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Digital Twins: Myths or A Reality for Clients and End Users

Background

A Digital Twin is a digital duplicate of the physical assets. While a BIM model contains as-is and historical data, a Digital Twin can be used to assess the current state of a digital duplicate of the built environment. The Digital Twin is based on cumulative, real-time, real-world measurements across an array of dimensions, and the consequent use of a digital model can span across the entire lifecycle of a project.

The CitA Digital Transformation Series on the 10th October will provide a focus on Digital Twins with keynote speakers from Trinity College Dublin (TCD), Invicara, Centre for Digital Built Britain (CDBB) and the Confirm Smart Manufacturing. The case study will provide a unique insight into the challenge of creating a live Digital Twin of their TCDs new Business School.

Trinity Business School

The TCD business school project is part of a €295 million capital investment plan, outlined in the college's 2014-19 Strategic Plan. The development consists of a business school, innovation and entrepreneurship hub, auditorium, cafe, and student accommodation with ancillary administration, staff and student uses. A roof garden is located on the top floor. Figure 1 provides a CGI of the proposed building.

Members from the academic and estates staff from TCD and Invicara have explored how the Digital Twin can be expected to deliver defined outcomes, through the application of 3D models produced from BIM authoring tools which will serve as a "seed" to create a Digital Twin, in combination with information from other data sources

Figure 1 – CGI of TBS from Pearse Street

This Asset Information Model (AIM) was created to become the "Digital Building Manual" for the operations and maintenance teams in TCD estates. The Digital Twin created enabled the AIM to become dynamic through the integration of information with other systems (1) to reflect the "as-maintained" conditions, (2) track building performance "as-used" against the occupant comfort, space and asset utilization, (3) and enable analytics and potentially, through machine learning, predict outcomes to optimise utilisation of space, utility consumption and the lifecycle of assets.

The AIM will typically consist of several data sets such as 3D and 2D graphics, performance data, commissioning data, specification data, and documents. TCD chose to build its AIM on the Invicara platform, which provided them with a flexible approach to define the AIM data model, to suit the initial outcomes and to be further enhanced progressively as information gaps are filled. This provided the TCD Estates and Facilities team with the comfort that they do not receive an unusable Digital Twin with an AIM, as delivered at project handover. The Invicara platform enabled them to implement solutions progressively either as "Apps" on the platform or by enabling integrations with other business systems.

As the Business School building is the first experience for TCD with Digital Twins, the initial focus was to try to achieve a reasonable level of maturity in the AIM, and as a future step, define and develop Digital Twin solutions to serve defined use cases.

TCD has implemented a Computerized Maintenance Management System that will integrate with the AIM to support various business workflows around preventive maintenance, warranty tracking, service request, and work order management and asset lifecycle cost management. Future integration with the Internet of Things (IoT) will enable situational awareness solutions that provide oversight to building performance concerning comfort, energy, and air quality, by blending sensor data with information relating to the involved assets. Integrating occupancy sensors, the time table of activities in the building, and room booking systems will enable solutions to visualize planned vs actual building usage. Other uses that have been considered and expected to evolve with time, range from incident response management, predictive maintenance using machine learning, to enabling the building to be monitored in demand response programmes of energy utilities.

This study, based on observations of a live project, the construction of the Trinity Business School, leads to the recommendation to build a platform approach to Digital Twin solutions, with a flexible and extensible data model at its core. The ability to build each solution as an independent App on the platform, each leveraging the core data model, user and permissions management framework, provides the basis for a scalable and interconnected set of Digital Twin solutions.

CDBB – National Digital |Twin

The CDBB in the UK is a strategic partnership between the UK government and the University of Cambridge. The CDBB envisions a broad scope of commitments to support the adoption of BIM as business as usual and the evolution of the UK BIM Programme. The CDBB has launched a "Research Bridgehead," which aims to build effective relationships with the research community to harness value, enabling results of innovative academic research to inform the development of Digital Built Britain. They have also published the "Roadmap to the Information Management Framework for the Built Environment."

The centre is also establishing the "Digital Twin Hub," a collaborative web-enabled community for those who own, or who are developing, Digital Twins within the built environment. They have published the first output of its "Digital Framework Task Group," The Gemini Principles. The paper sets out proposed principles to guide the National Digital Twin (NDT) repository and the information management framework that will enable it. The NDT has been cited as having the potential to unlock an additional £7 billion per year of benefits across the UK infrastructure sector. The vision for the NDT is not that it will be a huge singular Digital Twin of the entire built environment. Instead, it is envisaged to consist of 'federations' of Digital Twins joined together via securely shared data. The main principles are illustrated in figure 2.

Figure 2 – Gemini principles

The NDT would allow interdependencies across sectors to be understood in a way that organization level or sector-based Digital Twins could not satisfy. Better decisions, based on better data, will lead to better outcomes for the public per whole-life pound. The information management framework is intended to establish the necessary building blocks to enable effective information management across the built environment. This includes the secure data sharing that is fundamental for enabling the national Digital Twin. The framework will support the creation of an ecosystem of connected Digital Twins across the built environment. By complying with the framework, built environment data will be potentially shareable, only when it delivers value and it is appropriate and safe to do so.

The NDT and the framework will enable better use, operation, maintenance, planning, and delivery of national and local assets, systems and services.

Confirm Centre- Smart Manufacturing

Confirm is Science Foundation Ireland's (SFI) Research Centre for Cyber-Physical Manufacturing Systems Research. The Centre benefits from the expertise across 8 core research performing organisations in Ireland and 16 international collaborations. Their main objectives are; to research and develop future smart manufacturing technologies; promote talent and engage the public in promoting a positive perception of manufacturing in Ireland; and establish a community of practice to embrace the 4th Industrial revolution together.

Through Confirm, companies can implement Industrial IoT Digital Twins to enable them to evaluate production decisions based upon analytics, visualize products performing in their environments, or being used by actual people in real-time, thus gaining control over complex processes and systems-of-systems and other essential manufacturing insights. The key enabling technologies for this include networking systems and IoT sensors, wireless sensor networks, robotics and control and data analytics. Figure 3 illustrates the partnership between physical and digital assets.

The key industry impacts expected include; the optimization of efficiency by predicting failures and inefficiencies in production in real-time, the development of new products with insights based on the behavior of existing products or processes in the real world, as well as reduced services costs.

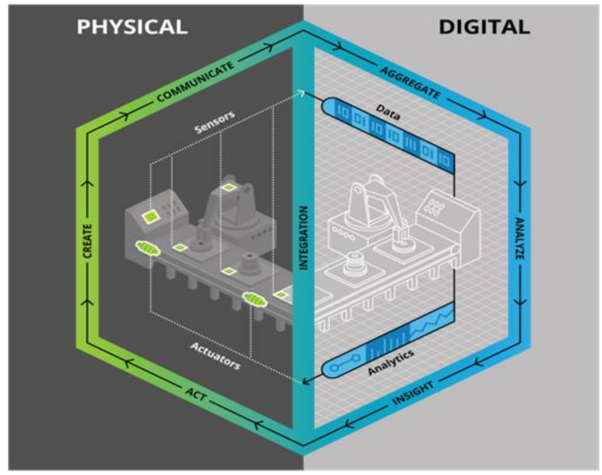

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Figure 3 – Physical and Digital

Conclusion

Digital twins have the potential to drive innovation and enable improved data quality, cost reduction, and enhanced revenue growth. While still early to the construction market they allow a unique opportunity in the management and advancement of one's business model by having access to real-time and usable data.

References and Acknowledgements

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