milestone report

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Automated Chiller Sortation system and data capture for smallstock plant

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Abstract

Development of a chiller automation system to group and transfer graded Lamb/Mutton carcases along chiller rails. Thereby improving chiller efficiency, labour reduction, accuracy put-away and timely reporting.

The chiller Management system has a simple user interface that will automatically enable entry to chiller rail, target grade and direct to a rail. The system will also count grades, types and advise when rail is full, redirecting to an alternative rail.

The project will enhance the capabilities of the carcase grading system to deliver chiller putaway dependant on AUSMEAT carcase and customer requirements.

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1 Background

The project has come about by our potential to move to Tier 1 export, and the consequent probability of increased kill numbers per day, as well the need for more accurate grading based on varying customer requirements.

Currently interaction between a competent weigher/grader and subsequent chiller labourer and branding staff is based on verbal transfer of instruction which determines where a lamb carcass is placed in the chiller.

The system is prone to variation and numerous inaccuracies that can see lambs being incorrectly placed on the wrong chiller rail.

Alternatives have been investigated i.e. currently being developed, but none offer the simplicity and cost effective approach that this system does. This system doesn't rely on expensive equipment – nor RFID technology, is relies on training an grading operator to make a number of pre-programmed choices at the scale into the chiller which direct each lamb in a pre-determined rail location.

The Chiller management system has a simple user interface that will automatically enable entry to chiller rail, target: grade and direct to a rail, also counting grades, types and advising when rail is full and redirecting to alt rail as required.

This will be a far more accurate put away grading system than currently possible.

2 Projective Objectives

The project with Tallangatta Meats will develop a chiller automation system to group and transfer graded carcases along chiller rails thereby improving chiller efficiency (2 FTE) and reliability with a cost effective solution for processors without a boning room.

2.1 Greater control of put away

The majority of abattoirs in Australia have carcase grading systems that determine the AUSMEAT grading of a carcase as it exits the slaughter floor. The put away to chiller and stack down is then done manually by semi-skilled labour. It is common practice that a follow-up task of chiller grade confirmation and re-sorting onto correct rail is required to verify stock and rail location for loadout staff.

This project will enhance the capabilities of the carcase grading system to deliver chiller put away automatically by rail dependant on grade of AUSMEAT carcase with a rail transfer system and tracking system.

By automating the chiller management we will achieve greater control over put away to a predetermined product specification reducing rework and need for trained staff within chiller improving productivity and ultimately quality at loadout

2.2 Labour reduction

Labour reduction of 1-1.5 persons expected, by changing the traditional manual tasks of feeding a carcass off production floor into chiller and onto the correct rail for that carcase grade, and reduced mis-allocation and checking. We envisage only 1 labour unit will be required to push carcases away on final destination rail, eliminating need to push carcases from production floor down header rail and selection of rail gate.

2.3 Accurate reporting of chiller put away grade, quantity, weight by rail

The system will allow for accurate reporting of chiller put away grade, Quantity, Weight by rail, allow for variation of control over put away to meet business needs and seasonal variation. This solution will provide real-time feedback for sales staff as to status of carcases grades available in chiller and their actual location.

3 Results

3.1 Milestone 2 – ITP R&D Development and testing

Through initial stages of development ITP

- Completed the R&D phase and successfully built and tested the system in-house as far as practical.
- Developed the required software interface between carcase grading station and chiller sortation PLC system.
- Confirm the PLC and necessary components have been purchased to achieve this.
- Await confirmation from Tallangatta of proposed installation date which will enable the final design, testing and commissioning onsite.

Software Interface - SCADA and Grading

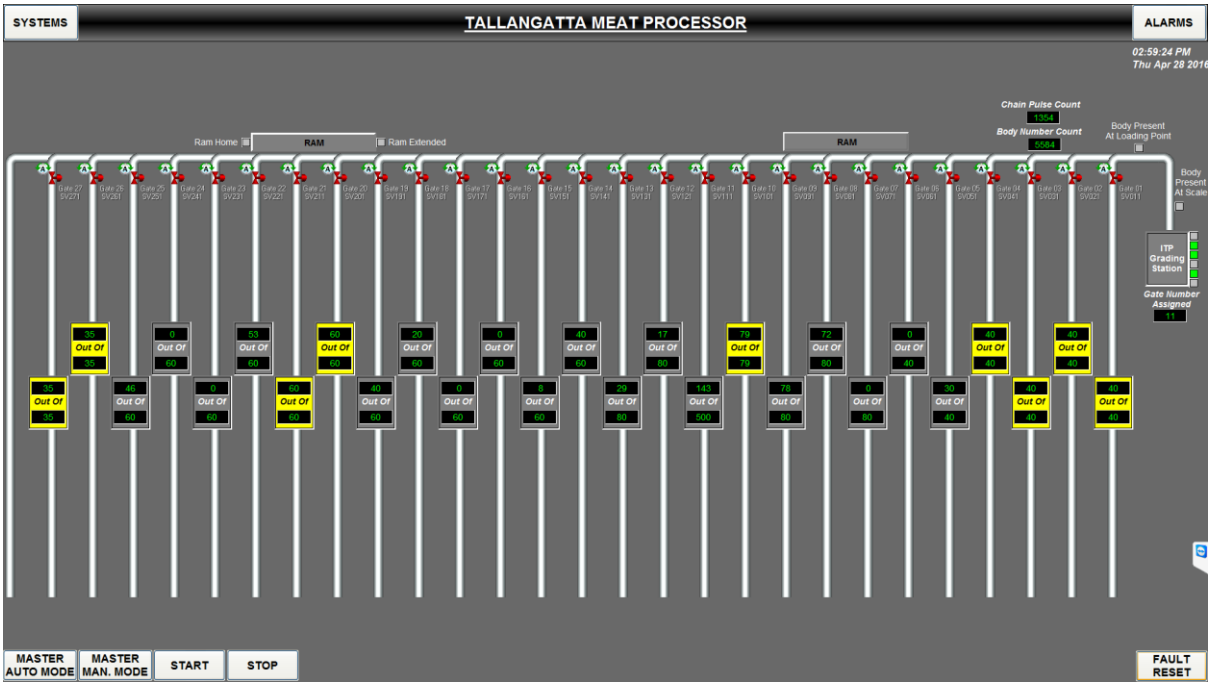
The SCADA package to interface to the PLC was changed from directly interfacing from the ITP .NET grading application to having a dedicated supervisor PC in the supervisor's office to monitor and control the operation of the sortation system. This was for two reasons:

1. More industry standard, off the shelf configuration relying less on custom proprietary software and interfaces
2. To not interfere with the grading station during production to monitor or control the system.

Both of these components seem to work well together.

Software components

Grading Station – ITP AUSMEAT configured .NET/SLQ grading application
I/O interface to PLC – Ethernet IO driver API used to interface from the grading station directly to the PLC
Schneider Citect SCADA Client – To overview and monitor the system and show a layout of the chiller. Interfaces directly to the PLC.



Software Operation

- A grade it selected based on AUSMEAT criteria on the grading terminal.
- Once saved and printed the ITP system checks the rail number for that grade. If the assigned rail is full it will nominate the next rail in a priority sequence as per below.

Company Grade Rails (13)

Company Grade	Rails	Last Mod At	Last Mod By	Created At	Created By
01001 - Kiewa T/L	9,8,7,6	17/03/2016 3:24 PM	Admin	17/03/2016 3:23 PM	Admin
01022 - T/L # 2	10,16	22/04/2016 11:14 AM	Admin	17/03/2016 3:23 PM	Admin
01091 - Gill's E/H	11	17/03/2016 3:25 PM	Admin	17/03/2016 3:24 PM	Admin
01092 - Diamond EH	24,	22/04/2016 1:08 PM	Admin	17/03/2016 3:27 PM	Admin
01093 - E/H #3	12	22/04/2016 6:28 AM	Admin	22/04/2016 6:27 AM	Admin
01041 - Spec # 1	20,21,22,23	31/03/2016 6:29 AM	Admin	31/03/2016 6:29 AM	Admin
01071 - Sides	13	17/03/2016 3:26 PM	Admin	17/03/2016 3:25 PM	Admin
01002 - Kiewa H/L	1,2,3,4,5,6	18/03/2016 8:25 AM	Admin	17/03/2016 3:22 PM	Admin
01113 - SHEEP trade	20,21,22,23	22/04/2016 6:19 AM	Admin	17/03/2016 3:27 PM	Admin
01031 - Dorper	14,15,16	17/03/2016 3:26 PM	Admin	17/03/2016 3:26 PM	Admin
01020 - T/L shank	19,18,17	17/03/2016 3:27 PM	Admin	17/03/2016 3:26 PM	Admin
01211 - LAMB EXPORT	20,21,22,23	20/04/2016 7:04 AM	Admin	6/04/2016 6:25 AM	Admin
01201 - Dam T/L	12	17/03/2016 3:25 PM	Admin	17/03/2016 3:25 PM	Admin

- The PLC then shuffles this value through the shuffle chain as it cycles and when the body reaches the required rail it will open the gate and let the body through
- It will then close the gate on the next cycle.

Onsite Testing and Go Live:

Testing and commissioning was done on site as best as possible during the installation and go live with the final components commissioned remotely after all the modifications were made with TMP staff on site and ITP programmer on standby. During testing certain issues arose such as:

- Managing the manual section of chain that is not synchronised
- Managing the human element of pushing carcases past the load in limit switch too fast or with multiple bodies
- Correcting operator mistakes and regrading bodies
- Installation of a second limit switch to create a que before the actual chiller to allow 5-10 to accumulate on gravity rail
- Extending of the shuffle chain mechanism to collect the next body correctly. This was mostly due to there being a door at the start of the chiller. If a body wasn't picked up correctly the system would be one out.
- Number of SCADA data points purchased. Once the system was implemented it became clear more points were needed for tracking which put the system into the next price bracket for the Citect software licence. ITP wore this cost.
- Processing on the scale. An extra signal had to be implemented to say read the grade now to allow for refreshing the grade in case of a regrade.
- There was an issue with the documentation from the valve supplier which led to the incorrect valve firing. The supplier technician was requested to attend site to help rectify the problem. Through trial and error it was corrected and the documentation corrected also. This was a big cause of lost time, both for ITP and TMP.
- Windows update on the SCADA PC caused the client software to not start. Required remote assistance to get this to go again after the update.

Impact on Production during commissioning phase:

- It was incredibly difficult to test and commission without real bodies loaded onto the system, which caused other issues of trying to test and commission with live production. TMP worked to limit the issues caused by this.
- No production time or numbers were lost during implementation, due mostly to extra staff helping when an issue arose.

Challenges Encountered:

- A requirement that had to be overcome was the ability to assign rails in reverse. I.e. from 10, 9, 8 etc. If the body arrived at gate 10 but it was full, there was no way to put the chain in reverse and shuffle backwards to put it on rail 9. This was originally a function of the PLC with priority setting but this function was moved back to the ITP grading station to manage the overflow rails so we know at point of loading that a rail is full and not to load onto that rail. This avoided the issue.
- Remote installation had many challenges with finding parts required urgently that were either missed or found that we needed extra relays, switches etc that were not easy to get same day.

3.2 Milestone 3 – Purchase Rams, Activators, Ducting, Gate Switches and Rails

There were a number of considerations through purchasing of equipment and materials in Milestone 3.

Gates

- TMP Decided upon using the existing design of gates (to allow for manual selection by operator). There was an option for smaller automatic gates design; however the use of manual operation as a backup to any software or hardware failure was weighted as important.
- Existing gates in chiller consisted of both mild steel and cast iron builds. The decision was made for all gates to be mild steel. Mass produced gates were ordered. This allowed for more efficient modification to attach rams.

Activators

- Selection rams 20ml bore & 80ml stroke. This allowed for a small enough Ram to fit in with design & also provide enough movement.

Ducting

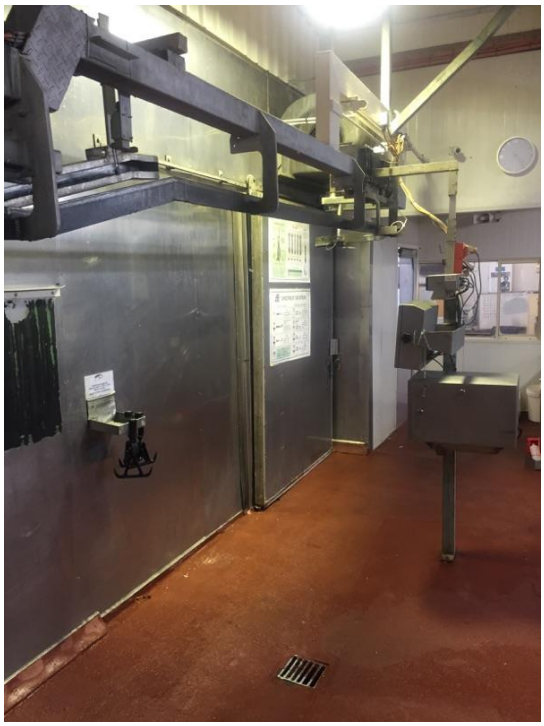
- Nylons are hoses were purchased. These were deemed more suitable for chiller conditions. Sizing was based on air required – 6ml for control lines, 12ml to drive Rams & 16ml for supply lines.

3.3 Milestone 4 – Fabricate Brackets/Mounting points & raise rail height

The new rail system design required a raised new rail height of production floor grading area .This involved a considerable amount of steel fabrication. Raising the rail height allows a carcase to clear the push rail when reaching the selected rail destination. In order for the system to reduce workforce the design involved bringing the carcase to the required height automatically. Otherwise additional labour would have to be added between the carcass wash and grading scales. Tasked included:

- Have walking beam section of Production Floor rail initiate lift in height. Lifting full scale overhead by 150mm
- Replace gate into chiller from scale allowing for the 150mm difference in height created by the lift.
- Adapt ram ending on production floor and fabricate guide that will allow for a change in height and gradient.
- Reposition actuators and switches, to pick up ram in new final position of its stroke.
- Fabricate a ten gate section of the chiller; this is to replace the oldest section of the header rail that cannot be used because of its gates being made from cast iron as opposed to mild steel.
- Adapt existing gates used to be able to be actuated using an air ram. Air rams were attached horizontally to the slide instead of the handle. Horizontal attachment allows for a shorter less complicated actuator & manual use of the gate if required. Particularly through a mechanical or software failure.

- Remove old section of header rail; shorten the droppers to allow for 50mm lift in header rail.
- Weld in new fabricated rail at new height. Cut and re-fit all other sections of the header rail at new height.
- The longitudinal rails have to be altered to take the slide from its new height. This means taking out a triangle from the bottom of the rail. Sections of 10x50mm rail were bent with a 10inch internal diameter, and cut into 250mm triangles. These were then welded to the top of the existing longitudinal rails with the highest corner checked out to allow to 20mm of the gate to sit inside.
- Once all rails have had curves welded to the top of them they were then seam welded and the leading edges were then ground back to allow for a smooth transition from header to selected rail.
- End rail to be altered to allow for change in height.
- Gate into chiller adapted to allow for change in height



Raised rail height on Production Floor. Push Ram was modified and steel guide Fabricated.

Gate and Air Ram attachment

3.4 Milestone 5 – Fabricate & mount walking beam to the header rail

A walking beam with a (shutter rail movement) which pushes from below, moving bodies' one position per cycle was the most suitable design.

Alternative design consideration included a looped motor driven chain. However the shutter rail allowed for:

- A less expensive design
- Easier speed control. The driven chain motor would have been difficult to run off time
- Existing chiller had limited space. The shutter rail allowed for a smaller design for automatic rail.
- Shutter rail was less restrictive for manual use if when required

The design featured:

- A cycle time of less than 8 seconds – this allows the sortation system to run at a quicker cycle time than the production line. This enables the grader flexibility if needing to leave grade station throughout production.
- nylon push fingers finish the stroke just as they come past the selection gate is important as it gives a maximum distance if the lamb hook was to slide on due to being a swinging mass
- spacing between fingers on the walking beam must be within 425mm, the ram is to stroke 500mm but there is 70mm required to get the finger mast the hook when it pivot forward.
- All nylon fingers are to be sprung.
- If walking beam was to follow the lines of the header rail, it would weave and mean a lot of extra force is required to shift the push rail- beam. This meant the beam had to be bushed up and made dead straight and the fingers will be cut at different lengths, to make up for the altering distance between rail and beam
- Ability to mount reed switches and actuation switches to rams and pick up point. This allowed for input points positioned on the beam to be ready for ITP installation of PLC.

The first change to the plan was to use two walking beams instead of one. The runout in the existing chiller rails would have meant a variance of finger lengths over 100mm. Therefore the best solution was to use two half-length beams running end to end, this meant an extra ram had to be used to drive the beams. However it allowed for a more solid design with the beam mounted closer to the rail.

Fingers had to be cut with a radius at the end; this meant that they would not lock up when they had to push a hook down a rail. This was known information, but the size of the curve was not. This resulted in required trials of modified fingers until successful clearing of the lamb without the finger jamming on the hook and busting it.

Springing the fingers was one of the more frustrating tasks when designing the push rail. A few designs were trialled on the full scale and two failed convincingly. One was to have a tension spring mounted through the finger; this was to keep it well out of the way of the back end of the selection gates as they swung open.

Also the initial design of the guides in which the walking beam slid meant the only place to mount the springs was inline horizontally with the nylon fingers. This design failed as it would

put a lot of strain a small section of the spring when forced open. This was not picked up in the workshop because it was only tested out as the lambs were moved through slowly (simulating the operation of the machine). The wear occurred very quickly however when the springs were mounted to fingers without the machine getting used. This is because the lambs come past the fingers a lot quicker when used manually to when it is used for its designed purpose. The other spring mechanism trialled was one under compression at the front of the finger. it wore just as quick in some places as the finger would shut hard against the spring causing it to bottom out and not return to original shape, only lasting around four days of production before needing replacement. The final spring design is a more expensive spring that has had no issue in the six months it has been mounted with the header rail ran as auto or manual.

3.5 Milestone 6 – ITP installation and commissioning

Installing final parts of hardware

These tasks are the early stages of commissioning the system; TMP had to wait until the plc had arrived with ITP, because their placement depended on the cable lengths supplied with the hardware. Most of the ELV wiring was done by ITP onsite, but staff here had to make changes as ITP could not be around for the commissioning when errors arose.

- all gates on header rail to have rams mounted and the shaft set to a length that ensures positive positioning when extended (gate closed)
- 6mm airline to be run from each gate back to associated valve set, pressure is to be set so that gate movement is fast and effective without being dangerous.
- The push rams to plumbed, 12mm airline
- All pneumatic valves are to be plumbed into air supply.
- Plc (controller for system) is to be wired into valve banks for push rail and selection gates, also back to computer, ITP

Success in achieving milestone

- The hardware was all fitted easily with objective one having the only change to plan being that; on some gates the lock nuts would stop the ram from reaching both positions for the gate, so instead lock tight was used to ensure tie rod ends did not unbolt from shafts on the smallest air rams.
- No complications with installing fittings and running air lines, airlines were partially installed until the system was working well so that diagnosing and repairing issues with pneumatics is possible during production.
- Plumbed without issue, but separate speed controllers are needed for each of the two rams so that movement can be more fine tunes so that lambs do not slide onto the next gate as the ram reaches its forward most position. Once known the first ones trialed were of two poorer quality to last.
- 16mm airline had to be used to run supply right down to the air receiver; the existing compressor was capable of keeping up with the demand of new equipment with full production running.

- issues were uncovered here, initially thought to be a mix up in the plumbing of airlines, turned out to be the wiring into the plugs for valve banks, took longer than predicted as pre-wiring was not possible off site.

4 Discussion

A number of benefits have been achieved, as outlined in project objectives. These include:

- Greater control at put away – more accurate traceability and order management
- Labour reduction 1-1.5 persons
- Accurate reporting of chiller inventory including quantity, grade, weight and location on each rail

Using these business processes greater confidence in traceability can be achieved and greater accuracy, not just for TMP with order selection but industry wide in case of a recall. Even without the use of carcase tickets, production can be traced to a time/date and rail position on any given day.

- **Greater control of putaway**

There has been a reduced need for training – grading task requires the ability to accurately grade a lamb carcase (the ability to accurately grade, plus having to select the correct rail has been removed).

This allows training to concentrate on grading. The reduced workload on the grader also allows for more flexibility and a greater time allowance per carcass.

An increased ability in being able to grade properly since installation of the sortation system has been evident in the reduction of “re-grading“product throughout Loadout. This is a direct result of the grading having more time with removing pushing down the header rail & also removing human error in having to remember and select a rail manually.

- **Labour reduction**

Labour reduction is the major benefit of the sortation system. This is a major cost saving. With an increased importance on grading, faster production speeds and increased kill numbers. The sortation system has allowed for no change in labour input for grading and branding.

Throughout installation, testing, trouble shooting and completion of the project – TMP gained Tier one accreditation. This has resulted in:

- Faster production speeds
- Increased requirements on grading for export (particularly weight, location in chillers & managing required numbers of export lambs for labelling requirements)
- Increased production numbers (roughly 20% through initial stages)
- Increased branding requirements in the chiller

The sortation system has allowed for the same input of labour & more effective grading, with an increased workload illustrated above.

- **Accurate Reporting**

Real time feedback has been a major benefit for sales staff. Being able to adjust mob & kill numbers if required is a considerable factor in successfully meeting customer specifications

and orders. This is particularly important for export orders where weight is of high importance.

Reporting on Quantity, weight and number assigned to a rail allows for an accurate report for the Sales Manager and Loadout Supervisor to go through at the end of production.

The rail assigned report is also beneficial when preparing and scanning export orders. Having the ability of real time reporting to monitor when rails are full in the chiller allows for staff to monitor when to scan product.

Electronic reporting has also been significantly beneficial for timely and accurate reporting on over the hook lambs & providing prompt daily feedback to Livestock buyers.

Although Project objectives have been met & significant benefits have been identified. There were implications through installation, testing and troubleshooting. Key issues are identified below:

Installation outside of production hours was challenging. With the production floor running through the day and loadout commencing early afternoon. Installation was mainly conducted Friday evening, Saturday and Sunday afternoon. This proved difficult with using existing our Maintenance team. There had to be re-allocation of shift hours with balancing normal day to day duties, unexpected tasks such as breakdowns & then additional hours for the sortation system.

TMP's existing chiller structure only allowed for a 150mm drop from header rail to chiller rail. A greater distance of drop would allow for more flexibility to chiller staff. The carcase would automatically fall and slide a greater distance onto the chiller rail. Allowing for an increased number of carcases which could be "banked up" before manual pushing was required. If there is a larger gap between the chiller roof and rail, than a high drop from header rail to rail would provide greater flexibility for chiller and branding staff.

Testing without affecting production was difficult. This required the allocation of extra staff at the grading station and chiller management. Carcases had to be carried onto allocated rails when troubleshooting was required.

Troubleshooting has been identified as the major issue with the system. This can be broken up into the following reasons:

Staff responsible for troubleshooting need to be "multi-skilled". Trouble shooting requires both a knowledge on how to operate software & possible hardware issues with machinery and parts.

An effective and efficient trouble shooting feature has not been installed within the design. The existing method is to manually count carcase allocation onto rails & then re-load back into software in production office. This requires additional labour and can affect production. Further development would include an efficient relay of manually pushed carcases onto rails when the system is not running. This could be achieved through the grading station "banking" the grade of a carcase while the sortation system is inoperable, then " dumping" the data automatically when the sortation system re-commences. Through trouble shooting – it should be noted that using the existing gate design that allowed for manual selection of a rail (easily) is a key design feature.

After a follow up visit onsite from ITP, there were a few changes made to make the system simpler to operate and more robust. Operator issues were found around managing the que with no visibility, this was eliminated by removing the Que. The benefit of allowing the body to be re-graded and corrected multiple times before loading in. It also allows the reprocessing of a body already in the chiller to change or correct details and be put back automatically again. The following was performed:

1. Remove the add to que limit switch from beside the scale
2. Remove the loading que from the scale to the load in limit switch from the PLC code
3. Add in functionality to regrade existing and current bodies
4. Reduce cycle and waiting times to increase shuffle speed
5. Added rail number to each position to allow the SCADA screen to show which rail a body will travel down when it gets to the gate, the solenoid light lights up and allows for easier fault finding

5 Conclusions/Recommendations

5.1 Summary

There are a number of benefits associated with the project – particularly the value of labour reduction, timely/accurate reporting & evidence of improvement to grading and rail allocation procedures.

This has been particularly valuable considering the timely nature of the project coinciding with export accreditation. Extra requirements placed on grading and chiller duties would not be manageable in an efficient/effective manner without such a system.

5.2 Future R&D

5.2.1 Extended development

The system was designed in such a way that it was not reliant on proprietary software. It could be implemented with minor change to most grading systems or the grades manually input.

- Further refinement to allow users to enter the grade of a carcase by push button matrix as the grade recorded may be different to the rail grade. Or possibly removing the need to interface the grading station, reducing implementation cost.

- Further refinement to allow the use of an SQL database in the SCADA system to hold history and allow more complex sorting and algorithms and reporting

- Ability of the system to implement animal health detail recording and sort and grade accordingly

- SCADA screen developed as a BIG SCREEN to allow the viewing of production figures and dashboards. Comparing to KPI's set and showing details like throughput, yield, average weight/fat ect displayed to all staff to encourage work performance.

- Monitoring of production speeds and recording of dressing defects/ trends in carcase dressing for particular mobs.

5.3 Practical Application of System developed to wider red meat industry

5.3.1 Industry Adoption

There are multiple installations of automated carcase put away systems implement in the Australian market however what sets this implementation apart is making the system smarter, able to record data and produce reports. Where other systems simply move carcases down to the chiller and sort onto the next available rail, the ITP system will allow dynamic configuration of the individual rails. Also allows for a visual of what is on each rail via the screen and reports. Problems and corrections can be flagged in real time.

- Adaption is suited to processors with manual put away, gravity type chillers

- Implementation is cost effective and simple to install and maintain
- Labour savings allow smaller processors the opportunity to compete
- Traceability and visibility is improved allowing greater information to be gathered and used by both the processor and government agencies
- Real time data assists daily sales – visually see rail allocation & real time grading allowing to adjust selection of mobs and numbers to be able to fill orders – particularly for export
- Accurate rail reports allow for effective feedback for Livestock buyer. Greater ability for mob weights & what orders (rails) they have been assigned to.

5.3.2 Value from the system

Value is driven by labour saving and information feedback. Whether this is via report to adjust or correct production issues, making the put away more accurate to limit order mistakes resulting in returns. There are many benefits for this kind of automation to be implemented in the red meat industry.

This system has seen value through export orders. The ability to track export numbers on chiller rails and real time feedback of average weight of orders allows for reduced labour and more accurate grade allocation.

6 Key Messages

As illustrated above there are a number of benefits gained from the sortation system

- Labour reduction
- Timely/accurate reporting – which is beneficial to different departments of the organisation – Loadout, Production, Sales, Administration, Livestock buying & Management.
- Improved grading and sorting ability for production staff
- Cost effective and efficient solution to increased requirements in key areas from export accreditation & growth of sales

Troubleshooting has been identified as the most time consuming and relevant issue. Being a smaller Meat processing Plant with a low level of machinery and technology, we do not have a multi skilled employee to troubleshoot both software and hardware problems. Trouble shooting can be done through remote access, however further training on nominated staff to effectively manage the system is required.