified a series of questions from AMG integration perspective. These will be addressed as part of the next ongoing testing and optimisation phase.

5. Key considerations on adoption of OM [AMG VIAscan CAS Case study]

This section will discuss insights, lessons learnt, opportunity & apparent barriers to adoption of new OM technology and will form part of the public report.

The project was successful in so much as valuable insights were gained and lessons were learned that can be applied to the VIAscan CAS project for its enhancement and future development, and these insights and lessons can be extended to all R&D projects developing new technology for the red meat industry.

With regards to the VIAscan CAS device, there were distinct barriers to adoption that were very challenging to overcome. Physical design constraints and technology choice meant that certain physical attributes and limitations were introduced that created the greatest barriers to adoption.

This section will outline the way that the Pre-Commercial Trial and Testing Phase 1 project stages were conducted and what insights and lessons were obtained. The final analysis of data collected and analysed during these project stages is presented.

5.1 Project brief [Snapshot]

The purpose of the project was to partner with AMG to jointly develop the VIAscan CAS system in line with their requirements, and more broadly the requirements of industry in general.

This partnership achieved two goals. The first goal was to expediate the adoption and use of cutting-edge technology that is currently in active development so industry may reap the benefits from using it. The second goal was for Marel Cedar Creek to gain guidance on the development of the VIAscan CAS so it better aligns with the specific needs of AMG, and the broader red meat industry.

These goals were achieved through collaboration and several on-site trials with respect to the project plan. At each of the trial stages, valuable feedback was provided that was taken into consideration for the next trial.

5.2 Process of adoption

At this stage of the project, the VIAscan CAS is not widely adopted into AMG's grading process due to physical and internal barriers to adoption.

5.2.1 Potential barriers to adoption

There were several apparent barriers to adoption of the technology. The primary adoption hurdles were considered to be:

- Current processes and procedures incompatible with device use
- Weight and overall size of the system that is required to be used in small, confined chiller grading spaces

- General apprehension and resistance to change on adoption of objective measurement technology over well-established manual grader processes

The primary results and key findings of the project were that cut surface cameras used for predicting grading traits are an important technological advance in the red meat industry, but it is vital that these devices satisfy operator expectations with regards to functionality, portability, and usability otherwise uptake of this technology is hampered despite accuracy and repeatability of trait predictions.

The key takeaway from the project was that objective measurement devices and associated solutions need to be very ergonomic even at the expense of robustness, otherwise it is very difficult to overcome apprehension and resistance to adoption.

Another very important insight that was learned through the partnership with industry was it is best to have a single device for the collection of all grading traits, even if those traits are not specifically predicted by the device as this reduces the amount of equipment that must be carried.

Key consideration to mitigation these apparent barriers to adoption were extensive reengineering and material selection and Identification and selection of a project champion. [Refer to Table 2].

Table 2: Apparent barriers to OM adoption from AMG's journey

Apparent barriers	Opportunity
Trust the data	✓ Continue to support early OM adoption ✓ Support data comparison & benchmarking
Capability & capacity	✓ Training device company champions ✓ R&D investments in semi- & full auto devices ✓ Support data integration in business IT systems
OM impacts on $	✓ Support data comparison & benchmarking ✓ Support provided to help review/revise business rules
OM solution(s) costly	✓ Customised support offering for each OM early adoption pilot
Right time to adopt OM	✓ Enhanced awareness that both accredited & non-accredited solutions can provide value

To support adoption and uptake of OM technologies, enabling systems and processes are recognised to play a critical role. Objective measurement is not only all about a device, it's also about the enabling processes and systems to unlock the value created by objective data in repeatable, consistent and profitable decisions.

5.2.2 Benefits to industry

The project was instrumental in facilitating a relationship between R&D, engineering and industry that is vital to ensure that the VIAscan CAS can perform in an actual production environment.

This project identifies insights and lessons that can be adopted by VIAscan CAS engineers and by any R&D project team creating devices for the red meat industry. The most important insight and lesson is that the technology needs to be as ergonomic as possible otherwise this alone will create substantial barriers to adoption regardless of any other feature or function of the technology. Another key insight and lesson were that the technology needs to be all-encompassing (i.e. a meat grading device that predicts a subset of meat grading traits) and should also be able to accept and store entry of all meat grading traits.

The expected benefits of the project, include:

- Consistent and uniform grading results across sites
- Ability to grade more carcasses more efficiently with less labour and reduced 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

The realisation of these insights because of this project means these particular aspects will be able to be applied to future developments in the red meat industry and overcome these barriers to adoption more readily.

5.2.3 Value proportions & potential impacts

Upon successful completion of the project, AMG will review the technology and develop a business case for adoption of the technology. By trialing the VIAscan grading system across the AMG business, the project will be able to test the technology on a large number of cattle of varying classes. This will give the industry confidence in its capabilities and breadth for easy adoption into other facilities.

Apparent value propositions identified by AMG for application of objective measurement solutions are highlighted in Table 3.

Table 3: Apparent value propositions for AMG or OM MEQ solution.

Technology enables	Value created by
1. Increased consistency and efficiency in carcase grading	Increase supplier and customer confidence in product grading outcomes and feedback
2. Hot carcase sortation	Pre-chiller sortation to improve processing efficiency and carcase to market allocation
3. Improved feedback to suppliers	Confidence in data enables producers to improve compliance to specifications
4. Automated cutting and yield prediction	Processing efficiency delivered by automation and informing cut plans to maximise carcase value
5. Automated sortation of offal disease and defects	Precise identification of offal disease and defects

The results and key findings of the project were that Cut Surface Cameras used for predicting grading traits are an important technological advance in the red meat industry, but it is vital that these devices satisfy operator expectations with regards to functionality, portability, and usability otherwise uptake of this technology is hampered despite accuracy and repeatability of trait predictions.

6. Conclusion

In the initial phase of the project (i.e. Milestone 1), project planning and design was successfully achieved, including:

- Conducted the initial start-up meeting with AMG, VIAscan and MLA
- Formed steering project group
- Developed draft trial plans
- Designed integration requirements

The project trial plans were developed, including estimated timelines, based on work previously done trials at the AMG plant with the VIAscan grading system with oversight by AUS-MEAT.

It was agreed by the project steering group to progress to Milestone 2. Specifically, in the current phase the "Supply and commission equipment" was successfully achieved. The was achieved by completing the order and commissioning of the equipment, including the supporting software. The VIAscan device was commissioned at the pilot site (AMG, Dandenong) and tested to be trial ready. Data integration protocols were developed and initiated into work pre-commercial processes. Device training & technical support was delivered.

In the current device trial phase (Testing phase 1), device trialling was successfully achieved, including:

- Data collection and data integration
- Review device performance and usability
- AMG report on results vs expected outcomes for initial trial period

At the conclusion of the successful completion of conducting device trials (Testing Phase 1), the steering group reviewed approved the project to continue to progress to Milestone 4 and beyond. The project steering group is scheduled to meet in mid-July to review the outcomes of the initial milestones (1-3) and approve the next phase of work as per the trial plan. This represents a critical Go/No go decision point for the project.

The next phase (i.e. Milestone 4) will be to continue to conduct device trials as per trial plan (Testing phase 2). This will involve data collection and data integration. The device performance and usability will be reviewed and reported back to the steering group through the trial testing phase. At the conclusion of the trial testing phase, AMG will report on results vs expected outcomes for six months testing period.

The pre-commercial start-up trial identified a series of questions from AMG integration perspective. These will be addressed as part of the next ongoing testing and optimisation phase.

6.1 Key findings

The project was instrumental in facilitating a relationship between R&D, engineering and industry that is vital to ensure that the VIAscan CAS can perform in an actual production environment.

The key takeaway from the project was that devices need to be very ergonomic even at the expense of robustness, otherwise it is very difficult to overcome apprehension and resistance to adoption.

Another very important insight that was learned through the partnership with industry was it is best to have a single device for the collection of all grading traits, even if those traits are not specifically predicted by the device as this reduces the amount of equipment that must be carried.

The realisation of these insights because of this project means these particular aspects will be able to be applied to future developments in the red meat industry and overcome these barriers to adoption more readily.

The results and key findings of the project were that cut surface cameras used for predicting grading traits are an important technological advance in the red meat industry, but it is vital that these devices satisfy operator expectations with regards to functionality, portability, and usability otherwise uptake of this technology is hampered despite accuracy and repeatability of trait predictions.

7. Future research and recommendations

To remain relevant as a reliable OM solution, it is also critical that the technology provider remains at the leading lead to ensure that the technology maintains its AUS-MEAT accreditation, and continuously seeks advancements on accreditation of new traits where applicable. To this end, it is recommended that ongoing work will continue improving the accuracy of the predictions and research and development of new technologies to support and enhance the prediction of meat grading traits.

Future developments for VIAscan CAS include but not limited to:

- Development of additional trait data entry fields in accordance with AMG recommendations during the project trial stages.
- Re-engineering of the VIAscan CAS to improve on the construction and physical design, in accordance with AMG recommendations that there were too many screws used in its construction.
- Addition of Artificial Intelligence and Machine Learning algorithms for supplementing the trait predictions. Presently several ML classification models have been trained for AUS-MEAT meat colour classification with the highest validation accuracy of 86%. Models are currently being developed and trained by Marel Cedar Creek engineers for rib eye detection, which will considerably enhance the entire image processing pipeline.
- Re-calibration or redevelopment of trait predictions of AUS-MEAT marbling and Meat Colour which were both very close to exceeding AMILSC minimum standards.
- Participation in more grading trials to test the system and collect additional calibration/training data.
- Continued engineering of the system to make it more ergonomic.
- Continued development of the system to make it more energy efficient.
- Subcutaneous fat measurement instead of rib fat
- Move to a machine learning model for meat colour prediction

- Lightening internals to use aluminium instead of stainless
- Engaging with the Marel innovation team for additional support with the project

The pre-commercial start-up trial identified a series of questions from AMG integration perspective. These will be addressed as part of the next ongoing testing and optimisation phase.

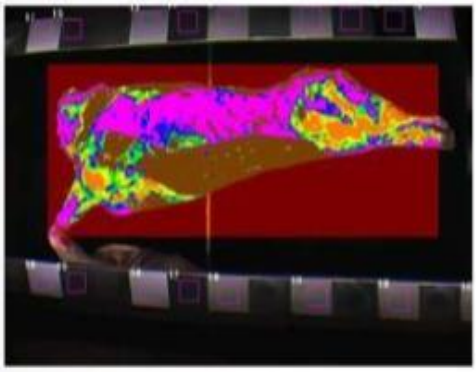
8. Appendix

8.1Related publications

[Source: Cedar Creek webpage - VIAscan Beef - Cedar Creek Company (yumpu.com) *]*

OBJECTIVE MEASUREMENT SOLUTIONS

- Objective measurement solution using Video Image Analysis (VIA) technology to assess multiple carcase attributes of beef on-line.
- Measurements assist companies to identify carcase value and process optimisation based on meat yield and other carcase attributes.
- This information on carcase performance can be used by all sectors of the beef industry to improve management and marketing decisions.



BEEF CARCASE SYSTEM (BCS)

BCS OUTPUTS

- Saleable Lean Meat Yield (weight and %)
- Primal weight & %
- Conformation
- Total Fat %
- Carcase dimensions
- Customisable shape and conformation outputs
  - *(Images both sides of each carcase)*

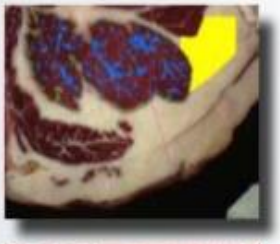
CHILLER ASSESSMENT SYSTEM (CAS)

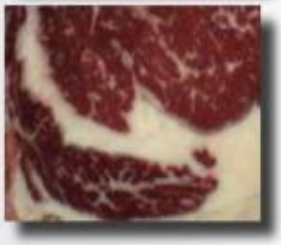
FEATURES OF THE CAS

- Totally objective measurement
- AUS-MEAT accredited for Chiller Assessment parameters
- Integrates to plant information systems

CAS OUTPUTS

- Marbling, Meat Colour, Fat Colour, Eye Muscle Area, Total Rib Fat Depth
- Saleable Meat Yield





"WORLD leading Technologies for the online Objective Measurement of Meat QUALITY and YIELD of Beef meat"

WEB-BASED INFORMATION DELIVERY

- Supplier benchmarking and ranking
- Trending of performance by individual carcase characteristic and compliance
- Fully dynamic central database
- Integrates with existing plan information systems

CEDAR CREEK COMPANY

CEDAR CREEK COMPANY PTY LTD
11 / 62 Bishop St, Kelvin Grove, Queensland 4059, **Australia** // phone: +61 (0) 7 3356 0999 // fax: +61 (0) 7 3356 2366
47 Princes St, Onehunga, Auckland, **New Zealand** // phone: +64 (0) 9 634 4075 // fax: +64 (0)9 634 4087
Pres E. Frei M.9950, Santiago de **Chile** // phone: + 56 2 499 4400 // fax: +56 2 499 4402

FoodChain VIAscan SASTEK