AIMCH

TRANSFORMING
HOW WE BUILD HOMES

Work package 7: Advanced Manufacturing – Future Factory Simulation

January 2021

Introduction

The AIMCH project aims to help tackle the UK housing crisis by using modern methods of construction (MMC) to deliver high quality homes faster, more reliably and at the same cost as masonry-built homes. It seeks to mainstream the use of panelised offsite building systems used in the housebuilding industry, to deliver high quality affordable homes.

The aim of this part of the project was to identify how modern technology could help reduce planning and analysis timescales for creating new factories and quickly generate a factory model specification for business case submission. It is one of a three part step within this work package that provides a digital blueprint, business case and ROI, for future Offsite Manufacturing (OSM) factory investment.

Stewart Milne Group, one of the UK's leading housebuilders, and manufacturing innovation hub the Manufacturing Technology Centre, worked together for several months in a highly innovative collaboration. Discovery processes, advanced modelling and simulation techniques were used to explore a multitude of scenarios and variables to create a model that would be easy to use yet extremely valuable, flexible but relevant.

This work has paved the way for Offsite Manufacturing (OSM) companies to make more agile decisions about increasing capacity to the market by using modelling and simulation tools to support and control digital factory planning activities.

Summary

As AIMCH partners, Stewart Milne Group and The Manufacturing Technology Centre collaborated to test modelling technology used in the automotive sector in order to reduce planning and analysis needed for future Offsite Manufacturing (OSM) factory investment and to quickly generate a factory 'blueprint' and specification for business case investment.

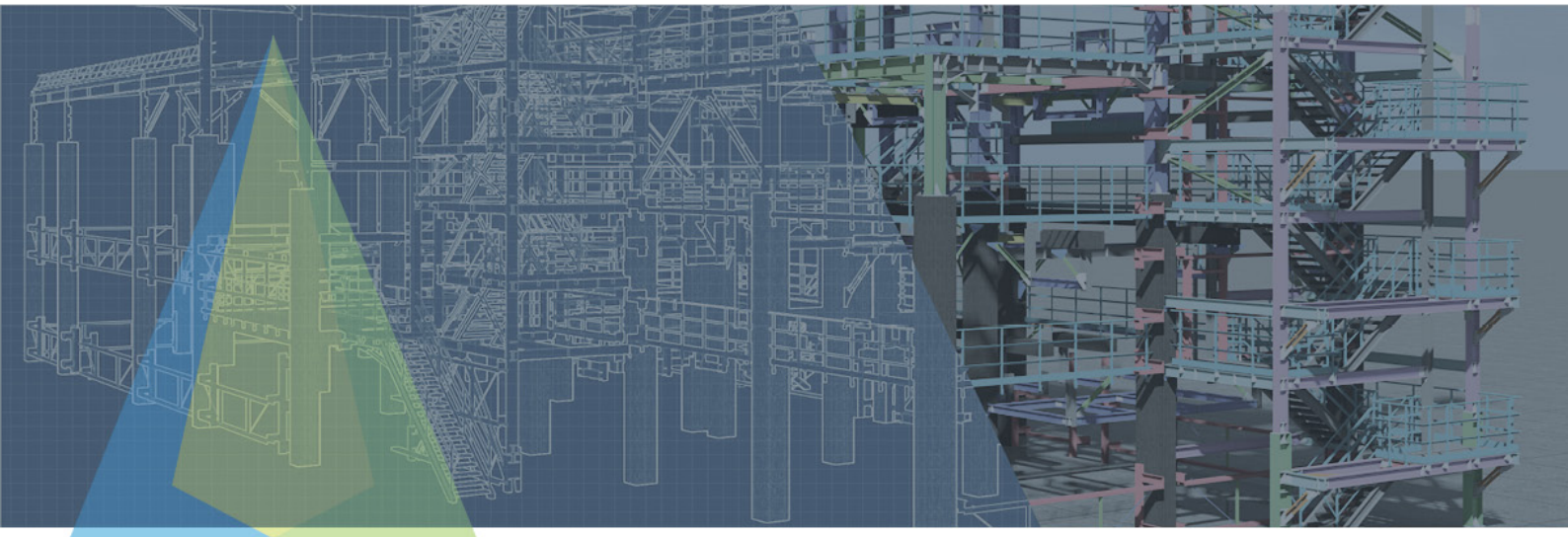
A methodical and highly collaborative approach, transferring knowledge from automotive sector, was used to maximise the advanced manufacturing outcomes from the AIMCH project through the following steps:

- Identified appropriate factory planning parameters appropriate to the panelised OSM.
- Factory discovery activity illustrated the complexities compared to traditional manufacturing.
- A modelling approach demonstrated different tools and techniques.
- Through collaborative development, flexible but relevant mathematical models and simulation tools were developed.
- Practical assessment and testing ensured robust tools and reliable outcomes.
- Real world application demonstrated the value of mathematical modelling and simulation.

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

Key outputs:

- Created a new standardised, flexible modelling tool capable of replicating a variety of industrial scenarios to many different levels.
- Provided non-experts with the ability to interact with simulation modelling technology and gain quick, fact-based insights to make better decisions without specialist software expertise.
- Enabled the adoption of modelling techniques as part of an in-house investment strategy process within an offsite manufacturing company, normally reliant on hiring specialist consultancies.
- Demonstrated the value of modelling tools for interacting with stakeholders when planning real future investment and developing business cases.



This report provides more detail of the following elements of this project:

- Mathematical model
- 2D discrete event simulation model (DES)
- 3D discrete event simulation model (DES)
- 3D Revit model
- Tool exploitation
- Business exploitation

Mathematical model

To demonstrate the capability of using mathematical modelling tools to support the creation of a new factory specification and layout, in terms of the shop floor system capacity, layout, flow and cost.

This helped to:

1. Illustrate the access and usability of modelling techniques for factory planning without specialist software
2. Create a factory specification and an associated visual layout of the proposed factory

Development of this model was a challenging prospect as it was designed to serve as a scalable and adaptable tool able to cope with various complex scenarios associated with OSM factory operations, as well as providing a structured and practical method for factory design.

The mathematical model not only calculates quantities of equipment and labour required to support the factory demand but allows the user to visualise the layout of the factory production system to better understand and communicate to others.

Watch our mathematical modelling video here.

2D Discrete Event Simulation (DES) Model

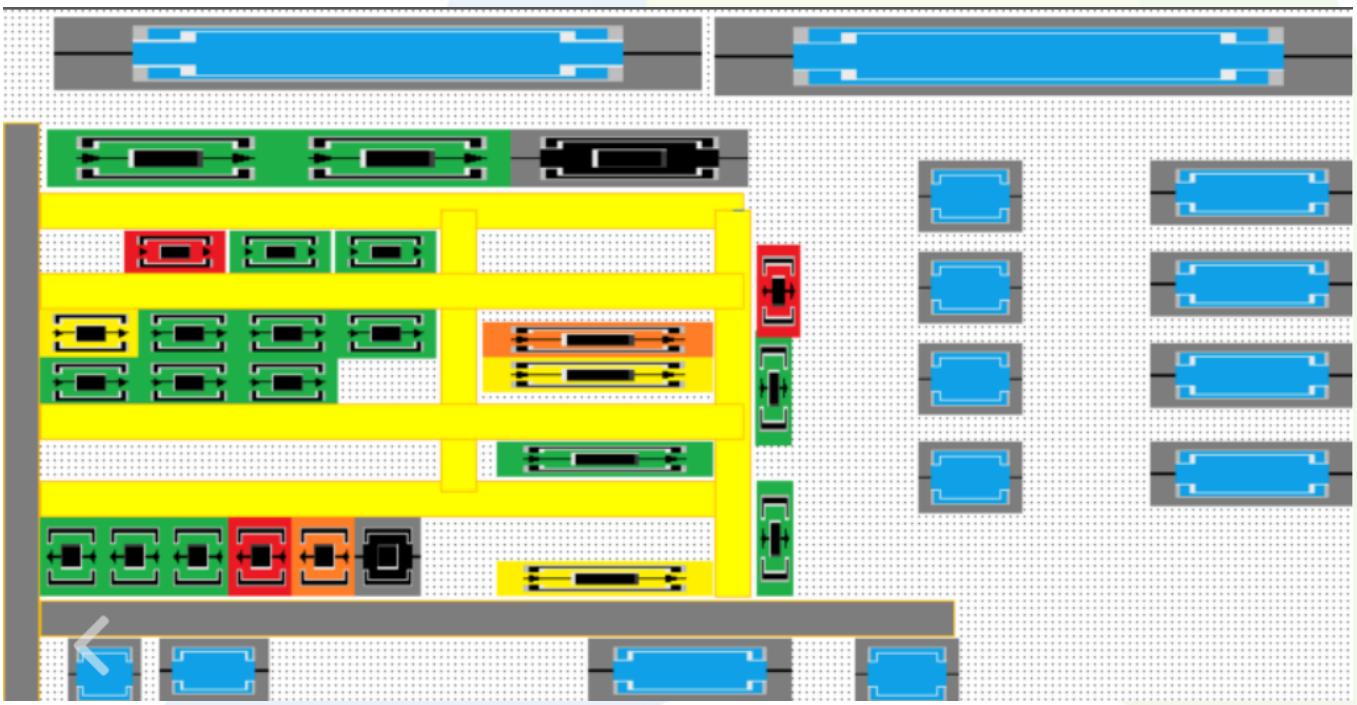
To assess the dynamic nature and performance of the factory production system over time and under various conditions and constraints.

This helped to:

1. Illustrate how factory analysis can be carried out using a structured platform, data sets and planning approach.
2. Create a set of key performance indicators highlighting production system process, interactions and outputs.

The 2D discrete-event simulation (DES) model managed to strike a fine balance between the provision of a user-friendly data management system and the scenario testing process.

A structured data interface was developed to enable the user to control and interact with the DES model for ease of data inputs, model build, scenario runs and output results without having to use the DES software directly.



3D Discrete Event Simulation (DES) Model

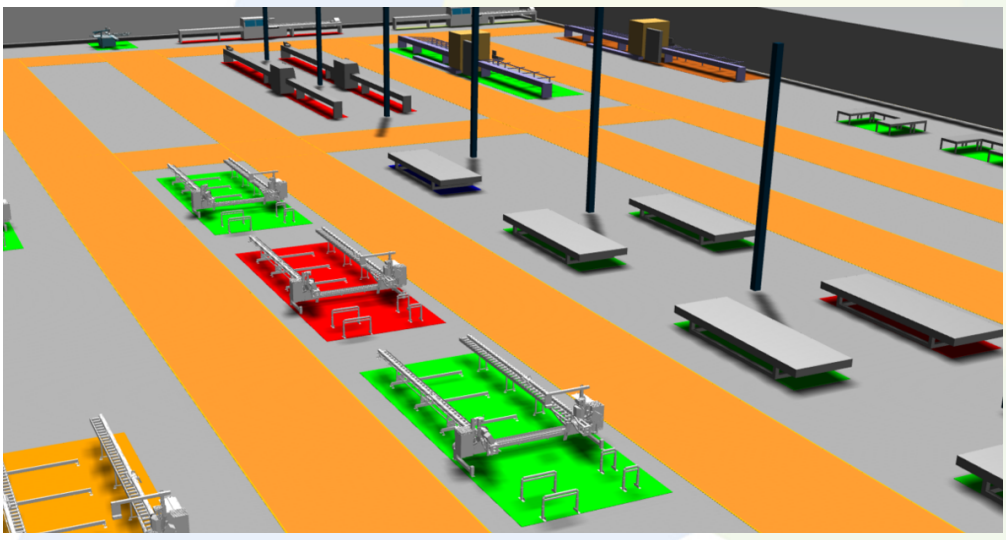
To enhance the factory visualisation by utilising CAD models, and some factory environment modelling, a 3D representation of the factory production system and shop floor was developed.

This helped to:

1. Illustrate how a planned and analysed factory specification can be presented as a final factory design.
2. Create a visual 3D representation to aid in the understanding and communication of a factory design.

The user interface used 3D CAD models to enhance the visualisation of the factory and its environment to sufficient detail, ready for a full 3D architectural model and flythrough to be developed.

The real 3D DES Model aids collaborative planning of future factory designs with internal and external stakeholder. This avoids potential issues and incorporates important factors into the overall design concept.



3D Revit Model

To engage with stakeholders and demonstrate the future factory design SMG engaged architects to develop a 3D Revit architectural model.

This helped to:

1. Illustrate a greater level of detail both within the factory unit and surrounding service areas.
2. Create an animated fly-through to bring the design to life.

Sourcing the 3D objects can be time-consuming, with some machinery suppliers not used to being asked for 3D CAD models of their equipment, and the smaller scale bespoke equipment needing to be modelled from scratch.

As well as providing a virtual reality view of the future factory design to wider stakeholders, it has also prompted positive challenges and engagement on design decisions enabling further design iterations and improvements.

Click here or on the image below to see our manual hub flythrough.

Tool Exploitation

The tool set and methodology developed provides the capability to build and evaluate many different production scenarios so that investment decisions can be made with deeper insight.

This new capability will be exploited in the following ways:

1. The toolset will enhance the MTC's offering for Business and Factory Optimisation, demonstrating that it is pushing the boundaries of the technology.
2. The tool set will not just service the construction industry, it will also be used across other sectors. This means the AIMCH project will have developed capabilities that can be exploited in traditional manufacturing industries such as Aerospace, Defence, and Automotive.

Going forward the toolset could be developed so that process and facility designs are optimised concurrently, leading to more cost effective production facilities. This will be explored beyond AIMCH.

Business Exploitation

The project has provided a number of agile and accessible tools that have been able to be used immediately.

This helped to:

1. Model (and remodel) scenarios quickly and without external consultant support
2. Inform real investment decisions with a greater degree of confidence.

It highlighted, especially with DES tools, that a certain degree of experience and understanding is required to maximise the benefits of the tools.

Conclusion

Through Advanced Manufacturing demonstrating these modelling and simulation tools it has highlighted the benefits of applying modelling techniques within the construction related manufacturing industry and will hopefully encourage the wider construction and manufacturing supply chain to adopt and embrace this type of technology to improve robust investment and expansion decision making.

- Close collaboration demonstrated that modelling and simulation can be simplified and become more accessible than traditionally thought.
- OSM supply chain and the construction industry can benefit from adopting modelling methods and technologies to improve agile, scenario-based decision making.
- Simulation can add value when re-planning existing production activities and facilities, as well as informing larger investment and expansion projects.
- There is the potential to expand the use of modelling from factory systems to further areas of application such as supply chain, resource management and material/product management.

Future factory simulation is part of the wider advanced manufacturing work package of AIMCH which also includes robotics and automation and shop floor data capture analysis. For more information on the full scope and outputs of the AIMCH project visit aimch.co.uk and follow us on LinkedIn and Twitter.