Final Report

AMPC
AUSTRALIAN MEAT PROCESSOR CORPORATION

AI Camera Carton Lid Inspection

JBS Brooklyn Cold Store, AI Camera Test and Validate

Project code
2025-1039

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1.0 Abstract

At the JBS Brooklyn facility, determining whether a meat carton had a lid (indicating it was destined for frozen storage) or was lidless (indicating chilled storage) relied on barcode scanning. This process was prone to failures caused by labels falling off, poor print quality, incorrect carton orientation, and bunching on conveyors. These failures resulted in cartons being misrouted between frozen and chilled cold store areas, causing operational downtime and manual handling costs.This project assessed whether AI camera technology — specifically the Cognex In-Sight® 2800 vision system — could reliably identify lidded versus unlidded cartons on the cold store conveyor network, replacing the unreliable barcode scanning method. The Cognex camera was purchased, installed, and trained using good and bad images across the full range of carton types. A trigger sensor was integrated to automatically fire the camera for each carton passing through. An HMI (Human Machine Interface) was developed for operator use, displaying real-time results and daily tallies of lidded and unlidded carton counts.The system achieved a 100% accuracy rate in differentiating between lidded and unlidded cartons, meeting the project's primary target. Errors observed were attributable to camera/lens issues or obstructions in the camera's field of view, not to the AI model itself. The project demonstrated that AI camera technology is a more reliable and robust solution than barcode scanning for carton routing in a cold store environment. The technology can be adopted broadly across the Australian meat processing industry to reduce misrouting incidents, decrease manual handling, and improve operational efficiency.

2.0 Executive summary

This project was undertaken at JBS Brooklyn to address a persistent operational problem in the cold store conveyor system. Meat cartons destined for frozen storage are lidded, while those destined for chilled storage are not. Prior to this project, differentiating between the two relied on barcode scanners reading carton labels. This method was unreliable due to labels falling off, poor print quality, incorrect carton orientation on conveyors, and cartons bunching together preventing scanner visibility.

The project assessed whether the Cognex In-Sight® 2800 AI vision system (IS2801M monochrome camera) could accurately and reliably differentiate between lidded and unlidded cartons on a live production conveyor belt. The objective was to replace barcode scanning with a more robust AI-based vision solution to prevent misrouting of cartons.

Objectives

- Assess whether AI camera technology can identify and separate frozen (lidded) and chilled (unlidded) cartons to ensure correct routing in the cold store.
- Determine whether AI camera technology performs better than the current barcode scanning method.
- Achieve 100% accuracy in lid detection.

Methodology

- Purchased the Cognex In-Sight® 2800 (IS2801M) camera system and associated hardware from ASC (Automated Systems Control), the Melbourne-based Cognex agent.
- Engaged GPS to design and build the camera cabinet, platform and housing.
- Two JBS staff were trained by Cognex over a two-day course in Sydney on system operation.
- Installed and configured the camera on-site; integrated trigger sensor on the conveyor.
- Trained the camera model using good and bad images across all carton lid types.
- Developed an HMI user interface for operators displaying real-time detection results and daily tallies.
- Progressively evolved the environment (lighting, covers, camera location, sensor placement) to optimise accuracy.

Results / Key Findings

- The Cognex AI camera achieved a 100% accuracy rate in identifying lidded versus unlidded cartons.

- Errors encountered were attributable to camera/lens issues or obstructions in the field of view, not to the AI model.
- The system was successfully integrated with a trigger sensor on the live conveyor belt, enabling automatic real-time detection.

Benefits to Industry

- AI camera vision technology provides a significantly more reliable alternative to barcode scanning for carton routing in cold store environments.
- Broad industry adoption of this technology can reduce carton misrouting, decrease operational downtime, and reduce manual handling costs.

Future Research / Recommendations

- Evolve the system to identify specific lid types by design when a carton is lidded, creating a more granular identification capability.
- Relocate the camera to an area directly connected to an automated rejection system to reject lidded/non-lidded cartons, providing direct process value.

3.0 Introduction

The JBS Brooklyn beef processing facility operates a cold store conveyor network that routes finished cartons to either frozen or chilled storage areas. Lidded cartons are destined for frozen storage, while lidless cartons go to chilled storage. Accurate routing is critical to product quality and operational efficiency.

Prior to this project, routing relied on barcode scanners reading carton labels. This process was inherently unreliable for a number of reasons: carton labels frequently fell off between the Sastek label machine in the fabrication floor and the conveyor entry in the cold store; barcodes were at times illegible due to print quality issues; cartons were sometimes placed on the conveyor in the wrong orientation, preventing scanner reads; and cartons bunching together end-to-end blocked the scanners from reading labels on trailing cartons.

These failures resulted in misrouted carton; frozen product sent to chilled storage or vice versa; requiring manual intervention, causing production downtime, and creating food safety risks. The industry problem addressed by this project is the need for a more robust, reliable, and automated solution for identifying carton status (lidded or lidless) without reliance on printed labels.

AI-based machine vision technology, such as Cognex In-Sight® 2800 series, offers deep learning capabilities capable of solving exactly this type of presence/absence detection and classification problem. This project piloted the technology at JBS Brooklyn to validate its suitability for this specific application and, if successful, to establish a model for broader industry adoption.

The target audience for this project is Australian meat processing facilities operating cold store conveyor networks, as well as AMPC levy payers and industry stakeholders interested in automation and efficiency improvements at the processing floor level.

4.0 Project objectives

The objectives of this project, as specified in the Research Agreement (Project Code: 2025-1039), were:

- To assess whether camera/AI technology can be used to identify and separate frozen (lidded cartons) and chilled (unlidded cartons) and ensure they are moved to the correct area of the cold store.
- To determine whether camera/AI technology is more useful than the current system of scanning barcodes for this carton routing task.
- To assess the accuracy of the camera/AI technology, with a target of 100% accuracy in lid detection.
- To develop a system user interface (HMI) and daily reporting functionality for operators.
- To evaluate enhancements or changes required to ensure the system is commercially viable for broader deployment.

5.0 Methodology

Equipment Setup

The Cognex In-Sight® 2800 (IS2801M) monochrome smart camera was mounted above the cold store conveyor line (CCL) at JBS Brooklyn. A proximity sensor was installed in alignment with the camera to act as a trigger, automatically firing the camera each time a carton passed beneath it. The conveyor operates at a constant speed, with carton spacing variable and uncontrolled.

GPS was engaged to design and fabricate the camera cabinet, platform, and housing. The initial unit was intentionally oversized to allow flexibility during the learning phase, with the intent to refine the design based on operational experience.

Staff Training

The Brooklyn and wider innovation team had a two-day training session with the Cognex team to teach them about the capabilities of the camera, with one of those functions being presence and absence checking.

Camera Training

The camera model was developed using Cognex In-Sight Explorer. A training image library of 300 images was captured on-site, comprising 150 images of lidded cartons and 150 images of unlidded cartons. The library covered 3–4 distinct lid types in use at JBS Brooklyn. Images were captured under live operating conditions to ensure the training set reflected the real variability of carton presentation on the conveyor.

Environment Optimisation

Physical modifications were made to the installation environment during the project to improve detection consistency. The camera housing cover was modified to allow the camera to be repositioned closer to the proximity sensor, improving detection geometry and allowing for future integration if required. An HMI was mounted on a rail adjacent to the conveyor for easier operator viewing and access.

Performance Validation

System accuracy was validated through manual spot checks by operators and ongoing operator feedback throughout the live testing period. A threshold of 100% accuracy was required before progressing between milestones. Live testing ran over approximately one year, during which the camera scanned over 3,200,000 cartons across the full range of lidded and unlidded carton types.

6.0 Results

System Performance

The Cognex In-Sight® 2800 (IS2801M) camera system was deployed on the CCL (Cold Chain Line) at JBS Brooklyn and monitored continuously from system activation through to project completion. The camera analysed each carton as it passed through, checking for the presence or absence of a lid and logging the result.

The system achieved a 100% accuracy rate in correctly differentiating between lidded and unlidded cartons over the full evaluation period, meeting the project's primary target. Errors observed were attributable exclusively to external factors — camera or lens fouling (condensation, debris in cold store environment) and obstructions within the camera's field of view — not to failures in the AI detection model.

Milestone Achievement Summary

- Milestone 1 – Inception and System Design (October 2024): Inception meeting held with JBS site management, engineering, and cold store management. Cognex IS2801M camera identified and PO issued 12/11/2024.
- Milestone 2 – System Build and Static Testing (February 2025): Camera installed and configured on site. Static detection tests completed 25/02/2025.
- Milestone 3 – System Training and Integration (March 2025): Camera trained on full carton range with good/bad image library. Trigger sensor integrated and live conveyor testing commenced.
- Milestone 4 – User Interface and Reporting (January 2026): HMI deployed with real-time image display, lidded/unlidded detection result, and daily running tallies.
- Milestone 5 – System Design Evolution (March 2026): Physical environment modifications completed (lighting, covers, camera relocation). 100% accuracy confirmed on live production line.

Comparison with Previous Barcode System

The previous barcode scanning method was subject to four distinct failure modes that caused misrouting: label detachment, illegible print quality, incorrect carton orientation blocking scanner reads, and carton bunching preventing line-of-sight. The Cognex AI camera system is inherently immune to all four failure modes, as lid detection is based on physical geometry rather than label readability or carton orientation, provided cartons pass within the camera field of view.

7.0 Discussion

The results of this project demonstrate that AI camera-based machine vision technology can reliably and accurately replace barcode scanning for carton lid detection in a cold store environment. The 100% accuracy rate achieved by the Cognex In-Sight® 2800 system represents a step-change improvement over the previous barcode scanning method, which was regularly defeated by label failures, print quality issues, and conveyor dynamics.

The project validated that the deep learning capabilities of the Cognex platform are well-suited to this type of presence/absence classification task, even in the challenging environmental conditions of a refrigerated cold store (condensation, variable lighting, frost build-up). The physical environment modifications — adjusting lighting, relocating the camera and sensor, modifying covers — were important contributors to achieving consistent accuracy and should be treated as essential elements of any commercial deployment.

The discussion during later project stages highlighted that the highest-value application of this technology may not be at the current CCL monitoring location. Connecting the camera to an automated rejection system where lidded cartons can be automatically diverted — would deliver more direct operational value. This should be considered for any Stage 2 development.

8.0 Conclusions

This project successfully demonstrated that AI camera vision technology — specifically the Cognex In-Sight® 2800 (IS2801M) — can accurately and reliably differentiate between lidded and unlidded meat cartons in a live cold store conveyor environment. The system achieved the project's target of 100% accuracy in lid detection over the operational evaluation period.

The project validated that this technology is a superior alternative to barcode scanning for carton routing in cold store environments. The AI vision approach is not susceptible to the label-related failure modes that routinely degraded the performance of the previous barcode system.

All six project milestones were completed, from inception and system design through to live performance validation. The system was fully operational for the projects entirety, and an operator-facing HMI was developed and deployed.

The project has established a validated, documented proof of concept that can serve as the basis for broader industry adoption. The methodology, system architecture, and configuration developed at JBS Brooklyn provide a practical starting point for other meat processing facilities seeking to improve cold store routing accuracy.

9.0 Recommendations

Practical Application

- Meat processing facilities operating cold store conveyor systems should consider deploying Cognex In-Sight® 2800 or equivalent AI vision systems to replace

barcode-dependent carton routing. The system is effective and delivers reliable results in cold store conditions.

Future Research and Development

- Stage 2 development should extend the lid detection capability to include lid type identification: when a carton is lidded, the system should use the lid's visual design to identify which specific lid type is present. This would enable product-level routing decisions based on lid design and significantly expand the applicability of the technology across multiple production areas.
- Evaluation of AI camera applications in other areas of the production floor should be pursued. The Cognex In-Sight® 2800's multi-class deep learning capability makes it applicable to a broad range of presence/absence and classification tasks beyond lid detection.

Adoption and Extension

- JBS and other AMPC member processors should review their cold store conveyor systems and cold chain label-dependent routing steps as candidate sites for AI camera deployment.
- AMPC should consider developing a deployment guide based on the learnings from this project to facilitate rapid, low-cost adoption across the broader industry. Key elements should include equipment specification, environmental preparation requirements, staff training approach, and HMI design principles.

10.0 Project outputs

- Inception meeting with ASC (Automated Systems Control), JBS site management, engineering, and cold store management – October 2024, JBS Brooklyn facility.
- Hardware acquisition – Cognex In-Sight® 2800 (IS2801M) camera system, trigger sensor, and associated components. Purchase Order issued November 2024.
- Staff training programme – Two JBS Brooklyn staff trained by Cognex over a two-day course in Sydney, March 2024.
- Camera installation and static testing – Completed February 2025. Camera mounted, configured, and validated under static conditions.
- System training – Completed March 2025. Full carton range trained using good and bad image library. Live conveyor trigger integration tested.
- HMI development and deployment – Completed January 2026. Operator-facing Human Machine Interface displaying live detection image, result, and daily lidded/unlidded tallies.
- Physical environment modifications – Completed 2025–2026. Lighting optimisation, camera and sensor relocation, cover modifications.
- Five milestone reports submitted to and approved by AMPC (Project Code: 2025-1039).
- Final project video – Supplied separately showing the camera and HMI operating in real-time on the live conveyor line.
- This Final Report.

11.0 Bibliography

No external published references were cited in the preparation of this report. All technical information referenced relates to internal project documentation (AMPC Milestone Reports 1–6, Project Code 2025-1039) and the Cognex In-Sight® 2800 product documentation provided by ASC (Automated Systems Control).

12.0 Appendices

12.1 Appendix 1

Cold Store Conveyor Network – Background

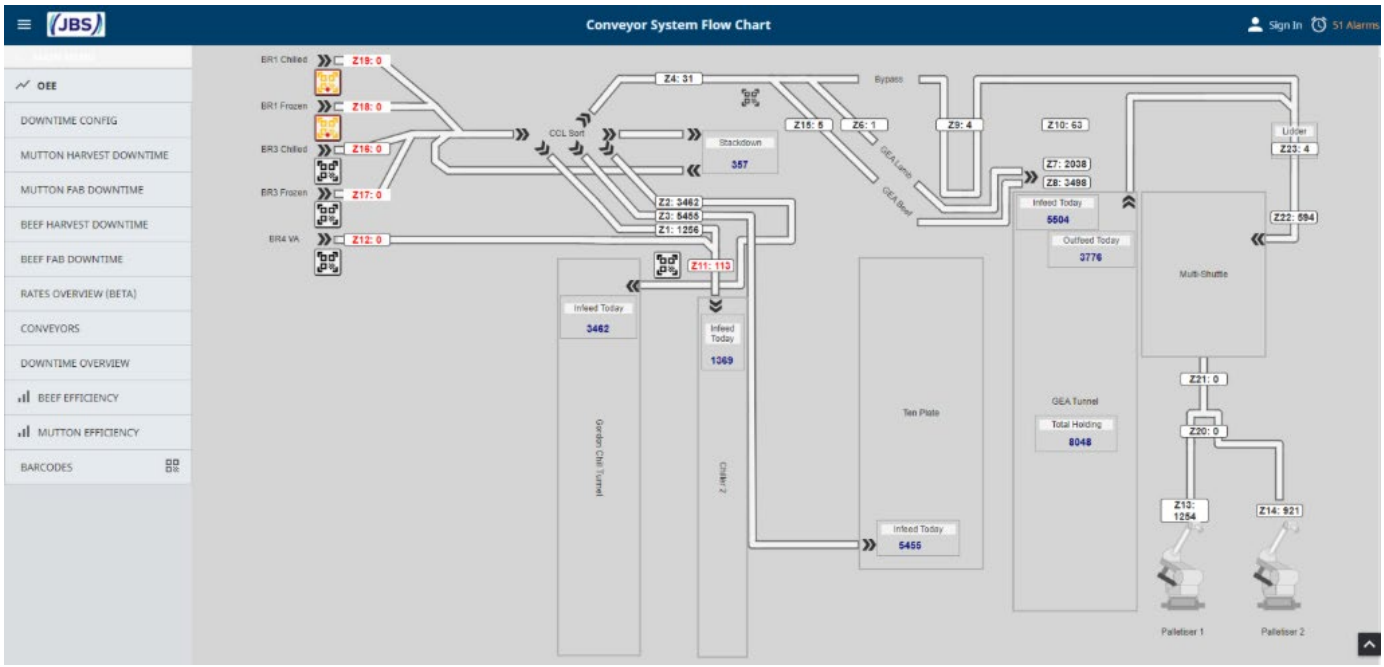

Figure 1: Cold Store Conveyor Network on Ignition

The JBS Brooklyn cold store conveyor network routes finished meat cartons from the fabrication floor to either frozen or chilled storage areas. Lidded cartons are destined for frozen storage; unlidded cartons are destined for chilled storage. Correct routing is critical to product quality and food safety compliance.

Prior to this project, routing was managed by barcode scanners reading labels applied to carton ends by the Sastek label machine in the fabrication floor. The key limitations of this approach were:

- Carton labels detached between the Sastek label machine and the cold store conveyor entry.
- Barcode print quality was occasionally insufficient for scanner reads.
- Cartons placed on the conveyor with incorrect orientation meant the barcode faced away from the scanner.
- Cartons bunching end-to-end on the conveyor — a deliberate design feature to reduce conveyor length and maintenance costs — prevented scanners from reading the label on the trailing carton when butted against the preceding carton.

12.2 Appendix 2

System Architecture Summary

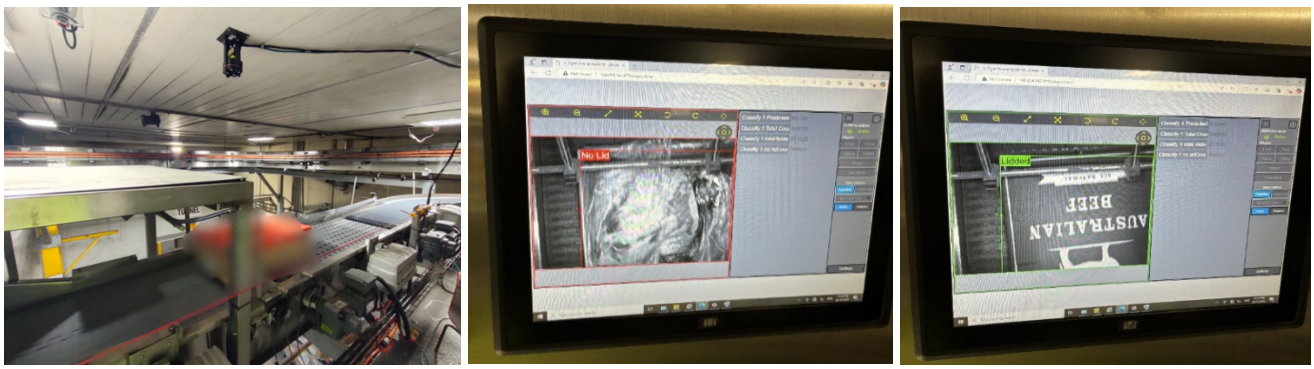

Figure 2, 3 and 4: Boxes moving through the area and triggering the camera, with the HMI of the no-lid and lid results

The deployed system consists of the following key components:

- Cognex In-Sight® 2800 (IS2801M) – monochrome smart camera with integrated deep learning and rule-based vision tools.
    - Trigger sensor – proximity/photoelectric sensor mounted on the CCL conveyor to automatically fire the camera for each carton.
- Cabinet and platform – designed and fabricated by GPS, housing the camera and associated electronics in a configuration suitable for the cold store environment.
- HMI (Human Machine Interface) – mounted on a rail for operator accessibility, displaying: live image of the last scanned carton, the AI detection result (Lidded / Unlidded), and daily running tallies of lidded and unlidded cartons.

The camera was trained using an image library of lidded and unlidded cartons spanning the full range of carton types used at JBS Brooklyn. The training process involved iterative rounds of image capture and model updates to ensure robust performance across all carton presentations and lid types.

12.3 Appendix 3

Video Reference

A video demonstrating the camera and HMI operating on the live production conveyor has been supplied separately to AMPC in conjunction with this Final Report. The video shows the camera detecting lidded and unlidded cartons in real-time and the HMI updating accordingly.