Optimizing Digital Twins for the Building Lifecycle:

A Data-Driven Approach

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Introduction

Over the past decade, critical advancements in digital twin technology have led to considerable new efficiencies for the AEC/O industry. From design and construction to ongoing maintenance and operations, the use of digital twins while leveraging building information modeling (BIM) empowers stakeholders with access to a wealth of valuable, real-time data about the physical assets within a building model. In addition to allowing for better decision-making throughout the entire lifecycle of a project, the insights produced by digital twins have the potential to reduce operating costs, improve operational performance and construction monitoring, enhance collaboration, and most importantly lead to increased environmental sustainability of built assets.

In current practice, the majority of tools and common data environments (CDEs) are model-driven, meaning that they operate on delivered BIM files, which are used as basis for creating insights. However, the accuracy and reliability of such an approach are dependent on the recentness and quality of the model – since a model represents a snapshot at a specific time. Furthermore, as the AECO industry is multidisciplinary, practitioners deal with partial and isolated models, representing multiple views and aspects on the same model elements. For example, a façade's wall could have its architectural representation, the same wall is also present in a separate structural model while including a different set of information describing its concrete characteristics and reinforcement. In such a case, both wall elements in the architectural and structural designs are not linked and have two different identities, although they represent the same real-world object.

This is one of the core challenges of the current model-driven approaches, which limit realizing the digital twin technology to its full potential. More specifically, rather than being centralized and seamlessly coordinated across all stakeholders in the building lifecycle, data is often created and managed in silos, causing unnecessary friction and operational bottlenecks, and eroding the quality and long-term integrity of project-critical information. To address these challenges, the industry will need to come together in support of a flexible, interoperable solution that both optimizes the management of data and maximizes the value of the digital twin.

This eBook will highlight the growing importance of data integration to the ability of digital twins to create real, sustainable value for the AEC/O industry into the future, exploring in more depth the current limitations of data-based capabilities, as well as potential solutions offered by the introduction of Building Lifecycle Intelligence (BLI) and an open standard, data-driven approach to design and building management.

I. DATA & CONNECTIVITY: THE LIFEBLOOD OF A TRUE DIGITAL TWIN

The future of digital twin technology in the AEC/O industry quite literally rests on the expansion of data-based capabilities, but in order to understand why, we first need to understand and appreciate the uniquely critical relationship between digital twins and data. And perhaps it may be best to start by briefly defining what a digital twin is and how it's used to benefit stakeholders across the building lifecycle.

What is a Digital Twin?

In the most basic sense, a digital twin is a digital replica or representation of any physical asset or environment, created for the ultimate purpose of optimizing both the design and construction of the asset or environment, as well as its operational performance and ongoing maintenance. Digital twins have a variety of use cases and benefits for the AEC industry, including the ability to obtain information about or monitor the performance of physical assets within a building, and to simulate systems and processes to predict and mitigate potential risks, increase efficiency, and reduce operating costs.

However, when we talk about digital twins, it isn't always immediately clear exactly what we're referring to, as the term is often used to describe separate technologies that are similar in concept yet distinct in functionality, and which can generally be separated into two categories: "basic," and "true". A basic twin is merely a digital representation of a physical asset, typically in the form of a model or simulation, used to capture information that helps optimize the design or performance of the asset; a true twin builds on these capabilities by establishing a real-time, ideally bi-directional connection to the asset through the use of IoT technologies, allowing changes in the physical twin to be reflected in the digital model, and vice versa.

Defining & Overcoming Data-Based Limitations

Whether we're talking about a basic or true digital twin, the use of data remains an essential and defining component and is in fact the sole enabler of the digital twin's ability to create value throughout a building's lifecycle. For the AEC/O industry, data-based capabilities and integration are what separates digital twins from traditional drawings or design models.

Despite the relative novelty of modern digital twin technology, its ability to leverage data intelligently and across all phases of the building lifecycle remains far from perfect, with existing limitations sometimes even outweighing the potential benefits. According to a 2017 report from McKinsey, productivity in the construction sector has only improved by 1% each year for more than a decade, suggesting that there's plenty of work to be done if we hope to see digital twins have a truly transformational impact on the industry. More specifically, we will need to solve for a variety of data-based capabilities that digital twins continue to lack, including:

- Contextualization. Most digital twins today lack the ability to integrate multiple data points from multiple sources, resulting in an incomplete representation of objects and environments. In addition to modeling and sensor data, digital twins need to incorporate all relevant contextual information to maximize value for all stakeholders across the building lifecycle, such as maintenance history and other relevant historical data.

- Real-time integration. In many cases, digital twins are reliant on outdated processes that prevent their ability to update and communicate the current status of their physical counterparts in real-time. This creates inefficiencies when it comes to monitoring an object or environment's performance and can even lead to systems being falsely diagnosed due to misleading or inaccurate information. Moreover, real-time integration of data and processes is critical to the creation and implementation of a true digital twin through insights and interventions performed quickly.

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- Interoperability. Perhaps the most pervasive limitation of all, the industry currently suffers from a lack of standardization and interoperability, meaning digital twin models and corresponding built environment data are frequently created in silos using proprietary file formats. This has led to a variety of persistent challenges, including an inability to collaborate effectively across the building lifecycle, loss, or erosion of data upon transfer between project stakeholders, and the "vendor lock-in" effect, which limits stakeholders' options when shopping for a vendor to those with interoperable software solutions.

To briefly summarize, while data and data-based capabilities are inarguably the lifeblood and core drivers of value creation for digital twin technology, the AEC/O industry still largely fails to leverage data effectively and efficiently across all disciplines. In order to increase the widespread creation and adoption of true digital twins and maximize value for stakeholders, we will need to increase our focus on data-based strategies and solutions, particularly the ability to establish seamless connectivity and intelligent relationships between multiple sources of complex information.

So how important is it to solve interoperability to increase and optimize the data-based capabilities of digital twins? And how can an open standard approach to BIM provide myriad benefits for the creation, processing, and transfer of intelligent data between stakeholders throughout the lifecycle of a building project?

II. OPEN BIM: UTILIZING BUILT ENVIRONMENT DATA FROM A SINGLE SOURCE OF TRUTH

As we have just seen, one of the biggest hurdles to optimizing data use for digital twins is a lack of standardization, and in turn a lack of interoperability between systems, processes, and workflows across the building lifecycle. This problem has been a unique focus for the Nemetschek Group over the years and has led to the development and increasing adoption of our OPEN BIM solutions and workflows, which leverage an inherently flexible, open standards-based approach to information modeling and data management for the AEC/O industry.

What is OPEN BIM?

OPEN BIM is an open standard-based strategy that allows for seamless collaboration and interoperability between users of building information from diverse modeling systems across disciplines in the AEC/O industry. Through the creation of a universal standard and open interfaces, OPEN BIM empowers architects, engineers, and virtually all stakeholders throughout the building lifecycle to exchange information through neutral, non-proprietary file formats.

Above all, OPEN BIM directly targets pervasive interoperability challenges and vendor lock-in by providing a centralized, cloud-based environment, or single "source of truth," from which built object and infrastructure data can be accessed and exchanged in real time between stakeholders, regardless of their individual software preferences. Most importantly, an open standard approach optimizes a digital twin's ability to connect intelligent data from multiple sources and phases of the lifecycle, and without the risk of compromising the integrity of the data, workflows, or broader digital infrastructure in the process.

Paving the Way Toward Accelerated Adoption

Fortunately, the ability of open standards to transform and build on digital twin use cases is not lost on the global AEC/O community. With a mutual interest in eliminating data silos wherever they exist in the building lifecycle and optimizing data-based capabilities, very real progress is being made toward the further development and improvement of open standards for digital twin technology. For example, in 2020, Nemetschek partner buildingSMART formed the Digital Twins Working Group (DTWG) with the purpose of developing a universal Industry Foundation Classes (IFC) standard specifically for digital twins, the underlying basis of which already informs a wide range of our own OPEN BIM-based software solutions.

It's important to keep in mind that before the integration of OPEN BIM and standards like IFC, leveraging a digital twin for a large building project wouldn't have been feasible. This is because a truly effective digital twin is much more than a drawing or digital model of a built asset, however seemingly sophisticated or easily produced

the representation might be. In order for the digital twin to create real or novel value for all stakeholders, the model needs the ability to both processes and synchronize multiple sources of data, including from IoT sensors, design and facility management processes, and a variety of other historical and contextual information, as well as perform complex queries that take all relevant data into account to deliver reliable, actionable insights to the end user.

Why is an open standard, data-based approach to managing the building lifecycle the key to unlocking the real value of digital twins for the AEC/O industry? How can the approach of Building Lifecycle Intelligence bring the data-based capabilities of digital twin technology into the future?

III. BUILDING LIFECYCLE INTELLIGENCE: OPTIMIZING CAPABILITIES THROUGH A DATA-DRIVEN APPROACH

More than just a lack of interoperability and standardization, digital twins and BIM-related processes are often inadequate due to being created and implemented using model-driven workflows. In other words, during the design phase, architects and engineers place their initial focus on creating a model that reflects the project's specific vision and requirements, leaving the data to be generated and validated as an afterthought.

The problem with the above approach, particularly as it relates to larger building and infrastructure projects, is that stakeholders fail to appreciate the complexity involved with linking and managing high volumes of project-critical data from multiple sources until it's too late. And as we've already covered, more often than not the data in question has been created and integrated in isolation, and frequently gets lost or eroded as it transfers from one stakeholder to the next. Ultimately, when utilizing such an approach, the use of a digital twin is very likely to present more problems than solutions.

Considering that the efficient use and management of data is critical to digital twins and virtually all other BIM-related processes, wouldn't it make more sense to focus on the optimization of data and data-based capabilities from the outset of the design phase? This is the core idea behind what we call Building Lifecycle Intelligence, a data-driven approach to designing, managing, and optimizing processes across all disciplines and phases of the building lifecycle.

What is Building Lifecycle Intelligence?

Building Lifecycle Intelligence (BLI) can be applied in different ways depending on the environment, but at the core, it's a data-driven strategy that prioritizes the interoperability, organization, and analysis of data as it relates to multiple sources and phases in a building project. Implemented from an open source-based ecosystem, whether OPEN BIM or a similar standard, BLI brings all relevant data together to provide an easily accessible, comprehensive representation of all systems, processes, and assets within the built environment.

This representation is in turn used to create a digital twin with the ability to establish real-time connectivity and synchronization to data originating from multiple sources and processes, including IoT sensors and other operational monitoring tools, as well as management systems, historical documents, and other contextual data.

In addition to enhancing the capacity for collaboration between stakeholders, access to the digital twin provides consistent advantages as it relates to monitoring, predicting, and optimizing the performance of physical assets throughout the building's lifecycle, and can produce valuable insights that work to inform and improve decision-making. Moreover, digital twins created and utilized with this approach serve to demonstrate the importance of data-based capabilities to digital twin technology as a whole, emphasizing the need for more than a mere visualization, 3D drawing, or captured point cloud.

Utilizing BLI in Practice

Importantly, BLI is not merely a conceptual or theoretical strategy, and in fact has already been leveraged and proven effective as a solution to common inefficiencies associated with the model-driven approach.

Take the Glassblokkene Project in Bergen, Norway, for example, the largest construction project in the region for nearly 40 years. The new 50,000sqm hospital for children and teenagers will include outpatient clinics, operating rooms, X-ray departments, intensive care units and many more.

By capitalizing on an open cloud-based planning and data management solution from the Nemetschek Group, the teams were able to implement a completely digital working method to maximize collaboration and efficiency. This provided significant cost savings, better project control, and substantially better outcomes for all project stakeholders. The client, Healthcare Bergen, also wanted an open system so that other software could access and add to the data within this database. They opted to use dRofus, a Nemetschek Group solution, which would provide all the functionality required to connect different systems and provide a data-first digital twin solution.

The entire hospital project is created based on a master asset database for all disciplines and models – always up to date with all the documentation required for any element quickly to be accessed just by clicking on the item in the model. For this reason, dRofus was embedded into other applications, which allowed on-site updates of data directly into the master asset database, and then synced to the design and engineering models and IFC files for a consistent and current set of information. The centralized information management the database offered provided a golden thread of data throughout the project. By using a digital twin, the documentation was delivered and controlled before the work started on site, unlike a traditional approach where the documentation is delivered after the building is finished. This resulted not only in an enhanced quality of the information, also complete and correct information was available throughout the project. The database was not only used for the design and construction but is also planned to be used throughout the entire building lifecycle, including operation, linked to building

control systems via APIs. Solutions like dRofus bridge the gap between BIM and Building Lifecycle Intelligence, creating a Digital Twin and providing a single source of truth that prevents data silos and ensures a data-driven approach that provides value across a built asset's complete lifecycle.

CONCLUSION

If one thing is for certain, it's that very few technologies share the potential of digital twins to transform the AEC/O industry. However, in order to realize the full spectrum of benefits being offered, we will need to collectively shift our focus away from outdated or misguided approaches and BIM-based solutions, and toward those grounded in an understanding and appreciation of data's critical role in the digital twin's ability to create real, sustainable value into the future.

To be sure, digital transformation of any kind is a long-term journey, and one that's bound to be accompanied by a variety of challenges and setbacks. But for the Nemetschek Group, unbroken focus on the task at hand is everything, and our journey toward advancing digital twins will start and end with the continued development and promotion of intelligent, open standard based solutions, the benefits of which we hope can extend to all stakeholders and beneficiaries of the industry, and from this generation to the next.

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