final report

Project code: P.PSH.0680

Prepared by: Gavin Inglis

Machinery Automation and Robotics

Date published: July 2014

PUBLISHED BY

Meat & Livestock Australia Limited
Locked Bag 991
NORTH SYDNEY NSW 2059

MAR Palletising Gripper development and trials

This is an MLA Donor Company funded project.

Meat & Livestock Australia and the MLA Donor Company acknowledge the matching funds provided by the Australian Government to support the research and development detailed in this publication.

Abstract

MAR is developing a number concept designs for red meat automated carton palletising with a goal of formulating a range of new design options for processing plants.

These design options ideally address a need to accommodate automated palletising where traditional Robotic and Layer Palletising systems do not offer viable solutions mainly due to the number of pallet positions required to accommodate production, cost of implementation and the footprint required to address these needs.

MAR has completed extensive investigation and preliminary design works including two activities reported to MLA as part of a partnership project “P.PSH.0627 Collaborative Adoption.

Highlighted in both these activity reports is that carton gripper designs for AMC Gantry Palletising and Multiple Robot Palletising rely heavily upon the following key aspects:

- Ability to minimise distance between pallets to enable best use of available floor space
- Gripper needs to be able to transfer cartons securely at speed without distorting cartons and without carton movement to allow for accurate positioning of cartons to promote stable pallet loads.

The concept of a combined Side Clamp with Partial tyne support Gripper was proposed as a result of these activities but could not be developed with the gripper available at the time. This project develops this concept and fabricates a gripper that is trialled.

Executive Summary

MAR is developing a number concept designs for red meat automated carton palletising with a goal of formulating a range of new design options for processing plants.

These design options ideally address a need to accommodate automated palletising where traditional Robotic and Layer Palletising systems do not offer viable solutions mainly due to the number of pallet positions required to accommodate production, cost of implementation and the footprint required to address these needs.

MAR has completed extensive investigation and preliminary design works including two activities reported to MLA as part of a partnership project "P.PSH.0627 Collaborative Adoption.

Highlighted in both these activity reports is that carton gripper designs for AMC Gantry Palletising and Multiple Robot Palletising rely heavily upon the following key aspects:

- Ability to minimise distance between pallets to enable best use of available floor space
- Gripper needs to be able to transfer cartons securely at speed without distorting cartons and without carton movement to allow for accurate positioning of cartons to promote stable pallet loads.

The concept of a combined Side Clamp with Partial tyne support Gripper was proposed as a result of these activities but could not be developed with the gripper available at the time. This project develops this concept and providing the following outcomes:

- Design and manufacture of a Side Clamp with Partial Tyne Support Red Meat Carton Gripper suitable for:
  - Typical Australian Red Meat Carton Variations (includes: Frozen, Chilled, Offal carton variations)
  - MAR AMC Gantry Palletising systems
  - MAR Multiple Robot Palletising systems

- Trials of this gripper confirming:
  - Gripper design, functionality and capabilities.
  - Operational speeds and cycle time capabilities

The trials conducted showed that the gripper could operate as proposed within the space restrictions of 245mm between pallets using bulging cartons weighing approximately 30kg. With this proven it allows MAR to proceed with finalising the concepts and layouts for AMC gantry and Multiple Robot Palletising systems.

Contents

Page

1 Background 5

2 Project Objectives 7

3 Methodology 8

4 Results Milestone 1 9

5 Results Milestone 2 17

6 Results Milestone 3,4 and 5 19

7 Conclusions and Recommendations 22

1 Background

MAR is developing a number concept designs for red meat automated carton palletising with a goal of formulating a range of new design options for processing plants.

These design options ideally address a need to accommodate automated palletising where traditional Robotic and Layer Palletising systems do not offer viable solutions mainly due to the number of pallet positions required to accommodate production, cost of implementation and the footprint required to address these needs.

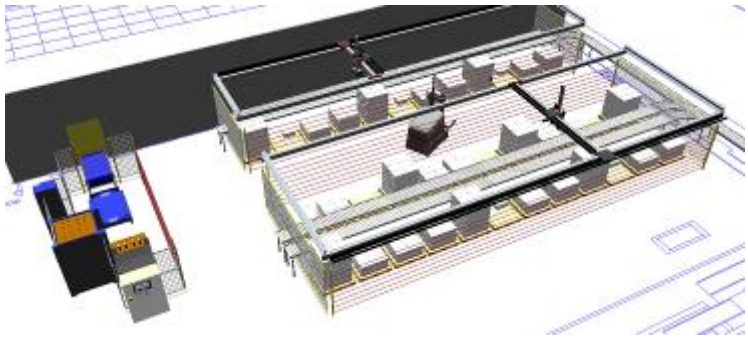


Fig.1 MAR - AMC Gantry Palletising

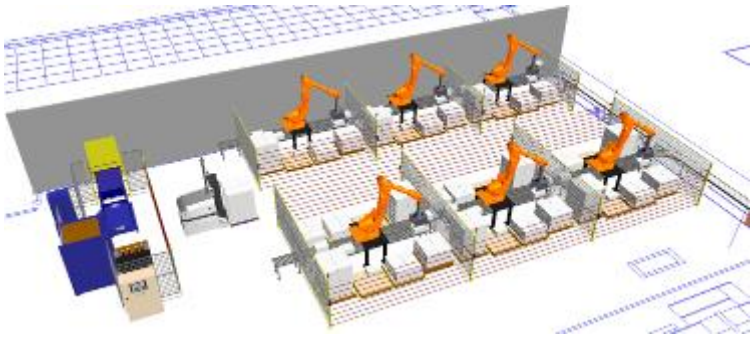


Fig. 2 MAR - Multiple Robot Palletising

As part of this development, MAR has completed extensive investigation and preliminary design works including two activities reported to MLA as part of a partnership project “P.PSH.0627 Collaborative Adoption (Capability & Research Strategy)”, these activity reports are as follows:

- P.PSH.0627-9684-20 - Activity No.20 Palletising Concept Development
- P.PSH.0627-9684-29 - Activity No.29 Carton Palletising Gripper

Highlighted in both these activity reports is that carton gripper designs for AMC Gantry Palletising and Multiple Robot Palletising rely heavily upon the following key aspects:

- Ability to minimise distance between pallets to enable best use of available floor space
- Gripper needs to be able to transfer cartons securely at speed without distorting cartons and without carton movement to allow for accurate positioning of cartons to promote stable pallet loads.

Trials performed as part of "P.PSH.0627-9684-29 - Activity No.29 Carton Palletising Gripper" resulted in unsatisfactory results for MAR's initial; concept of utilising a "Side Clamp & Underhook" style carton gripper system, but offered promising results for a newer concept to combine a side plate gripper and tyne style gripper together. This gripper concept incorporates side plate gripping together with a tyne style mechanism to support and secure cartons from the underside.

This concept could not be fully tested using the gripper available for trials as significant modifications to the gripper would be required to enable full tyne support operations. To fully test the concept a new gripper needs to be designed and built as per the concept and trialled.

The design of a new compact gripper system is fundamental to finalising palletising system layouts that maximise available footprints in processing plants working with MAR to finalise concepts and layouts of AMC gantry and Multiple Robot Palletising systems.

There is a need to confirm the gripper design prior to finalising layouts, design and budgets of these systems. This new gripper has the potential to reduce automated system footprints by 3M in length which in most cases makes the difference between automation being viable or unable to accommodate production requirements.

This project has been set up to allow the build and testing of the concept gripper to take place and MAR is confident that this project will lead to automated palletising being installed within a number of processing facilities.

2 Project Objectives

The project will provide the following outcomes:

- Design and manufacture a Side Clamp with Partial Tyne Support Red Meat Carton Gripper suitable for:
    - Typical Australian Red Meat Carton Variations (includes: Frozen, Chilled, Offal carton variations)
    - MAR AMC Gantry Palletising systems
    - MAR Multiple Robot Palletising systems

- Design and manufacture a partial carton pick off conveyor section, designed to accommodate carton gripper and to simulate production model for a full system.

- Project will utilise the following MAR supplied components:
    - Robot System (to simulate robot and/or gantry)
    - Robot base, pallets and Portable Chiller for cartons
    - Controls systems, sensors and actuators where required

- Procurement of pre-filled red meat cartons filled to weight with bone/fat/trim for trials and to simulate production where practically possible.

- Setup, Program and perform gripper trials at MAR Silverwater

- Trials will be used to confirm the following:
    - Gripper design, functionality and capabilities.
    - Operational speeds and cycle time capabilities
    - Finalise concepts and layouts of AMC gantry and Multiple Robot Palletising systems.

- Documented report including videos, images and results

3 Methodology

The above objectives will be achieved by completing the following Milestones:

Milestone 1 – Design and manufacture a Side Clamp Partial Tyne Support Red Meat Carton Gripper

Milestone 2 – Design and manufacture a partial carton pick off conveyor section, designed to accommodate carton gripper and to simulate production model for a full system

Milestone 3 – Procurement of pre-filled red meat cartons filled to weight with bone/fat/trim for trials and to simulate production where practically possible

Milestone 4 – Setup , program, and perform gripper trials at MAR Silverwater.

Milestone 5 – Documented report including videos, images and results

4 Results Milestone 1

A gripper was set up for the trial that was conducted under the P.PSH.0627 project. This was a side plate gripper with 16mm round bar used to simulate a partial carton tyne style mechanism protruding 100mm under the carton. The trials with this gripper proved successful but the concept could not be fully tested with the available gripper and hence the current project was proposed.

With this concept in mind the design developed as shown below.
The parameters to be dealt with were determined:

- Maximum box weight
- Various Box sizes
- Pallet sizes
- Pallet patterns used

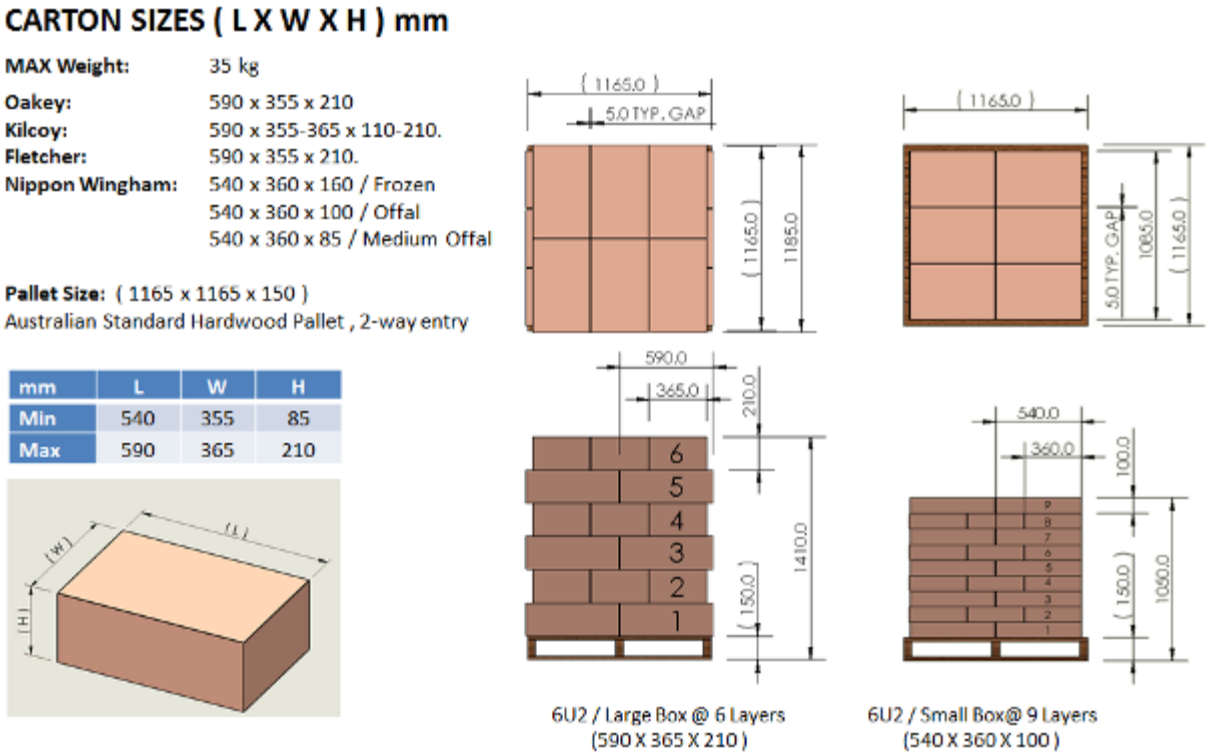
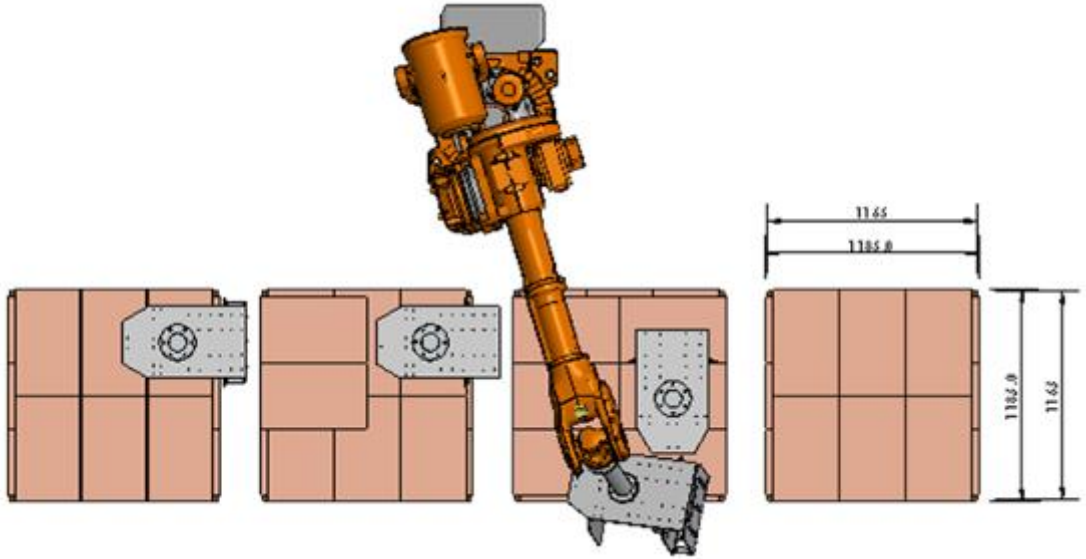


Fig.3 Carton sizes and pallet patterns

General Gripper dimensions and requirements were established and reach tests were performed with robot simulation software to

- confirm the robot required
- that the proposed design could successfully palletise all box sizes
- establish that the gripper designed would allow palletising with a gap of only 245mm between pallets (compared to the 400mm traditionally required for a tyne style gripper). This allows 4 pallets to be palletised within an overall space of 5.4m.

Gripper General Layout / 6U2 / Large Box @ 6 Layers (590 X 365 X 210mm)



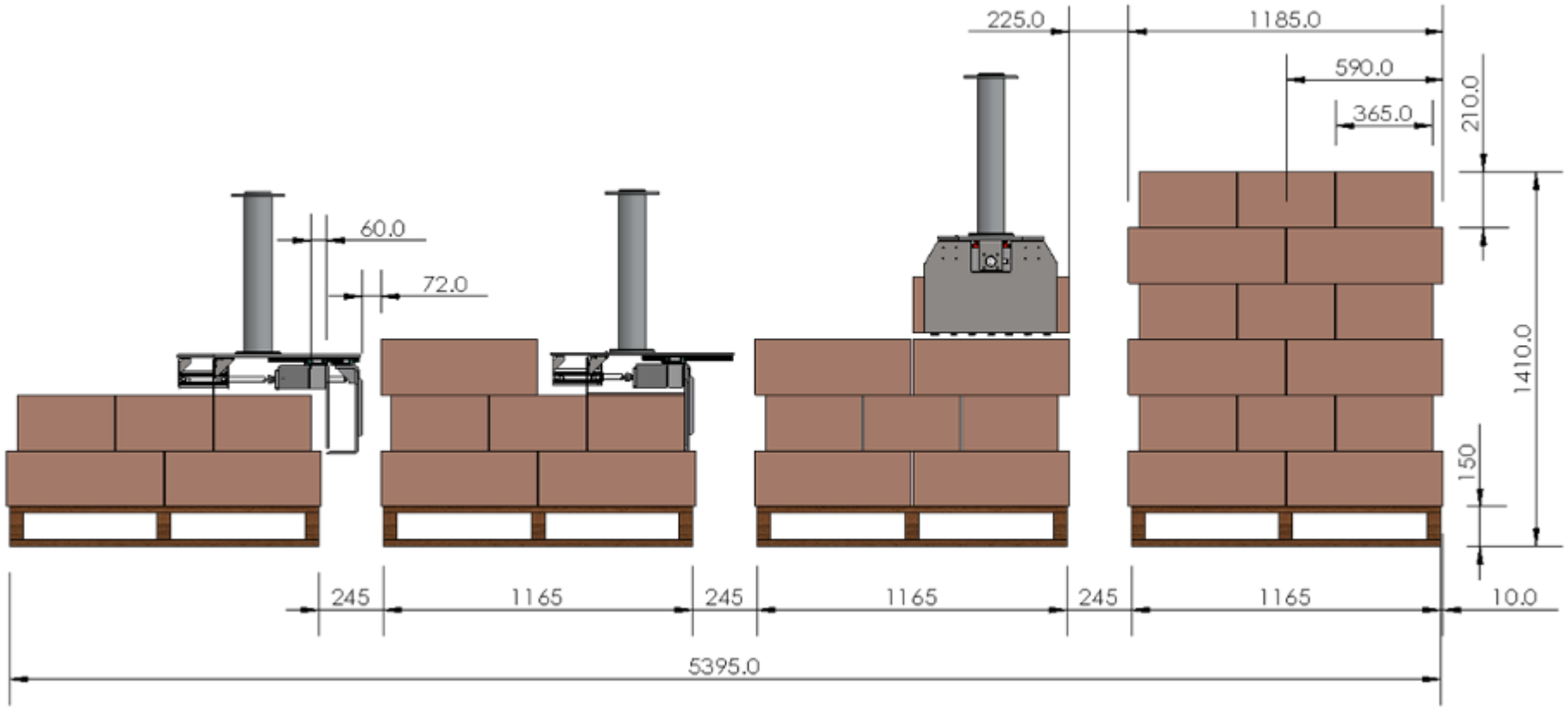
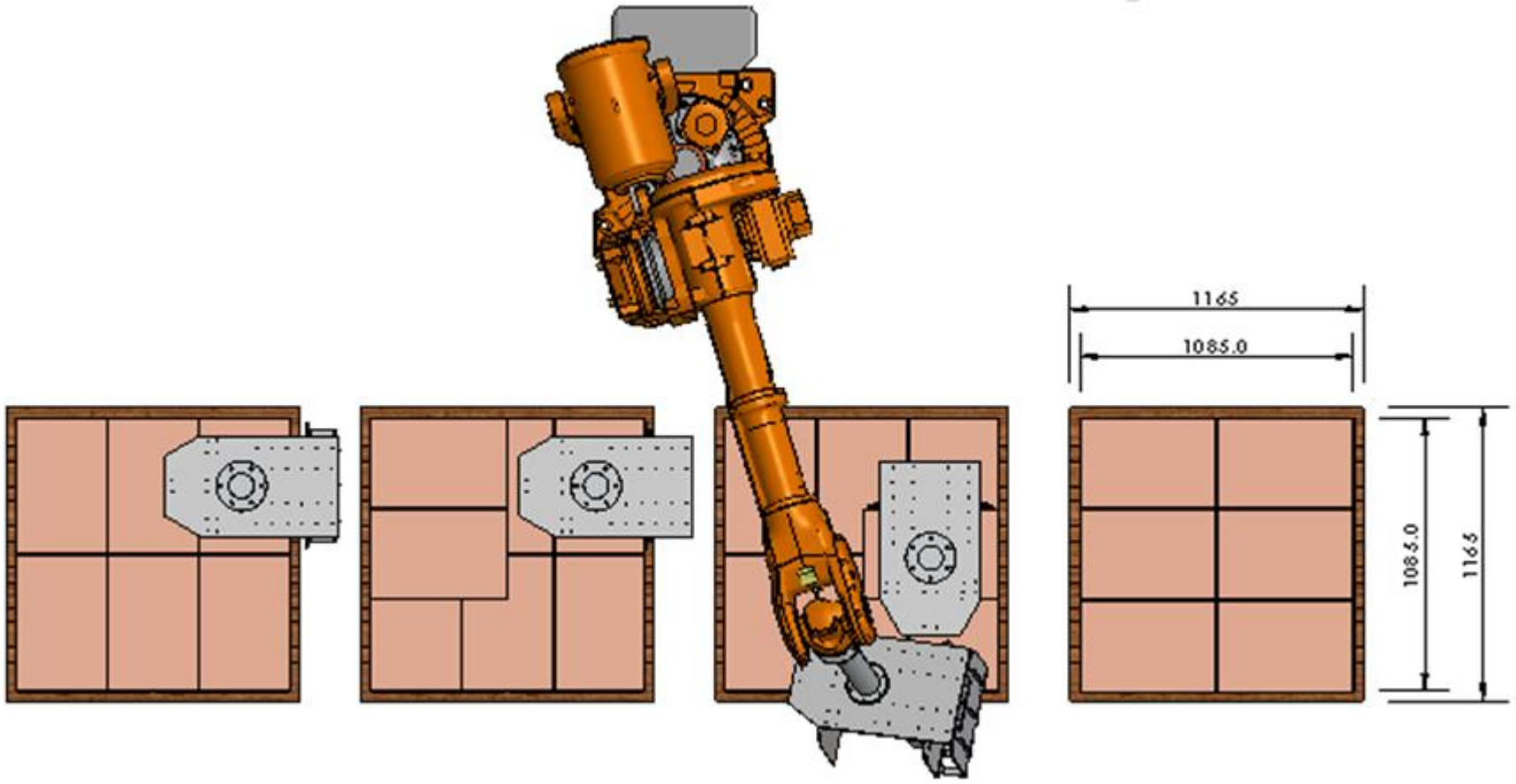


Fig.4 Pallet layouts

Gripper General Layout / 6U2 /Small Box @ 6 Layers (540 X 360 X 100mm)



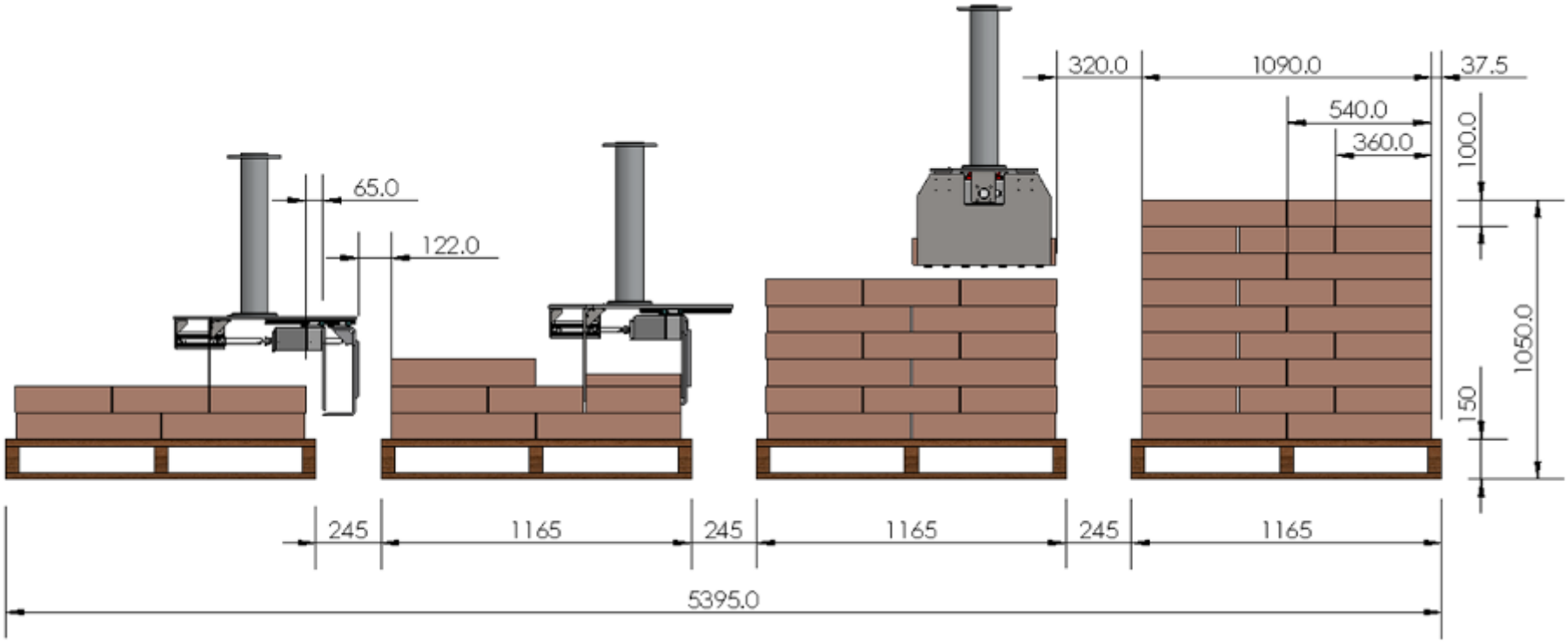
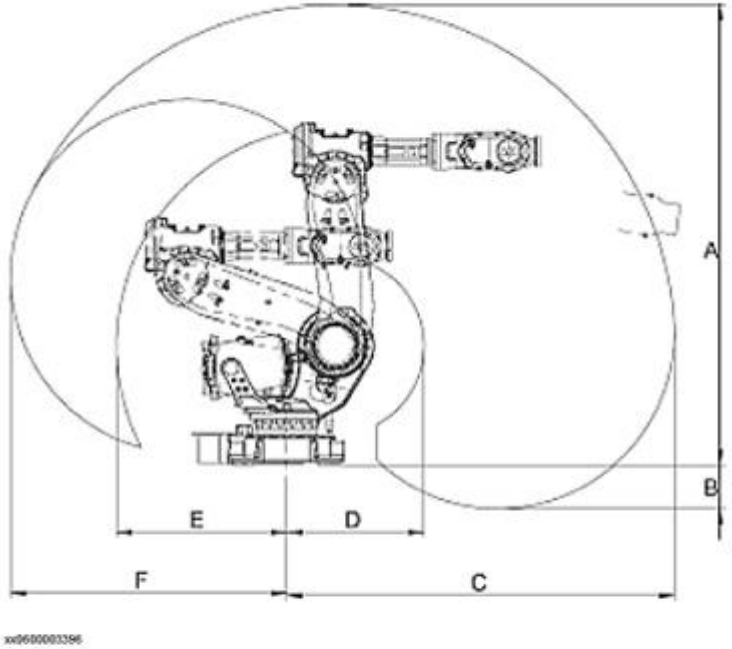


Fig.5 Pallet layouts

ROBOT Working Range
(IRB 6640-3.2 / 130 kg)



xx0600003396

Robot model	A	B	C	D	E	F
IRB 6640-2.55	3013 mm	284 mm	2550 mm	903 mm	1119 mm	1814 mm
IRB 6640-2.75	3219 mm	268 mm	2755 mm	961 mm	1252 mm	1999 mm
IRB 6640-2.8	3261 mm	533 mm	2800 mm	1004 mm	1324 mm	2061 mm
IRB 6640-3.2	3665 mm	713 mm	3200 mm	1067 mm	1604 mm	2445 mm
IRB 6640ID-2.55	3013 mm	284 mm	2550 mm	903 mm	1549 mm	1814 mm
IRB 6640ID-2.75	3219 mm	268 mm	2755 mm	961 mm	1682 mm	1999 mm

IRB 6640 - 130/3.2 "Vertical Wrist" (±10°)

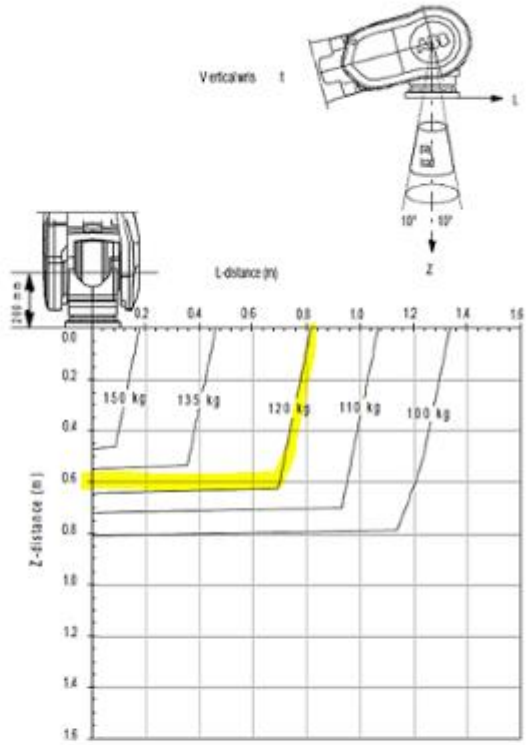


Figure 25 Maximum permitted load mounted on the robot tool flange at different positions (center of gravity) at "Vertical Wrist" (±10°).

For wrist down (0° deviation from the vertical line).

	Description
Max load	155 kg
Z_{max}	0.441 m
L_{max}	0.121 m

Fig.6 Robot Reach

Components were then chosen to suit the requirements, and the detailed design completed. Fabrication of the gripper followed. The image below shows the assembled gripper attached to a robot ready for trials at MAR's Silverwater workshop.

. **Fig.7 Fabricated Gripper**

5 Results Milestone 2

The design of the pick off conveyor needs to incorporate the ability for the cartons to be consistently positioned as well as picked from underneath by the short tynes. The images below show the conveyor procured. This is a roller conveyor that allows the cartons to be driven to an end stop. Once the end stop is reached the smaller rollers are pneumatically raised to lift the carton and allow access under the carton for the gripper tynes. Once the gripper is closed and the carton removed the smaller rollers drop allowing access for the next carton

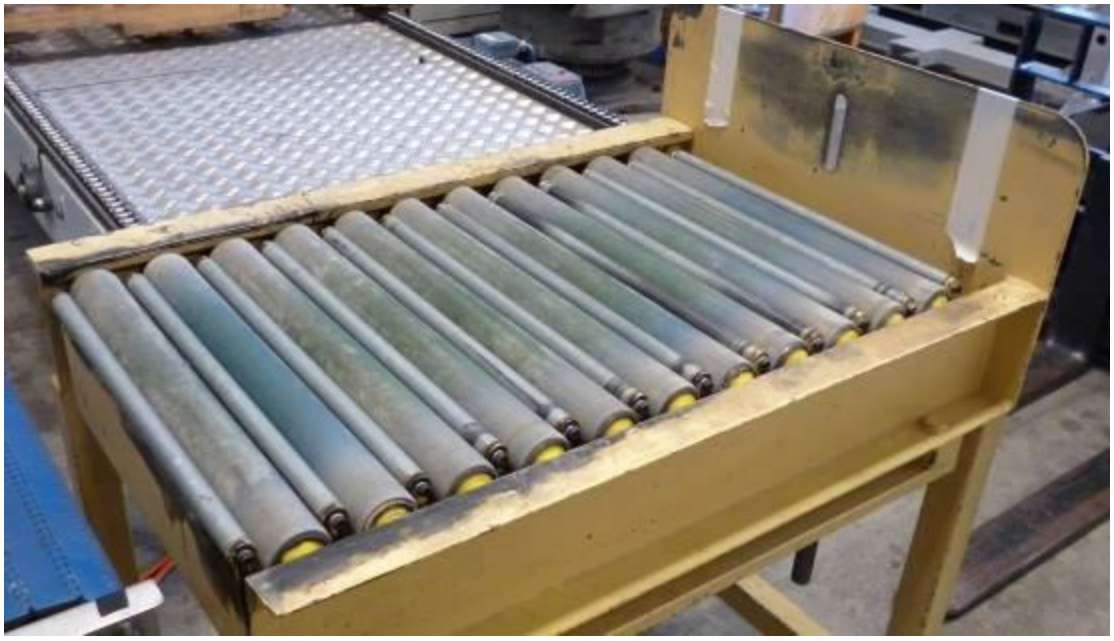


Fig.8 Roller conveyor designed and procured to accommodate the gripper

6 Results Milestone 3,4 and 5

Initial trial work was conducted with empty uniformed sized boxes as shown in the image below. This allowed us to prove the operation of the gripper and confirm the minimum distance between pallets that could be achieved.

Fig.9 Uniform empty boxes used for initial trials

Following this initial setup boxes filled with fat to a weight of between 25 – 30kg were procured from Oakey Abattoir. These cartons were plate frozen so had considerable bulge along the sides of the boxes which enabled more realistic testing of the gripper. The attached videos show the trials taking place and the images below show the resultant palletised cartons.

The images below show the bulge in the plate frozen cartons

.

Fig.10 Bulgy Cartons

The images below show the space between pallets 245mm and adjacent cartons including the bulge approximately 200mm. It can be seen in the video that the gripper still successfully palletises with these bulging cartons.

Fig.11 Distance between pallets and cartons

7 Conclusions and Recommendations

As can be seen in the Results section above the concepted combined side clamp, tyne style gripper has shown that it can successfully palletise, within an acceptable cycle time, bulgy meat cartons of approxmately 30kg in weight with the adjacent pallets separated by only 245mm. With this proven it allows MAR to proceed with finalising the concepts and layouts for AMC gantry and Multiple Robot Palletising systems. The illustration below shows the pallet layout of a single cell of the proposed MAR - Multiple Robot Palletising system and potentially reduces the system foot print by approximately 3m in length making the system viable to a large range of processors who are typically short on space in palletising areas.

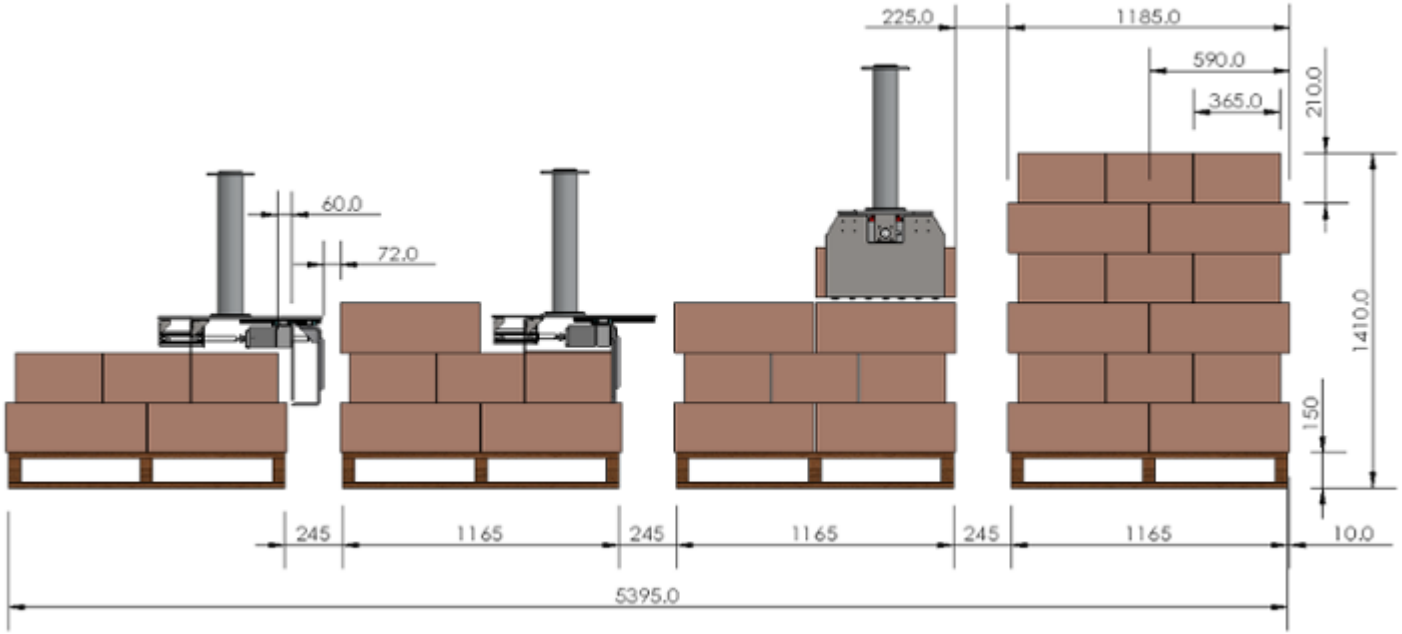


Fig.12 Pallet layout for a single cell of the proposed MAR – Multiple Robot Palletising System