AIMCH

TRANSFORMING HOW WE BUILD HOMES

Work package 7:

Advanced Manufacturing Robotics - Project Summary

September 2021

mtc Manufacturing Technology Centre

L&Q

Construction Scotland Innovation Centre

Forster Group

Stewart Milne Group

Barratt Developments PLC Building Excellence Since 1958

Industrial Strategy

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CONTENTS

INTRODUCTION

The AIMCH Advanced Manufacturing Robotics work package (WP7), led by Stewart Milne Timber Systems, seeks to develop the manufacturing processes involved in Category 2 MMC wall panel production. The use of automation and robotics is seen as an opportunity for the industry. The work was done in partnership with CSIC innovation factory and a commercial automation specialist technology partner.

This summary report summarises the design of the following workstations:

- Sheathing: Sheath wall panels.
- Insulation: Fill wall panels with insulation.

SUMMARY

Advanced Manufacturing Robotics (WP7) is an area of improvement that has the potential to make a large impact within the offsite manufacturing and house building industry.

The project involved the design of three separate robotic workstations for sheathing and insulation applications.

The use of Advanced Manufacturing techniques has provided AIMCH with several benefits including a reduction in manufacturing costs, increased productivity and capacity. Additionally, it has improved product quality and reliability, whilst eliminating manual handling and safety risks.

JOURNEY

Advanced Manufacturing Robotics in the manufacturing of MMC wall panel production is beneficial not only to manufacturers but the housing industry. The design and development of the three workstations was as follows:

Key Considerations

Sheathing Station

The design of the workstation considered the following factors:

- Using pre-cut boards and/or using full sized boards trimmed in situ
- Boards to be applied to a variety of panel sizes
- Handling a variety of board types and weights
- Ability to utilise a variety of fixing types
- Accurate positioning of boards based on CAD information
- Cycle times needed to increase production output

Insulation Station

The design of the insulation work station considered the following factors including:

- Supply of raw material to feed the insulating operations.
- Accurate positioning and repositioning, of equipment is required.
- Insulation to be applied to a variety of panel sizes and configurations.
- Insulation to be applied to a variety of panel void sizes and configurations.
- Cycle times needed to increase production output.

1. SHEATHING STATION

1.1 Sheathing Wall Panels

This assembly process activity can be described as the picking, placing, and fixing of sheathing boards onto Cat 2 MMC panelised wall panel frames. Commonly, sheathing boards are lifted, positioned, and secured manually by one or two operators.

The key advantages to automating the sheathing of wall panels are:

- Reduce manual handling activities
- Increased robustness of quality assurance
- Increased output rates

1.2 Requirements

The design of the workstation considered the following factors:

- Using pre-cut boards and/or using full sized boards trimmed in situ
- Boards to be applied to a variety of panel sizes
- Handling a variety of board types and weights
- Ability to utilise a variety of fixing types
- Accurate positioning of boards based on CAD information
- Cycle times needed to increase production output

1.3 Sheathing Boards

Two approaches to processing the boards ready for fitting were considered: pre-cutting boards to size and full sheets cut within the Sheathing Station.

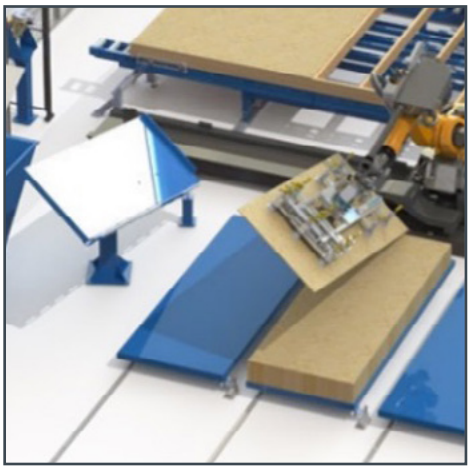
Pre-cutting the boards marginally increases material optimisation but generates more pieces to be fitted therefor, increasing the cycle time and material handling to cut and sequence the boards.

Placing full sheets reduces the number of pieces to fit, therefore improving cycle time but milling opening and trimming edges add activity thereby increasing the cycle time. This method produces small offcuts which are hard to deal with.

The AIMCH proposal uses a hybrid approach where sheets are pre-cut to height, reducing in-station milling, and panel designs are optimised to half or full sheet widths, reducing small off cuts.

1.4 Position Precision

It proved to be difficult to place board stacks precisely and, in any case, the boards have the potential to slip and move when the top board is being picked. As a result, a jig is used to ensure that every sheet is picked up with a consistent origin point.



1 - Jig

1.5 Fixings

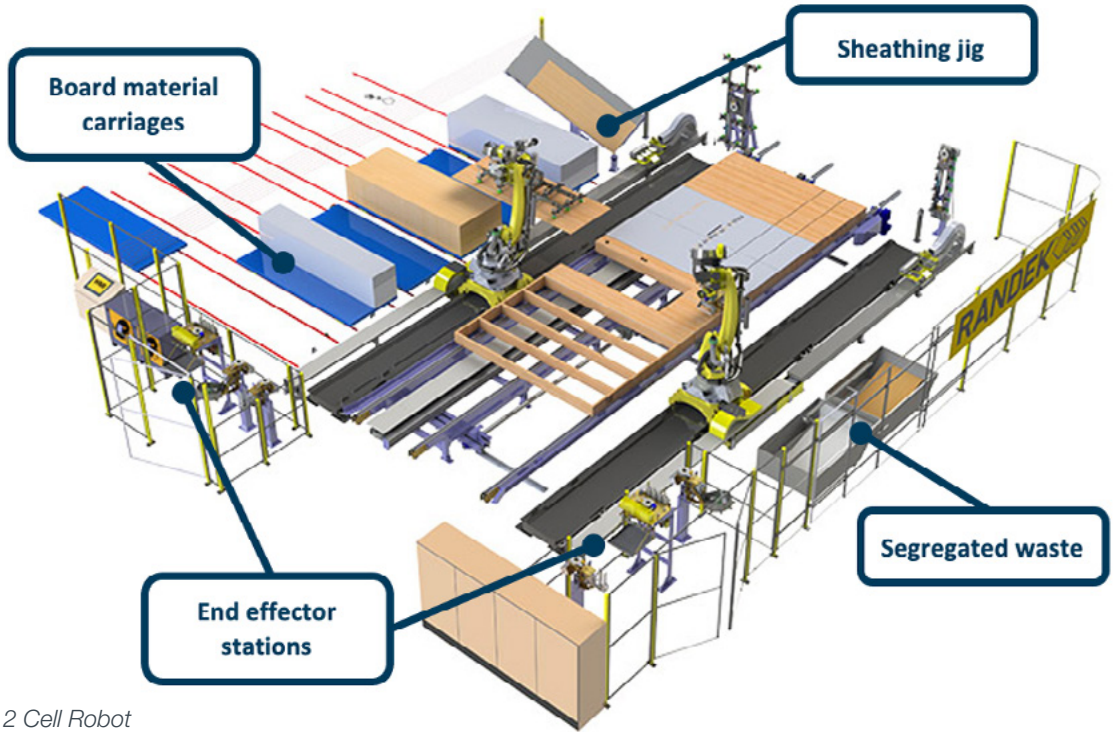
Several end effectors are available to suite a selection of standard nails, staples and screws. It is possible to develop end effectors for bespoke fixings or to hold and utilise standard hand tools.

1.6 Output

A multi robot cell can achieve outputs, like the existing manual labour dependent solution, but with a smaller footprint and much greater reliability and accuracy.

This would eliminate manual handling, increasing precision, and free up labour resources, whilst reducing costs. Combining optimisation of panel design could yield further output benefits.

2 - Multiple Screw Gin End Effector



3 - 2 Cell Robot

2. INSULATION STATION

2.1 Insulating Wall Panels

This manufacturing process can be described as filling wall panel frames with insulation. Equipment is available to deliver the insulation to the required density however, the positioning and alignment of the equipment within the panel voids must be carried out manually by an operator using a winch and roller table.

The key advantages to automating the insulating of wall panels are:

- Increased output rates.
- Reallocation of operative resource.
- Increased robustness of quality assurance.

2.2 Requirements

The design of the insulation work station considered the following factors including:

- Supply of raw material to feed the insulating operations.
- Accurate positioning and repositioning, of equipment is required.
- Insulation to be applied to a variety of panel sizes and configurations.
- Insulation to be applied to a variety of panel void sizes and configurations.
- Cycle times needed to increase production output.

2.3 Material Supply

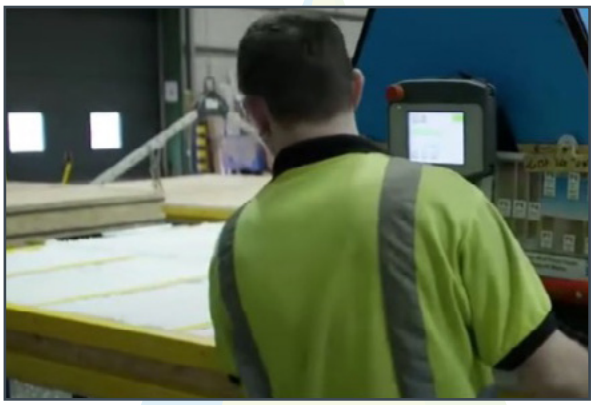
The insulation arrives in a compressed form. Achieving the goal of increasing the output will require the successful management of the material infeed. To assist with increased material requirements at high throughput levels, insulation is available in a bale format.

2.4 Insulating Fitting & Output

Multiple factors affect the rate at which insulation can be fitted, some of these are:

- the type of insulation
- the size and shape of the void being filled
- the distance the material needs to travel

The range varies pending size and shape of voids to be filled. Through design assessments a solution was developed to achieve the original project target, for insulated wall panel output. Further work was carried out to explore what other options could be pursued to achieve future increases.



2.5 Increasing Output

AIMCH invested significant time, effort to develop an automated insulation process and station. Optimising the sizing of the panel voids, can help increase output, but is unlikely to yield significant improvement.

Several options were determined was to increase levels of automation and equipment. This involves the additional cost for equipment, workstation setup, and the cost of additional factory floor space.

In all options additional material supply would be required to maintain fitting rates and additional floor space would be required for material feed.

Principal Outcomes

The AIMCH Advanced Manufacturing Robotics workstream delivered the following outcomes:

Sheathing

- A multi robot cell can achieve similar outputs, to existing manual labour dependent solution, but with a smaller footprint and much greater reliability and accuracy.
- This would eliminate manual handling, increasing precision, and free up labour resources, whilst reducing costs.
- Combining optimisation of panel design, and additional automation, could yield further output benefits.

Insulation

- AIMCH developed a proof of concept design for an automated insulation solution, with insulation equipment working independently.
- Potential exists through further improvements that could double output.
- More time, effort and investment are needed to commercialise solutions, with automation/ robotics technology partners
- Optimising the sizing of the panel voids, can help increase output, but is unlikely to yield significant improvement.

CONCLUSION

Through this research, AIMCH are confident that it is the right time to be investing in advanced offsite manufacturing technology and by doing so, the house building industry can greatly benefit from scaling up Cat 2 MMC capacity and transitioning to a more manufacturing orientated sector.

The use of advanced manufacturing technology can lead to reducing costs, improved quality and safety, increased consistency and reliability, greater output and reduced labour dependency, free up the workforce to undertake more higher value manual assembly operations.

Looking beyond AIMCH, the proof of concept and learnings gained from the project, will fuel further commercialisation and deployment of new advanced manufacturing applications, mainstreaming the use Category 2 Panelised MMC systems, supplied by Stewart Milne Timber Systems.

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