# Embracing Construction's Digital Opportunity

By Paul King, director, product solution engineering, Bentley Systems

The construction industry has done whatever it takes to deliver projects during the past two years despite huge difficulties, including the pandemic. Ongoing challenges—such as project complexity, resource availability, and data silos—mean that organizations must now decide how to best embrace the technology revolution that is under way in construction and, by doing so, maintain a competitive advantage to succeed in the long term. Construction margins remain stubbornly low, which makes the industry a fertile ground for improvement—but it has resisted adopting new technology despite considerable evidence showing significant, attainable benefits. Other industries have proven that companies that are quick to embrace emerging technologies will gain a strong competitive advantage. Construction's digital future is already here, but remains unevenly distributed.

**An Industry Snapshot**

According to the Confederation of British Industry's Fine Margin report, in 2019, the United Kingdom's 10 largest contractors by revenue made an average profit margin of -0.1%, compared with an average 2.6% across the top 100 firms. Contractors experience very low financial gain, considering that they hold most of the risk affecting project outcomes. Margins that hover around 0% are a constant threat to businesses because when projects hit problems, claims multiply, investments in technology and training stop, and firms can go bust. For contractors, risk and margin are intrinsically linked, and allocating and managing risk are significant barriers that are stopping construction firms from making the sustainable margins that would encourage and promote investment in business improvement.

It is challenging to prepare accurate pricing for materials, labor, and time in a competitive tender process—even before trying to assess the likely time and cost impacts of different project risks. Poorly informed estimates can cause contractors' bids to be overly high or low, and contracts can leave almost no room for correction once work has started. The Get It Right Initiative found that up to 21% of project costs are wasted due to avoidable errors in the field, unrecorded process waste, indirect costs, and latent defects. Overall, the annual cost due to error is estimated to be around seven times the total annual profit of the U.K. construction industry – and the U.K. is not unique.

Many of the problems faced by construction firms in recent years existed before COVID, but the pandemic made them even harder to manage. For example, within organizations it can be difficult to manage and use the vast amount of data that's becoming available. It is challenging to scale best practices across the organization, as well as to attract and retain the best people and use them to best effect projects. Externally, there are challenges that amplify internal problems such as complex projects, interconnected teams, fragmented value chains, and extensive subcontracting. None of these make projects easier, but the pandemic has accelerated the adoption of new technology, which is beginning to change how construction firms operate.

The global economy is becoming increasingly digitized, and there are huge opportunities for construction organizations if they can get on board with new technologies. Digital design and smart construction, underpinned by a motivated and skilled workforce, will help to deliver infrastructure that is low-carbon, sustainable, and resilient.

**Everyday Hurdles for Delivery Teams**

Transitioning the world to a low-carbon economy is a growing responsibility for construction firms at every level in the supply chain ecosystem. However, firms face challenges on the path to digitization. For example, procurement processes often restrict early collaboration between clients and their supply chains when they could properly explore options for innovation. Lessons from successful innovation are not captured and applied to future projects, and the commercial viability of innovative products and services can be uncertain.

A Dodge Data report considered the uptake of technology on construction projects and found that only a third of civil contractors used model-based technology, compared with just over half of vertical building construction firms. That slow uptake is significant considering the post-COVID pipeline of government infrastructure projects. It was reported that the two main drivers toward adopting that technology were improved profitability and reduced costs, which show that construction firms are seeking new ways to reduce their risks and increase their margins.

Construction has traditionally been slow to change and adapt to new ideas and technologies. Too often digital engineering is bought as a commodity on each project rather than implemented during construction and maintenance as a long-term best-practice process, which helps to explain why many construction companies do not invest in innovation.

**The Construction Technology Opportunity**

Digital technology presents many opportunities to improve how projects are designed and constructed, including data analytics, modular designs, BIM, virtual design and construction (VDC), 3D printing, reality modeling, robotics, and asset performance management. Single or multiple technologies can be leveraged in different combinations to support practical workflows, giving organizations the modular technology, tools, and processes needed to digitize their operations—and a robust framework for a construction digital twin. Digital twins build on existing best practices and organizations that get the basics right will have a head start on the competition.

Construction digital twins start with creating high-quality digital components using the latest design and BIM technology to ensure that designs are complete, consistent, and correct. Secondly, best-practice workflows ensure that your data is managed securely and effectively using a common data environment (CDE), which stores and manages content created by the team, and then delivers that content to the right people, in the right format, at the right time, for the task at hand. The third consideration is context. Surveying technology makes it easy to place and review components in their correct context. Photographs taken using a phone or a camera mounted on a drone can be converted quickly into an accurate 3D reality model for use

in subsequent workflows, and as a reference point with which future surveys can be compared. Reality modeling is routinely used to monitor and measure construction works on site.

It is also important to consider the alignment, accountability, and accessibility of data because projects have data in different formats from different sources. Data alignment ensures that you can take information from different software applications and reuse it. For example, a contractor can take models and data from design firms that are created using different vendors' BIM tools and create a 4D construction sequence without needing the source software applications. The aligned data could also be viewed easily and quickly in a virtual reality environment to help with construction planning. Data accountability means that you know who created the information and what it can be used for. Data accessibility ensures that your construction teams can get the information they need by using their preferred device—wherever they are. Bentley's iTwin technology addresses these considerations and provides the backbone of the construction digital twin.

When you have the digital components, the workflows, and the context, then you have the basis for a construction digital twin.

**Construction Digital Twins: Create-Connect-Consume**

At its simplest, a digital twin is a digital representation of a physical asset, process, or system. But it is also a live, evolving set of data that must be continuously synchronized, and it should exploit data-driven workflows to optimize performance. Construction digital twins are being enabled by advances in areas such as reality modeling, artificial intelligence, mixed reality, and machine learning. More technology is coming onto the market, and it is getting cheaper.

There can be multiple versions of a digital twin throughout the lifecycle of an infrastructure asset, enabling users at all stages to make better-informed decisions for better outcomes. The foundation of a construction digital twin is inputs like drawings, 3D models, BIM data, GIS data, pre-construction information (such as record information, health and safety hazards, and planning information), and feeds from the field (including IoT data, progress updates, drone data, and inspection data). The inputs support construction workflows such as 4D planning, model-based estimating, and machine automation. The result is a jump in productivity.

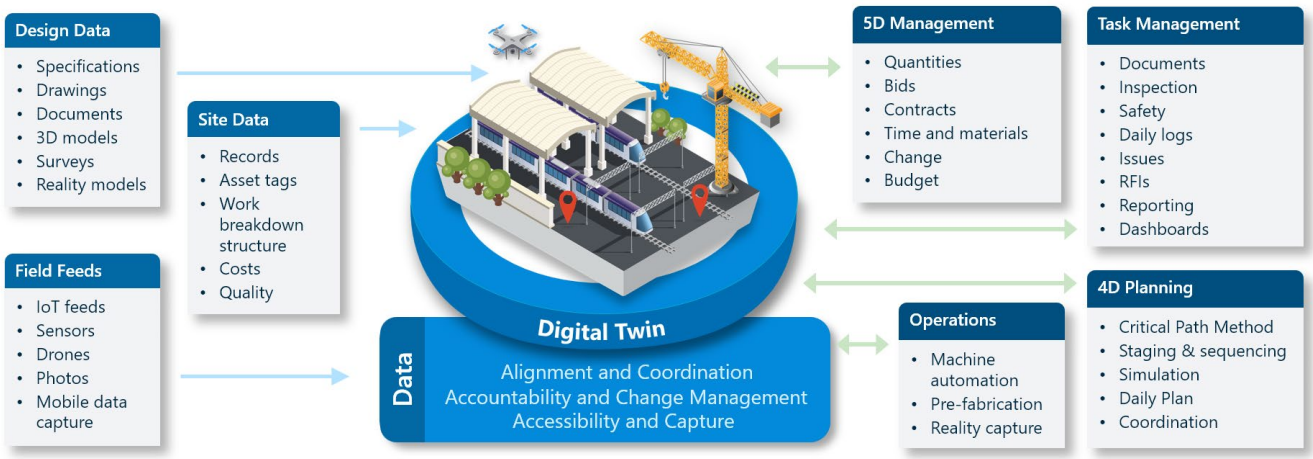

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**Image Caption**: Construction Digital Twins: The Backbone of Best-practice Construction. *Image courtesy of Bentley Systems.*

There are three steps to working effectively with construction digital twins.

Step 1 involves assembling the design and reality models and transforming them quickly and efficiently into constructible content. Data from multiple sources is stored in the cloud and made available through apps and web browsers for tasks, such as 4D scheduling and simulation and model-based estimating. 4D is one of the most effective ways to implement digital best practices because it reuses the design and schedule data. Proponents commonly report up to 15% shorter project schedules, when compared with company and industry benchmarks. By making designs constructible and making mistakes in the model rather than on site, Step 1 is where construction teams set themselves up for success.

In step 2, the construction model is connected to real-time updates from the field, which helps teams to better orchestrate site logistics, work areas, resources, and procurement.

Step 3 leverages the live model using analytical tools, machine learning, and augmented reality.

An example of this workflow is instances where site teams submit live progress updates from the field using mobile apps. Progress data is used to update the master 4D model so that planners, schedulers, and project managers can make timely, informed decisions about optimising the path of construction. Smart 4D planning tools can quickly run multiple scenarios to bring a project back on track after an unexpected delay, as well as alter procurement to optimise cashflow. Issues can be identified early, and it helps to keep the project in control by enabling faster decisions based on better data. Without good data, you are just another person with an opinion.

A construction digital twin helps projects by providing real-time data visibility, ensuring that everyone is always on the same page at the same time. It provides 4D planning and 5D estimating so that resources are optimised and risks are reduced, and it provides operational efficiencies and business intelligence so that teams make better decisions faster.

Digital technology is helping contractors win projects with better, sustainable margins, it is enabling them to deliver them more efficiently on site, and it is improving their longer-term viability and profitability.

**The Future of Digital Construction is Happening Now**

There is clear evidence from our users' projects that construction is going digital by leveraging digital twins, which is helping to reimagine the industry's future. Bentley's most innovative and visionary construction customers, and their supply chains, are leading the way by

delivering unique and improved business outcomes across the project delivery process. Here are some examples.

**Level Crossing Removal Project, Australia**

The Victorian government in Australia implemented a project to remove 85 of the most dangerous and congested rail level crossings in Melbourne by 2025. The Southern Program Alliance (SPA) is one of five program alliances responsible for delivering the project and it consists of ACCIONA, Coleman Rail, WSP, Metro Trains Melbourne, and Level Crossing Removal Project (LXRP). By removing the level crossings, building three new stations, and revitalising the areas with shared-use paths, people can safely and easily cross the railway line to take children to schools, visit each other, support local businesses, and enjoy a more reliable commuter experience.

SPA uses SYNCHRO to manage multiple datasets and help with developing construction methods, performing constructability analyses, managing cost plans, optimizing logistics, and monitoring progress. The daily cost of a rail occupation along the project corridor is around AUD 1 million, which means that work must be planned meticulously to avoid overruns. SYNCHRO enabled the project teams to optimize work sequences and perform spatial clash analyses well in advance. It delivered direct measurable outcomes, including a 67% reduction in the time to prepare and validate staging plans, an 88% reduction in drafting requests by enabling users to create their own dynamic sections from models, and a 75% cut in the time to distribute information to construction personnel. SYNCHRO was also instrumental in helping the project to meet its sustainability reporting and outcome targets by providing accurate material quantities and data.

*"Bentley's connected systems have enabled unparalleled end-to-end 2D, 3D, and 4D project information access, effective coordination and communication whether on the go, on site, or in the office; unlocking opportunities for reliable use of project data on our SPA project,"* said Dan Easter, head of digital engineering, Southern Program Alliance.

**Seattle Tacoma International Airport, U.S.**

Clark Construction Group built the world's longest elevated walkway over an active runway, which they accomplished with digital modeling and construction scheduling. The Port of Seattle unveiled a USD 968 million plan to construct a new international arrivals facility (IAF), which is the most complex capital development program in the airport's history. Passengers access the IAF via a 780-foot-long walkway suspended 85 feet over an active taxiway. The 320-foot center span alone weighed 3 million pounds, so it had to be created as a single piece at a cargo area three miles offsite rather than assembled in segments on site.

Careful planning and measurement were critical. The team could not rely on 2D drawings because of the risk of human error and misinterpretation, which might have caused an airport shutdown or accident. Clark created a reality model of the project to clearly picture what they wanted to build and how they could build it. The design team used laser scanning and Bentley's SYNCHRO to create a digital replica of the airport as it existed before construction

began, with all elements that would be added or altered. Every detail matched real-world conditions and the exact plans for development, which clearly communicated the scope of the project. The digital replica was used to map every step of the construction process, including the construction and transportation of the center span, the location of construction materials, and the movement of work vehicles. The center span was transported to the project area and hoisted seamlessly into place between the new building and the existing structure, all without interrupting airport operations.

"*The IAF is a model for how digital tools can enhance the design and construction of our nation's most critical and complex infrastructure projects*," said Brian Krause, vice president at Clark Construction.

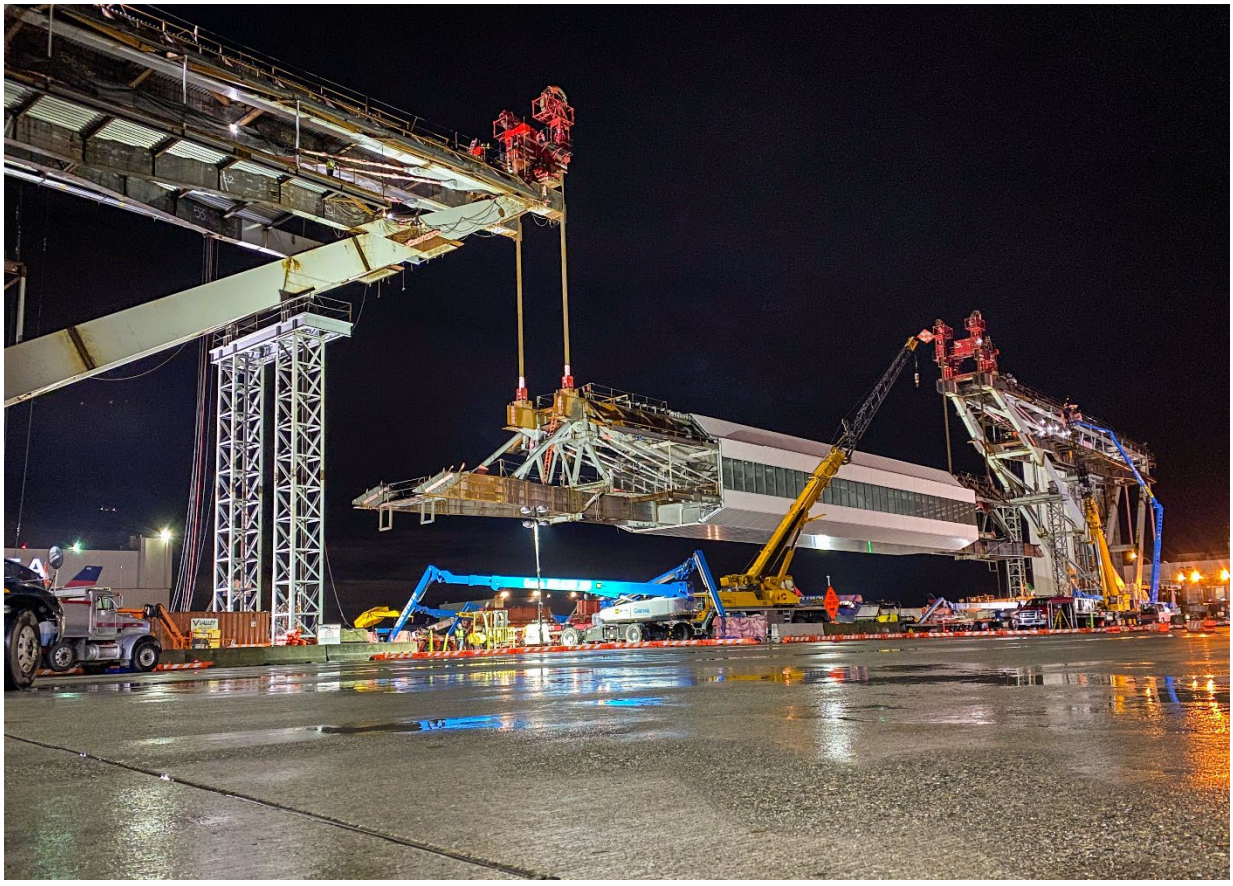

**Image Link:**

**Image Caption**: Clark Construction used SYNCHRO to plan the center span's transport to the project area and seamless placement between the new building and the existing structure, all without interrupting airport operations. *Image courtesy of Clark Construction.*

**Thames Tideway East, U.K.**

As part of a major upgrade to London's 150-year-old sewer system, the CVB JV (Costain, VINCI, and Bachy Soletanche) is responsible for delivering the GBP 850 million eastern section of the new sewer, including 10 kilometers of tunnels 70 meters below central London and six shafts. The project involves 12 design disciplines and numerous supply chain companies and stakeholders, all of which had to avoid damaging nearby historic buildings and

neighborhoods amid tight scheduling constraints. CVB JV used digital technology to push the boundaries of conventional construction to deliver this super-sewer.

CVB JV implemented 4D construction modeling and collaborative planning to overcome project challenges and streamline engineering and construction management. The team created more than 30 intelligent 4D models using Bentley's integrated technology, and SYNCHRO was used to optimize project sequencing and construction activities, enabling efficient, safe, and sustainable construction works. SYNCHRO enabled site teams to easily access, view, and interrogate the models to test and validate the constructability of the complex construction works. It also helped to identify and resolve potential clashes between concurrent works amid multiple subcontractors working in highly congested sites and streamlined decision-making and approval processes.

4D construction models were used in weekly collaborative planning meetings for developing and scheduling complex construction activities in advance, saving significant project time. The process improved site analysis, enhanced constructability, avoided damage to existing buildings, and eliminated rework. CVNB JV saved more than 90 days in the construction program, equalling GBP 300,000 in direct cost savings and GBP 1 million from indirect savings.

*"Bentley's technology shortened design time, reduced resource hours, made meetings more productive, and eliminated tedious tasks. The collaborative approach achieved through SYNCHRO has been key to involving the client, designers, and fabricators during early decision-making,"* said Sandra Reis, BIM manager for the CVB joint venture.

**C-43 West Basin Storage Reservoir for Everglades Restoration, U.S.**

The Lane Construction Corporation is delivering the C-43 West Basin Storage Reservoir in LaBelle, Florida, that will add storage capacity to the Caloosahatchee River basin. The USD 524 million project includes the construction of a sand embankment dam with a perimeter of 16.3 miles, a 2.8-mile-long separator dam, 18 water control structures, 14.7 miles of perimeter canal, discharge piping for an already-constructed pump station, and a nearby local access bridge.

Lane used SYNCHRO to simplify the planning process and mitigate risk before the construction team arrived on site. It provided a safe environment to explore new methods and deal with project challenges. They began by using 3D models for quantity take-off, schedule management, and overall project management, and then developed the 3D models into 4D models. By splitting models multiple times in various ways, Lane could analyse different scenarios pre-bid and throughout the life of the project, driving them to the most efficient, safe, and economical solution.

The dam is built in segments throughout the whole basin's perimeter, which are all bound to construction constraints such as settlement waiting periods. By leveraging 4D simulation, the team was able to understand the critical path and leapfrog from one segment to another – and confirm the logic and practicality of the sequence. With 20 office-based staff and over 100

field personnel using SYNCHRO, Lane has provided a mechanism to its client that better refines cost, schedule, and risk, and the project is accelerating the firm's adoption of digital technology and processes.

*"SYNCHRO made it easier for us to plan the project, as well as mitigate risk, before the construction team arrived on the site, providing a safe environment to explore new methods and deal with project challenges,"* said Matt Blake, VDC/BIM director for The Lane Construction Corporation.

**Conclusion**

It is important for the construction industry to start exploiting digital technology to do a lot more with a lot less. Construction is starting to shift in the right direction, and organizations are moving from the old ways of doing things to new, better methods. Construction software is enabling project teams to define and implement best practices consistently across every project and through the whole supply chain. Digitization means that everyone can be on the same page at the same time and make better decisions faster. It means that resources can be optimized, risks can be mitigated, and rework can be avoided. It also means that teams can increasingly spend more time working on value-added tasks.

Construction's digital future is here, and it is helping firms win projects, deliver them more efficiently, and improve their profitability.

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