AIMCH

TRANSFORMING HOW WE BUILD HOMES

Work package 7:

WP 7 - Advanced manufacturing robotics and future factory simulation

May 2022

mtc Manufacturing Technology Centre

L&Q

Construction Scotland Innovation Centre

Forster Group

Stewart Milne Group

Barratt Developments PLC Building Excellence Since 1958

Industrial Strategy

UK Research and Innovation

BACKGROUND

The advanced manufacturing work package examined the use of automation in manufacturing processes for MMC wall panels. At the same time, it looked at the possibilities presented by using modelling technology to plan future offsite manufacturing (OSM) facilities.

Stewart Milne Group, in partnership with equipment technology partner Randek, led the development and design of three robotic workstations for sheathing, window fitting and insulation applications.

Forster Roofing, in partnership with MTC, assessed the use of a mathematical model to complete a worked example of a small factory unit, testing its use and applicability in replicating a real industrial scenario.

Stewart Milne Group, working with MTC, showed how modelling and simulation tools can inform investment decisions, reduce the need for external consultation and speed up the development of offsite construction, manufacturing facilities.

APPROACH

Advanced manufacturing robotics

This project designed three robotic workstations for sheathing, window and insulation applications.

Sheathing involves picking, placing and fixing sheathing boards onto Category 2 MMC panelised wall panel frames. That meant the design needed to consider how the station would cope with different-sized boards, or trimming in situ, as well as varying board types and weights. It also had to be able to apply a range of fixing methods, delivering a precision result.

The fitting of windows involves assessing supply chain logistics, identification, sequencing and robotic insertion, as well as loading and offloading of windows into panelised external wall systems

Filling wall panels with insulation materials via an automated system meant thinking about the supply of raw insulation material to the system, and accurate positioning and repositioning over a range of panel/void sizes and configurations.

In all cases the partners also had to think about the cycle times needed to positively affect output.

The use of advanced manufacturing techniques has provided AIMCH with benefits including a reduction in labour dependency, lowering of manufacturing costs, increased productivity and capacity, improved product quality and reliability and elimination of manual handling and safety risks.

Future factory simulation

Stewart Milne Group and MTC collaborated to test modelling technology that could be used to speed up investment in future OSM factory planning.

Drawing from technology used in the automotive sector, they examined its potential for reducing the planning and analysis needed to support investment. They also considered its use in speeding up the creation of factory blueprints and specifications needed for business case investment.

The partners worked together to:

- Identify appropriate factory production flows and work planning parameters for panelised OSM.
- Model different tools and techniques.
- Created a flexible but relevant mathematical model and simulation tool.
- Undertake the practical assessments and testing needed to ensure robust tools and reliable outcomes.
- Test the tool effectiveness in real-world applications and justifications.

They also had to ensure the modelling and simulation tool was flexible and accessible enough for non-expert use, and scalable for any size of business.

Mathematical Model Assessment

A user pilot assessment demonstrated the practical use of the mathematical model to evaluate its usability and functionality. Stewart Milne Group input data for a real-life scenario, then used the resulting development model to build three factory scenarios. This exercise helped assess the model's ability to represent a real scenario and allowed the validation of results by comparing output from the modelling tool with known results from existing factory operations.

The output was a mathematical model, simulating work flows and crystallising future factory layouts and designs for inside and outside spaces, that were then developed into 3D blueprints and walkthrough animations.

Forster Roofing's project made further assessment possible by using the mathematical model to create plans for a new factory unit. The exercise assessed the model's ability to represent a smaller production system. Modelling consisted primarily of:

- Inputting data and assumptions into the mathematical model from the industrial scenario
- Output of model data and 2D layouts
- Assessment of modelling process and performance

The exercise also allowed assessment of user understanding of key components:

- Inputs/assumptions – key data entries for the scenario
- Model exercise/methodology – modelling process and scenario concepts
- Outputs/interpretation – key data output for the scenario

OUTCOMES

The **advanced manufacturing robotics team** were able to determine that a multi-robot cell could effectively deliver similar outputs in sheathing operations, but with a smaller footprint and a significant increase in accuracy and reliability.

They also created a proof of concept design for an insulation solution that demonstrated the potential, with additional improvements, to double output. At the same time, the team acknowledges the need for more work and investment with technology partners to fully commercialise the operation.

Looking beyond AIMCH, the proof of concept and learnings gained from the project, will fuel further commercialisation and deployment of new advanced manufacturing applications.

The **modelling technology team** were able to develop four modelling systems:

- A mathematical model to serve as a scalable and adaptable tool that would cope with complex OSM scenarios, provide a structured and practical method for factory design, calculate equipment and labour quantities and visualise the layout of the factory production system.
- A 2D Discrete Event Simulation (DES) Model that balances a user-friendly data management system with scenario testing processes. A user interface was designed to allow users to input data, build models, run scenarios and assess output without having to use the complex software directly.
- A 3D DES model that shows the planned and analysed factory specification that can inform an architectural model and help communicate plans and designs. It also supports collaborative planning between internal and external stakeholders.
- A 3D Revit model to show greater detail in the factory unit and service areas, as well as an animated fly-through that brings the project to life. This also helped to prompt positive challenges and engagement and to improve further design iterations.

Forster Roofing's mathematical model trial highlighted the capability of this type of modelling to help both larger production businesses and SMEs by supporting business decisions and ventures into unknown production type activities. They felt that the modelling could be further refined to increase capability, make it more generic and allow it to be more applicable across the construction sector.

> There is proven interest in the repeated use of the model to support other project deliverables and present a standard process for this level of system assessment. The structured and practical nature of the model lends itself to wider use throughout MTC, industrial partners and customers.

This project has created tools that can be used in both construction and other manufacturing industries, and showed that they can be simpler and more accessible than might previously have been thought. They will improve decision making and add value in planning new facilities or remodelling existing factories or processes. There's also huge potential for these tools to be used beyond AIMCH and the construction sector.

The demonstration of these modelling and simulation tools has highlighted the benefits of applying modelling techniques within the construction industry and will hopefully encourage the wider construction community to adopt and embrace this type of technology to improve robust investment and expansion decision making.

Read the full Advanced Manufacturing report

Read the full Mathematical Model Assessment report

AIMCH

TRANSFORMING
HOW WE BUILD HOMES

mtc Manufacturing Technology Centre

L&Q

Construction Scotland Innovation Centre

Forster Group

Stewart Milne Group

Barratt Developments PLC
Building Excellence Since 1958

Industrial Strategy

UK Research and Innovation

@AIMCH2

aimch

aimch@cs-ic.org

www.aimch.co.uk