

Investigating the role of the digital twin in optimising

Benefit to

Asset managers, infrastructure owners and operators, design engineers, contractors

Impact and value

- enabling adoption of data curation and information management approaches for the lifecycle of built assets

The digital age brings opportunities for optimising the use of our physical assets. A key component to realising the whole-life value of our built environment is the development of digital twins – digital replicas of physical assets, processes and systems. CSIC researchers at the Institute for Manufacturing (IfM) are collaborating on the flagship research project of the Centre for Digital Built Britain (CDBB) at the University of Cambridge with joint CSIC-CDBB industry partners (Bentley Systems, GeoSLAM, Topcon, and RedBite), to develop a dynamic digital twin of the University of Cambridge's West Cambridge Site. The aim of the project is to demonstrate the impact of the digital twin on facilities management, wider productivity and wellbeing.

Collaborations between industry and academia offer benefits and value to both parties as well as the wider infrastructure community. By sharing our combined expertise and skills we are able to test new technologies and tools on live projects, accelerating the timeframe for cutting edge innovation to become part of mainstream industry practice.

Digital twins

The vision for a digital twin is to integrate artificial intelligence, machine learning and data analytics to create a living digital simulation model which continuously learns and self-updates from multiple sources to represent near real-time status, working condition and/or position of the physical asset. Digital twin models will help organise data into interoperable formats and also share this data, with defined levels of access, to inform better policy, planning, and management decisions on the interaction between the built environment and the economy, society and the natural world.

Developing a digital twin of the IfM and the West Cambridge Site

The West Cambridge Site and the IfM, the offices of the CSIC/CDBB researchers, are the ideal location for the test bed for this ambitious and innovative project. The aim is to create a digital twin that will incorporate multi-layered information models to integrate heterogeneous data sources at asset, building and district scales. This will support intelligent data query and smarter decision-making for operation and maintenance management, as well as bridging the gap between people and the buildings they use via more intelligent and visual use and display of information. This dynamic digital twin will be supported by an as-is Industry Foundation Classes (IFC) Building Information Model (BIM) and data from the facilities management systems and Internet of Things (IoT) sensors and devices. Between December 2017 and May 2018 a platform has been established to build a geometry model of the West Cambridge Site, a BIM model of the IfM building with a medium level of detail, and BIM models of specific areas in the IfM with highly detailed information (Figure 1 and Figure 2). This work is being carried out through a joint effort between CSIC and CDBB researchers at the IfM, Bentley Systems, GeoSLAM, and Topcon.



Figure 1: Snapshot of BIM Model of IfM Plant Room from ContextCapture modelling software by Bentley Systems

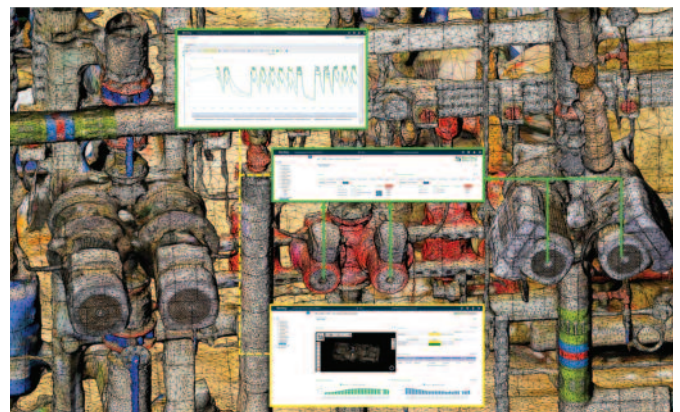


Figure 2: View of the BIM Model of IfM Plant Room with information about components displayed

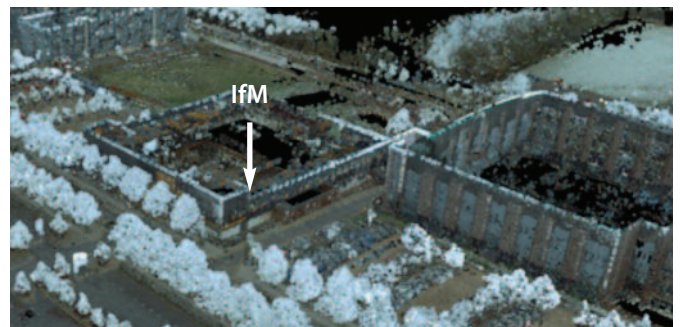


Figure 3: Snapshot of the mobile scan of the IfM and surrounding area performed by Topcon

Next stage – comprehensive, business-objective-led asset information management

A comprehensive high quality asset register will be generated by CSIC/CDBB researchers using itemit, RedBite's asset management solution. The itemit app will be used to provide asset users and stakeholders with relevant information and to incorporate input and feedback from users through the use of itemit QR and RFID asset identification tags on critical equipment. Asset maintenance and inspection schedules and records will also be built in to itemit. RedBite will develop APIs (application programming interfaces) that can be used to integrate the asset data with the 3D BIM model through Bentley's AssetWise operational analytics solution. In addition, the project team will explore potential ways in which the data collected through the Building Management System (BMS) and the Estate Management's work-order system (Planet) can be integrated with itemit and the BIM model.

Bentley Systems, working together with Topcon, and GeoSLAM expect to further advance the extent of data captured via a hybrid Reality Model of the whole West Cambridge Campus including external and internal building data. Focus will be upon continuous updates and automation of model generation. Focus then will be on the linking with time series data flows from sensors and data from the Building Management System (BMS). The data set will then be available for CSIC and CDBB researchers, together with application specialists from Bentley Systems, Topcon, GeoSLAM, and RedBite to test and validate workflows.

Working closely with University of Cambridge Estate Management, CSIC and CDBB researchers at the IfM will identify potential opportunities for, and test the feasibility of, deploying additional sensors that will help monitor the condition of critical assets in the IfM and the usage of the building. Other sensors may also be deployed across the site, subject to availability.

Future work

- During 2018 -2019 the aims of the project are to:
- continue the work on integration of live data with BIM and expand this to include data captured from other buildings on the West Cambridge Site
 - explore data integration from different sources using open standards to ensure that the digital twin development is vendor agnostic

- install and deploy additional sensors in key areas of the IfM
- develop novel applications (the 'APP STORE' in Figure 4) that exploit data capture through the digital twin including augmented reality support for maintenance and inspection, predictive data analytics to improve asset maintenance, improved asset tracking across the West Cambridge Site and improved equipment utilisation and management.

Long term vision – a dynamic digital twin

The long-term goals of this work are to demonstrate the impact of digital modelling and analysis of infrastructure performance and use on organisational productivity across an estate or district through development of a dynamic digital twin representing current conditions at any point in time. This will provide the foundation for integrating city-scale data to optimise city services such as power, waste, and transport and understanding the impact on wider social and economic outcomes. Additionally, CSIC together with CDBB aims to establish a 'research capability platform' for researchers to understand and address the major challenges in implementing digital technologies at scale and to foster a research community interested in developing novel applications to improve the management and use of infrastructure systems.

Further work (3-5 years)

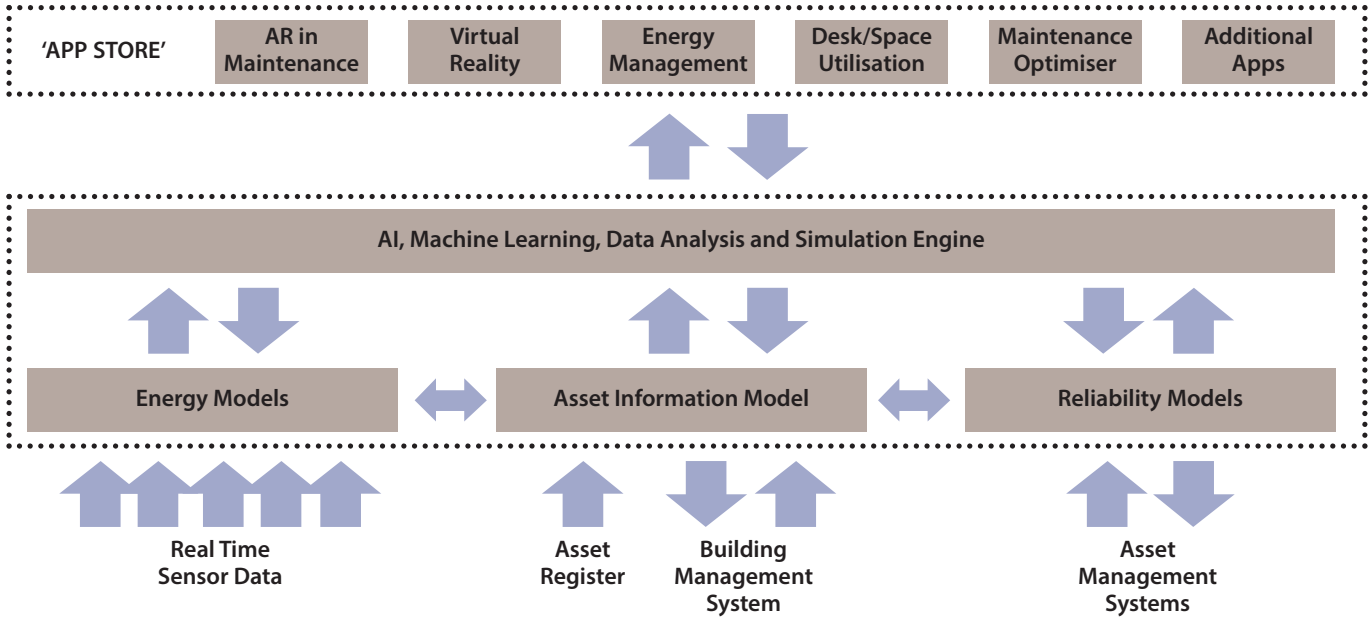


Figure 4: Digital Twin Vision

“ Collaborating with leading experts in industry and academia is central to achieving the Centre’s mission to deliver a digital built Britain. We are delighted to be partnering with academics from the University of Cambridge, and with Bentley Systems, Topcon, RedBite and GeoSLAM to deliver this flagship project.

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