

Part 1

Digital Twins: Answering The Hard Questions

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Digital twins in the built environment are digital representations of real-world infrastructure using building information modeling (BIM) software. Applying these tools in a disciplined manner can help built environment professionals find answers sought by building owners and operators pertaining to optimization of capital, efficient operations, change management, resiliency and much more.

Despite the promised utility and widely acknowledged benefits of digital twins, barriers to adoption have been significant. Perhaps the least understood impediment is the influence of multiple corporate stakeholder groups involving both sides of the balance sheet.

The *decision by committee* modus operandi in the corporate environment is, in the author's opinion, the primary reason for the lack of integrated software solutions in the built environment industry. Adding to this situation is a gross lack of well-defined use cases that support the end goals of a digital twin environment with actionable metrics.

In Part 1 of this column, we will introduce the use cases necessary to drive compelling change for adoption of digital twins in the built environment marketplace. In Part 2 we will examine some of the details of deployment.

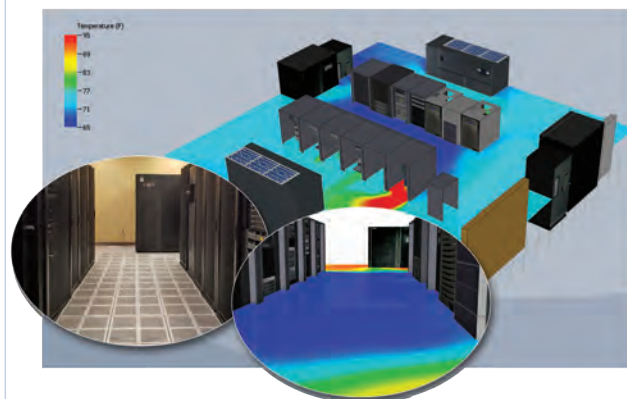
Digital Twin Use Cases

Use cases define the reasons to deploy digital twins

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within the built environment by answering some obvious business case questions. Use cases must define the reasons for deploying this new technology and ultimately how to measure the return on investment. Without viable use cases, stakeholders and decision makers will be paralyzed because investment in digital twins (or any integrated software solution) is typically based on capital

PHOTO 1 For the mission-critical environment, digital twins take on additional importance by providing improved alignment of information technology evolution and infrastructure to potential mismatches in the data center.



expenses alone and not readily justifiable.

Fortunately, valuable and relevant use cases exist in today's environment. Current COVID-19-related travel restrictions have further reinforced the importance of virtual environments and off-site management of digital infrastructure. A digital twin is an invaluable virtual environment that enables continued analysis and operation of built infrastructure without needing a on-site physical presence. Furthermore, it permits modeling many "what if" scenarios with zero risk to ongoing operations.

Umbrella Use Case

The "umbrella" use case for digital twins can be defined as having the ability to answer all the multitude of executive questions related to "what if" and "can we do this?." In a typical corporate environment, questions often flow from the top-down and at multiple levels, resulting in significant legwork by staff to source reliable answers.

Those answers often require triangulation of data from multiple sources and data gathering from multiple departments because information is often incomplete, in disparate systems or lacks useful integration and key performance indicators (KPIs).

Gathering this information, applying proper analytic techniques and making actionable, timely decisions are fundamental stumbling blocks that often lead to speed-to-market delays. An illustrative example might include the following scenario: A data center provider wants to replace existing servers with new servers in an existing deployment to support a new software application.

The change in operational power density of the new servers raises questions of whether power and cooling systems have sufficient capacity to handle the change. The ensuing cross-department Q&A goes on for months before a decision can be made on the necessary modifications to support the request. Using a digital twin would make the decision much quicker.

Another relevant example may be this: A grocery store chain has implemented pandemic-related changes like social distancing, altered pedestrian traffic flows and reduced occupancy density. Having the ability to model various scenarios using a combination of real-time indoor position systems (IPS) and BIM models would help to rapidly prototype the optimum aisle layouts and pedestrian traffic flows to maximize customer

purchasing yields, despite lower permitted occupancy density.

Having the ability to model these "what if" scenarios, despite unpredictable or rapid changes in the business, can make all the difference as to whether the business maintains a market leadership role or remains in business at all.

Information Technology Refresh Use Case

For the mission-critical environment, digital twins take on additional importance by providing improved alignment of information technology (IT) evolution and infrastructure to potential mismatches in the data center. IT refreshes (updates) occur at a significantly faster pace and interval than changes to the data center's power and cooling infrastructure.

An illustrative example might be: What if a data center operator wanted to deploy a different central processing unit (CPU) chip density on their servers across some portion of the existing IT hardware in a data center?

Digital twins could be used to explore the following: What infrastructure would need to be updated to accommodate this proposed change? What other deployment strategies could be used to make that change possible without altering the building power and cooling systems? Potential approaches could include separation of the upgrades or consolidation of the upgrades to one portion of the data center where the limiting capacity factor has more margin (i.e., cooling capacity closer to the HVAC due to airflow management limitations).

Another example: Each software application has an associated business case, which includes the life-cycle costs of developing, deploying and managing that software from end to end. Many beneficial applications are never executed because of the inherent barriers to deployment.

In many companies, software applications must compete against each other for the same funding or functional end use. If questions arise whether major infrastructure upgrades are required to make the software application possible, it can lead to simply abandoning the project.

Once a software application is deployed, often questions exist of resiliency and operational continuity. If some portion of the infrastructure goes down, can the application sustain operation? More recently, sudden surges in demand, as seen with the massive shift to a

remote workforce, have resulted in enormous spikes in use for some software applications.

Having the ability to model these infrastructure utilization scenarios in advance using digital twins has a direct impact on capital efficiency for software deployments and their subsequent resiliency in operation.

IT vs. Infrastructure Utilization, Capacity Management And Optimization Use Case

Fundamental issues for data center operators often include the following questions: How much over-provisioning is occurring as part of the current design strategy? How much capacity is underused due to a limitation in one or more parts of the infrastructure (i.e., constraints on the cooling capacity, airflow management or power distribution)? These capacity questions are not easy to answer based on nameplate information or analysis of design drawings. Using digital twins can help with the answers.

Data center designs are often one-for-one approaches where cooling provisioned is matched to power delivered. On paper, this approach seems acceptable, but it gives little to no consideration that both energy vectors cannot be evenly distributed across the entire data center footprint due to a variety of limiting factors.

Since the infrastructure and equipment variations that impose these limits can be infinite and largely unknown (e.g., details of the IT deployment), it's not practical to design in advance for infinite flexibility. This inevitably leads to constrained resources, lack of efficient utilization, and stranded capacity.

For colocation data centers, service level agreements (SLAs) of various tenants can lead to further stranded capacity. Day-one designs often have limitations or design assumptions for acceptable (and allowable) inlet conditions per the ASHRAE thermal guidelines. If those conditions change as the result of SLA requirements of a new tenant, the by-product can be constrained cooling capacity (either at an airflow or cooling capacity level or both).

Being able to answer these executive questions rapidly and concisely directly affects a business' ability to quickly respond to evolutionary changes to the IT within a data center. Digital twins offer the ability to simulate many parameters of these questions and quickly identify viable options.

Those options can then be analyzed to determine an optimized strategy to reduce capital costs and improve

rapid deployment of the software solutions.

Energy-Efficiency Improvements

Digital twins also offer an opportunity to calibrate and verify building automation system (BAS) operation as part of both a pre- and post-installation commissioning process. Many data center designs are constructed using a common deployment strategy or prototypical basis. As such, optimizing that first installation through a combination of calibrating installed systems and a "what if" digital twin analysis on system modifications can identify real-world savings with subsequent data center builds.

A useful example may be: A data center wants to determine the maximum number of economizer hours available for a given location based on a combination of allowable entering air conditions per ASHRAE thermal guidelines and x-factor for airborne contamination risks.

In the traditional model, this scenario would be modeled using various tools like MS Excel, computational fluid dynamics (CFD) and related energy modeling tools. Fundamentally, results from those tools are heavily dependent upon gross assumptions for the IT equipment and their associated performance. As a result, these assumptions will often vary widely from real-world conditions.

Conversely, a calibrated digital twin enables real-world modeling of the actual IT conditions and operational parameters. The yield is an optimized design supported by accurate operational decisions for the next generation of that data center. These differences can be monetized and generate significant capital and operational cost savings.

Operational Management Improvements

Digital twins offer additional abilities in operational management improvements beyond the typical functionality of BAS or data center infrastructure management (DCIM). Specifically, digital twins incorporate an element of predictive modeling and analysis that can't be replicated within other software solutions.

An additional level of functionality comes from the digital twin's ability to create a virtual environment that can be shared with remote teams without needing on-site attendance. This feature has become a particularly interesting benefit in 2020 when site access for all

facilities globally has been severely limited.

Buildings undergo continuous change throughout their life cycle. That change can come in the form of different operational staff, different building systems and shifting occupancies. In the case of data centers, rapidly changing IT presents a magnification of the impacts change can exert.

In data centers, the loads can move around the white space in a disproportionate manner as a result of shifting software loads and use of equipment (servers, switches, routers, etc.). Those fluctuating loads can quickly result in stranded capacity for space, power or cooling systems, or, even worse, insufficient capacity.

Closing Comments

Digital twins offer a solution for answering hard questions from facility management and operations that other technology and tools are incapable of performing. The delay between these demanding questions being asked and the resulting implementation can be significant. This is particularly true in the data center market or where the unexpected forces demand timely adaptation in a given vertical market.

Properly defined and metric-driven use cases will serve as the catalyst to propel adoption of digital twins. The challenge is they are difficult to fully quantify since the answers they seek to find are part of the use case itself (infinite loop). It can become the proverbial chicken-and-egg problem to solve.

Businesses that take the leap first are often very tight-lipped about their successes using digital twins, since it can often provide market differentiation. The net result of these challenges are significant barriers to entry for this new technology.

Ultimately, many businesses still operate with legacy change-management policies, sluggish data collection approaches and indeterminant decision-making processes. In an increasingly changing world, digital twins are arguably becoming more of a necessity to enable rapid decision making. ■



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