

Magnetic conveyor: Proof of Concept Design & Simulation

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1.0 Abstract

The Magnetic Conveyor: Proof of Concept Design & Simulation Project was undertaken to determine if the theorised concept of product being transported in a 2D, non-linear fashion on magnetic conveyors was feasible with the following objectives.

- Demonstrate a simulation using a magnetic planar motor conveying for the non-linear product motion.
- Perform data collection, weights and run rates.
- Conduct a cost-benefit analysis for the proposed solution.
- Advance magnetic conveyor technology development towards an automated boning room.

A simulation of the concepted design was generated from the collected data to provide confidence of the concept and rates to produce a cost benefit analysis.

This system could benefit businesses who are packaging a high volume of product at significant throughput, requiring non-linear conveying to achieve efficiency gains. It also reduces labour associated with manual processing.

2.0 Executive summary

The Magnetic Conveyor: Proof of Concept Design & Simulation Project

2.1 Problem

This project aims to demonstrate a proof-of-concept design of a magnetic planar conveyor and its simulation within a processing environment.

The previous AMPC project trial (2021-1225) demonstrated the potential use of magnetic conveyors in an Australian meat boning environment over 6 months. One use case that has been identified is the transferring of product on the process line to optimise process flow, ensuring accuracy and consistency through 2D, non-linear conveying.

2.2 Objectives

The objective of the project is to deliver industry confidence of the concept solution based on real production line data that the system will be capable of generating line savings by:

- Allow an estimated 2 staff to be redistributed elsewhere in the business.
- Generate a cost benefit analysis indicating the benefits of the application of the system in a commercial environment.

These were all achieved in the concept and simulation designs.

2.3 Methodology

Site data was collected on a target production line.

From the collected data a concept design was formed and a simulation of the data and concept design created. Iterative concept and simulation designs were created and concluded with a system that met the objectives.

2.4 Results

The key results of the project are:

Simulations using actual data theoretically proving that optimisation of the packing line is possible and feasible.

With the line data and products evaluated it was conceptualised that a magnetic conveyor system would be suitable to achieve the desired benefits for the line assessed. The objectives were met and through achieving these, confidence to progress to further testing is present.

2.5 Benefits

The key benefits of the project to industry that the project has produced, are that it has the desired cost benefits for a facility to reduce the level of manual labour intervention (depending on line set up) by implementing the magnetic conveyor system.

2.6 Future Research

From the results of this project, it is recommended that additional stages of research be undertaken to implement a test module on site to review rates, interface requirements with existing processing line controls and hardware. Subsequent stages toward a production model would be examined based on rates tests and interface knowledge.

3.0 Introduction

The problem identified is the transferring of product in a non-linear fashion on a process line for meat products. This project aims to optimise process flow, ensuring accuracy and consistency.

Results from the project, being a simulation and concept design for the production line assessed have confidently provided the results to indicate that the project has the benefits to proceed to further stages and subsequently a commercially installed solution.

4.0 Project Objectives

To achieve the goal, this project presents a proof of-concept design and simulation phase. A simulation was conducted to understand the benefits of the technology.

SKU types and parameters, such as weights and rates, were collected. This project will present a cost-benefit analysis. The results will then guide the design of the required planar motor size.

Successful validation in this stage will lay the groundwork for future development to build, evaluate, refine and deploy prototypes, as well as exploring the application of the technology in other material handling opportunities, including boning room automation.

4.1 Data Collection

Perform data collection, including SKU types, weights and run rates.

4.2 Simulation and concept design

Demonstrate a simulation using a magnetic planar motor table for the non-linear transfer of product. Data collection from the simulation to concept design the next stage for testing and validation.

4.3 Cost Benefit Analysis

Conduct a cost-benefit analysis for the proposed solution.

4.2 Development

Advance magnetic conveyor technology development towards an automated boning room. If the project is successful, a submission will be prepared for next stage to test and validate the presented concept to further de-risk and develop a submission for a production machine. This submission will also include budget costings of a production system.

5.0 Methodology

5.1 Information Discovery

Both Intelligent Robotics and Coles Retail Ready Operations Australia worked together to collect the data over several site visits and generate a concept and simulation of the product management and review a cost benefit analysis.

5.2 Concept Design

A design to work with the acquired data will be conceptualised.

- Design the required planar motor layout.
- Work through the site data to define rates and quantities.
- Make sure the concept design meets the site requirements.
- Compile the test data for the layout simulation.

5.3 Planar Motor Simulation

A simulation of the proposed concept will be assembled based on acquired site data.

- Simulate the number of movers and size of the system to meet the site requirements.
- Collect SKU types and parameters, weights, sizes, etc.
- Collect SKU run rates and current labour requirements.
- Collect SKU product quality required data.

5.4 Cost Benefit Analysis

To determine the cost benefit analysis of the project the following milestone items will be performed

- Program the simulation to take data as an input and model different layout setups to optimise the planar motor size and number of movers.
- The yield gains, labour savings and quality improvements of the proposed solution.
- Compile the Coles supplied data for the CBA with the results of the IR analysis and simulation.
- A report will then be developed and presented to Coles, summarising the opportunity, estimated costs and time frames, risks and providing a recommended pathway to implementation.

5.5 Review for the Next Stage of the Project

The next stage of the project will be proposing that using the original planar motor table, together with additional prototype hardware for the machine concept be setup on site to determine and perform the next stage of validation of the concept in a physical environment against site requirements.

Trial space is limited on the data collection line for any physical tests that may be deemed necessary for the project.

6.0 Results

6.1 Information Collection

Initial Data Collection (collected from Line 4)

This data is collected by the site's manufacturing database system. The data is associated with a dummy order which can then be exported as a CSV file for the simulator to analyse.

Product Data Collection (Line 2A)

To simulate the magnetic conveyor's ability to organise product, the project requires product data from a production run where various simulation scenarios were run. An additional set of data beyond the data collected in Milestone 1 was required to provide a larger product data set. The test was run for 70 minutes.

The relevant cost-benefit data was provided for a 12-month period across lines 2 and 2A from July 1st 2024 to July 1st, 2025, with the second line producing the SKUs from April 2025 only and representing only a portion of the overall data volumes.

6.2 Design and Simulation

The data collected was used to make synthetic data that we could use to simulate different product flows.

A Python program was used to simulate a new machine layout. This simulation helps us figure out the best way for the product to flow. The key goal of running this simulation is to determine the ideal layout size.

By simulating different scenarios we can gather data to make an informed decision about the most cost-effective machine design. This output data can then be analysed to assess performance.

The simulations on the synthetic data achieved the desired results. The simulations showed that a viable layout could be achieved.

6.5 Visual Components Simulation

An important part of the simulation process was also to solve for the total size and the total number of movers required.

A visualisation of the mover motion was simulated using Visual Components. Different iterations of the simulation were developed to allow for the motion of the movers, and to allow for various processing scenarios and requirements.

The simulation was linked to the data processing simulation code, to allow the visual simulation to follow the output data and subsequent algorithm result.

The movers and planar motor arrangement are based on the speed required for product management. The final size will depend on the findings from Stage 2.

The various changes required to the site's existing process line layout were identified and discussed with Coles.

The concept indicates that 2 operators that typically perform manual operations can be redistributed to other process areas on the lines.

6.6 Cost Benefit Analysis

The initial findings look promising, with labour and yield savings. A high-level estimate of a Stage 3 Project to design, program, manufacture, install and commission a unit onto one of the production lines was estimated. This scope and cost will be finalised in the Stage 2 project.

7.0 Conclusions and Recommendations

The simulation of a commercial system with real line data and a simulated control of upstream process has indicated that the system will deliver cost benefits for Coles (RROA). Based on cost benefit analysis results of Stage 1 it is recommended that Coles proceed with the Stage 2 scope of work to further refine the concept design, with a view to ultimately proceed to a Stage 3 project to implement a full production system on one of the processing lines.

8.0 Project outputs

The following required project outputs were achieved.

- Simulation of the sanitary magnetic planar motor conveyors.
- Data collection from the simulation to design the next stage for testing and validation.
- Cost-benefit analysis.

Preparation of a submission for next stage to test and validate the proposed concept. This submission will also include budget costings of a production system.