# How to Overcome Digital Transformation Challenges

Learn from the challenges firms have faced in their digital transformation and infrastructure digital twin implementation
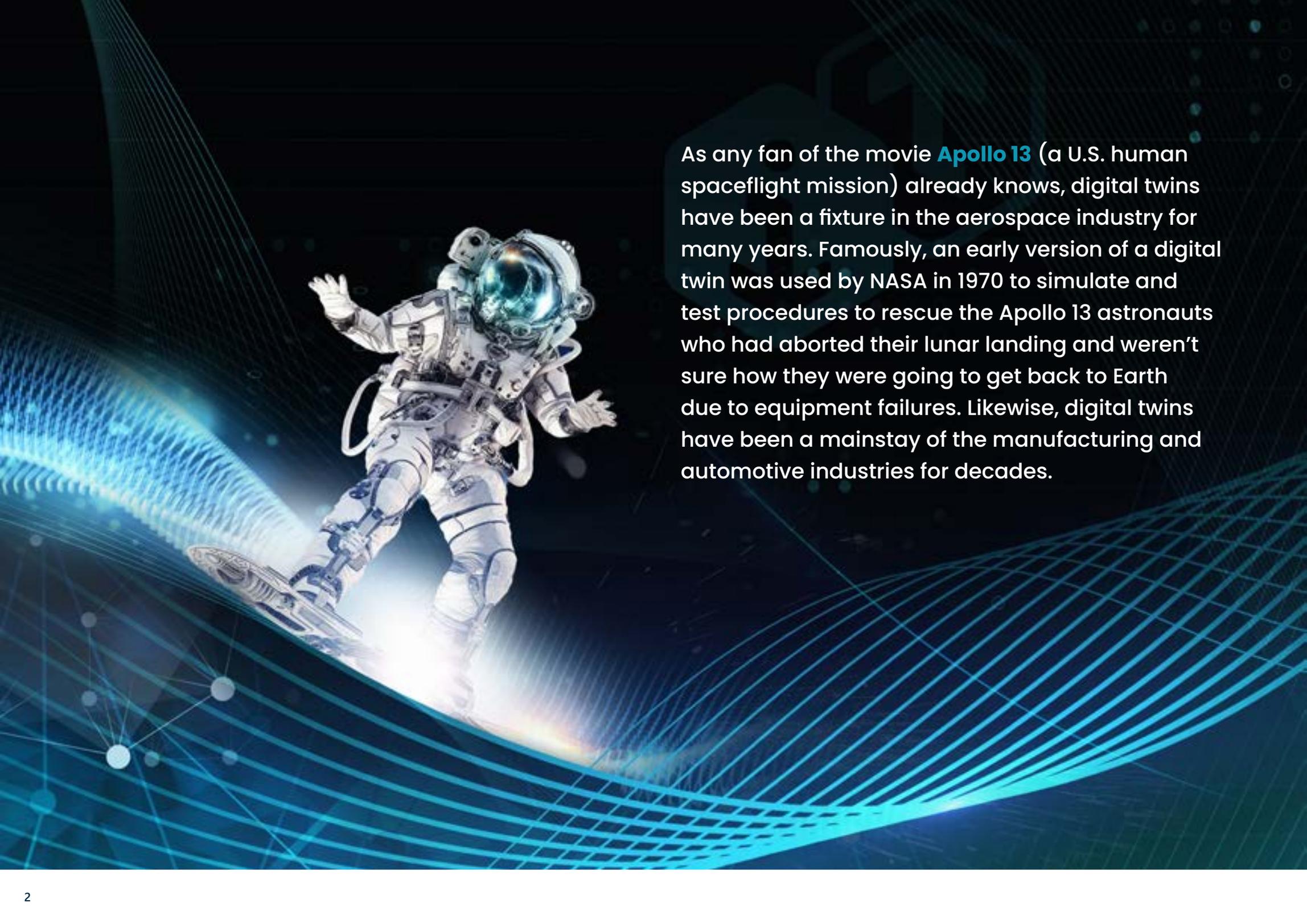
As any fan of the movie **Apollo 13** (a U.S. human spaceflight mission) already knows, digital twins have been a fixture in the aerospace industry for many years. Famously, an early version of a digital twin was used by NASA in 1970 to simulate and test procedures to rescue the Apollo 13 astronauts who had aborted their lunar landing and weren't sure how they were going to get back to Earth due to equipment failures. Likewise, digital twins have been a mainstay of the manufacturing and automotive industries for decades.
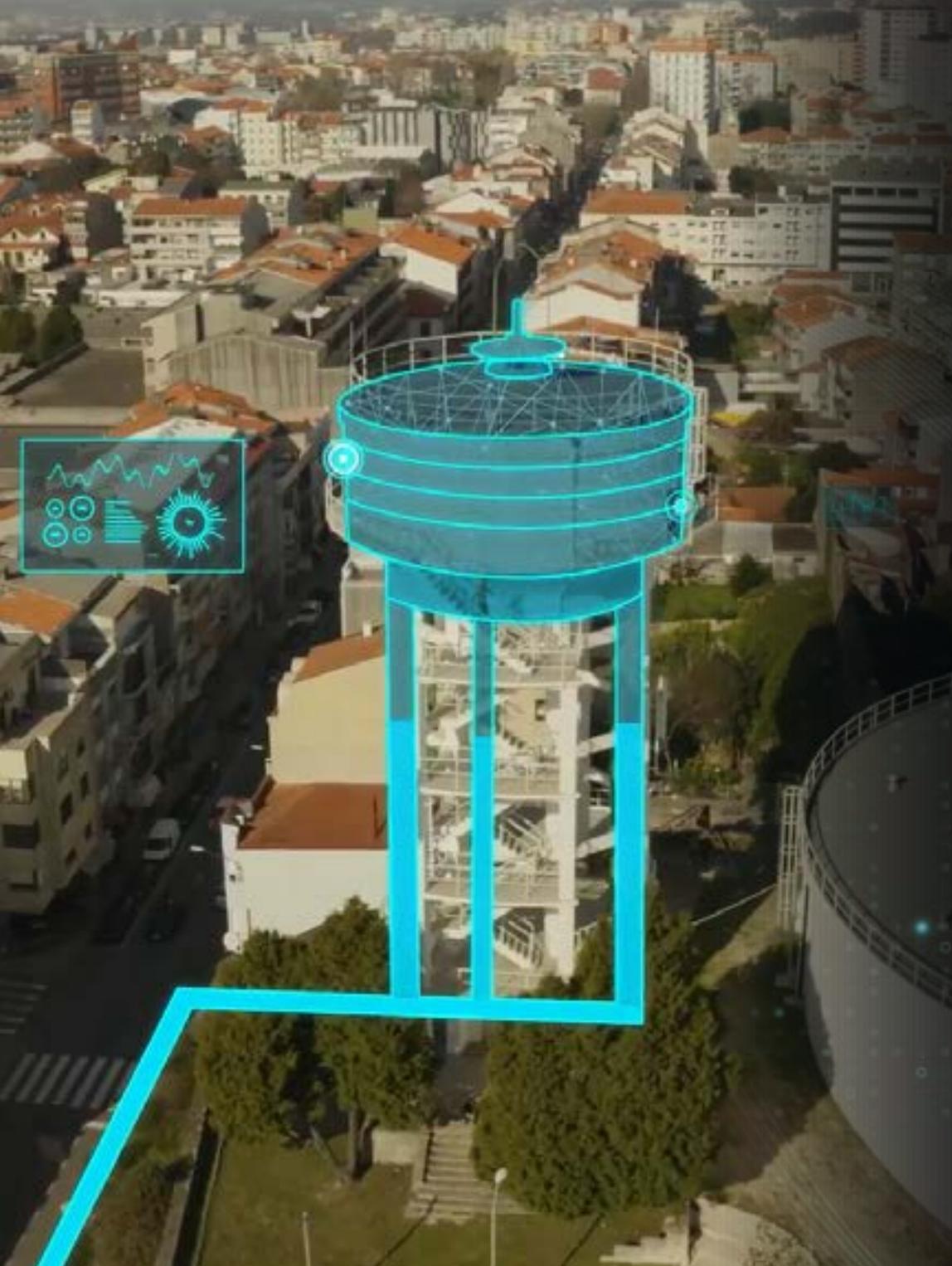
But the sheer size, complexity, and relative permanence of infrastructure—be it a municipal water system, a power plant, or a skyscraper—make digital twins a more significant technological challenge for the infrastructure sector. Moreover, their size and complexity result in infrastructure assets that typically involve massive amounts of data—such as photogrammetry, GIS, Internet of Things (IoT), and sensor feeds, as well as subsurface, near-surface, and aboveground contextual data—from both public and private assets owners.

These silos of disconnected data can be overwhelming.

However, these digital twin challenges also **offer unparalleled digital transformation opportunities** for the infrastructure sector. Engineering firms can use them to advance their internal processes, win more bids, deliver higher quality designs, provide more value to their clients, and potentially create new revenue streams to improve their own sustainability.

This e-book examines the challenges infrastructure firms face in their digital transformation and infrastructure digital twin implementations. It will also offer insights on how to meet those challenges head-on to accelerate going digital and provide value to internal teams and clients with an open, scalable, and vendor-neutral digital twin platform.

Noted Challenges

Companies around the world have been using digital technologies to help drive productivity growth and transformative change. The pandemic and ensuing economic pressures have accelerated the pace of digital transformation, which is taking center stage in operational efficiency and innovation strategies across industry sectors, including infrastructure.

Conservatism in the engineering, architecture, and construction (AEC) industry is largely driven by a need to get things right. With such large assets that so many depend on, it may lag behind other sectors when it comes to digital transformation.

Deep-rooted systemic industry practices might risk siloing people, processes, and data, hampering digital transformation initiatives. However, firms are increasingly recognizing that to remain competitive, they need to apply digital technologies to the way they work collaboratively, and they need to do so quickly. Currently, the U.S. is lagging behind other industrialized countries in digital transformation (see the figure below, which ranks the G20 countries based on their digital transformation). Nevertheless, in 2016, the Boston Consulting Group estimated that many infrastructure projects, when leveraging all available digital technologies, are realizing a 15% to 25% reduction in engineering and construction costs.
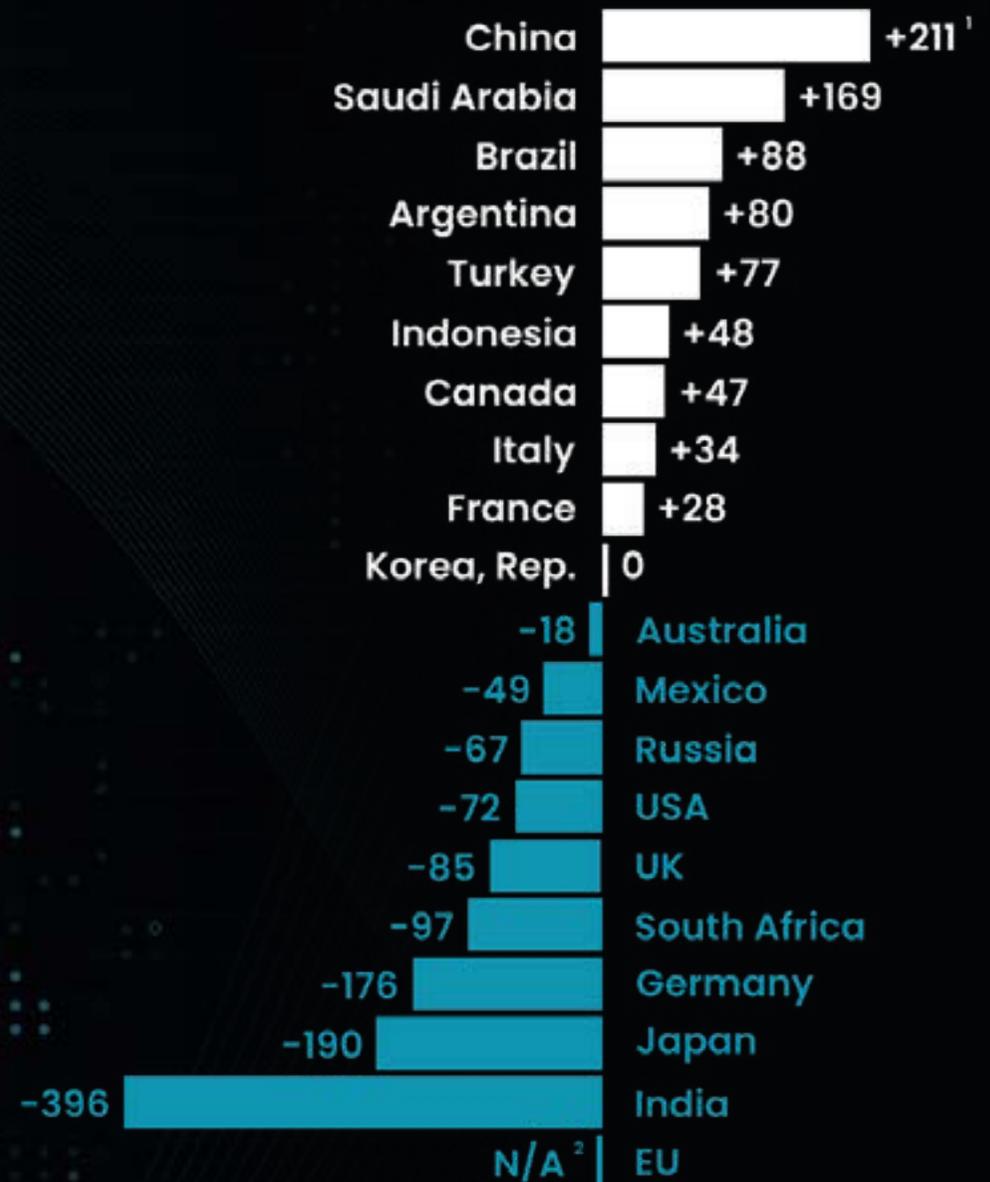
[1] *European Center for Digital Competitiveness, Digital Riser Report 2021*

[2] *Boston Consulting Group, www.bcg.com/publications/2016/engineered-products-infrastructure-digital-transformative-power-building-information-modeling*

Country	Value
China	+211 [1]
Saudi Arabia	+169
Brazil	+88
Argentina	+80
Turkey	+77
Indonesia	+48
Canada	+47
Italy	+34
France	+28
Korea, Rep.	0
Australia	−18
Mexico	−49
Russia	−67
USA	−72
UK	−85
South Africa	−97
Germany	−176
Japan	−190
India	−396
EU	N/A [2]

Digital transformation ranking of G20 countries relative to their global peers from 2018 to 2020. (source: European Center for Digital Competitiveness)

Digital twins, and overall digitization, can transform businesses and spearhead the digital transformation. Many firms are improving internal processes by combing data from disparate sources into a single view, while others are improving the quality of deliverables and reducing risk. This federated environment reflects an asset's current condition and predicts future performance, resulting in insights for more effective, data-driven decision-making for owners and operators. Firms are benefiting from more efficiency and reduced frustration. In some cases, it has opened the door to new revenue streams.

In addition, digital twins can help infrastructure firms meet their climate change commitments. During design and construction, digital twins can be used to track the environmental impact of an infrastructure project. Once in operation, digital twins can simulate the physical world, helping organizations improve the operational performance of the infrastructure asset and reduce its carbon emissions.

Organizations exploring infrastructure digital twins for their own use or as part of a service developed for others should choose carefully when deciding on a digital twin platform. The complexity of infrastructure dictates that the software used to build and utilize an infrastructure digital twin is, by necessity, diverse. The resulting scope is so large that no single vendor can provide all of the software pieces, just as no single vendor can provide all the physical pieces required for infrastructure assets. Openness is crucial.

"Tracking the environmental impact of an infrastructure project involves a constant stream of design changes coming from various engineering disciplines. By unifying these data streams, users can quickly create a quantity takeoff report at the right aggregation level required for lifecycle assessments (LCA) calculations while reducing the lifecycle assessment workflow from weeks to hours."

— Kaustubh Page, Director of Product Management, iTwin® Platform
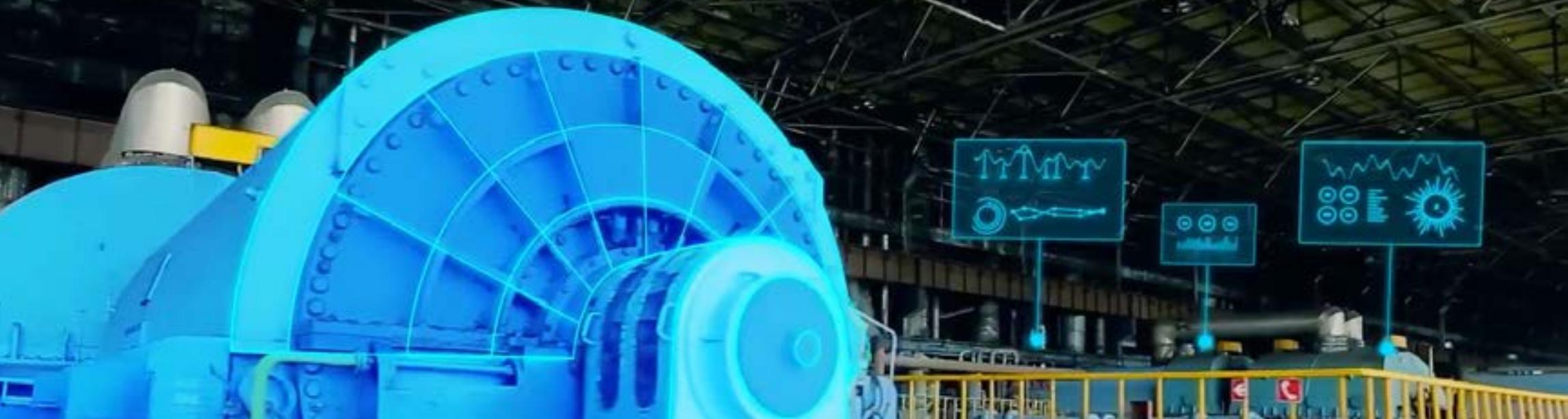
Demonstrated Solutions

An industry-grade development platform for digital twins must contain features such as visualization, artificial intelligence and analytics, IoT integration, and security. Critically, it must also have the ability to federate data and models from many sources and to incorporate enabling technologies from many sources and vendors. For example, depending on its planned uses, an infrastructure digital twin may require very specific capabilities, from carbon calculations to subsurface data, to augmented and virtual reality simulations and a broad discipline of engineering analysis sources.

"Regardless of infrastructure type, over time, the digital twin of an asset or a project will become both its lifeblood and its central nervous system. We believe that to achieve a sustainable infrastructure digital twin, it is imperative that you build your systems around open-source technology so the keys to your destiny remain in your hands.

You are not going to 'buy' your digital twins from a single vendor. Instead, you are going to assemble, build, customize, and evolve your twin with pieces from many vendors, the mix of which will change over time.

Each [vendor] will tell you how 'open' they are. Only those who are open-sourced (meaning you can use your digital twin and the source code that powers it without a fee) really mean it."

— Keith Bentley, Founder and CTO, Bentley Systems

Thus, an infrastructure digital twin will not be based on a single technology or vendor. Instead, it will blend multiple technologies from many sources in a mix that will change over time. Therefore, the software development platform for digital twins must offer matching openness and the flexibility to build digital twins that address a wide variety of specific uses throughout the lifecycle of an infrastructure asset.

When selecting a development platform for modeling, visualizing, and interpreting the content and context of a digital twin, there are three critical factors to consider: openness, scalability, and vendor neutrality.

Open

No one can predict how technology will evolve. As the use of a digital twin evolves, its future needs will be different. Digital twins must be flexible enough to work on new and different problems, which will mean adding other capabilities, components, and data sources. And there is no way of knowing if the original platform technology and vendor can satisfy those future needs.

Using open-source technology, available for use without a license, means that digital twin data and business processes are not tied to a specific vendor. An open source digital twin platform ensures that organizations can advance and evolve the digital twin as needed, with no barriers to adaptation in the face of future changes. Open source means that the digital twin – its underlying data and the source code that powers it – can be used in the future without a fee, ensuring that the digital twin and its data remain entirely accessible without buying anything from any specific vendor. An open platform encourages an environment of choice and flexibility.

"The success of digital twins will be heavily influenced by the level of engagement from infrastructure organizations and asset owner-operators, and the creation of a robust ecosystem of technology developers serving the infrastructure community. "

— *Frost & Sullivan, 2021, An Open Platform for Infrastructure Digital Twins*

Scalable

The size of an infrastructure digital twin and its underlying data could be massive. With the rise of IoT and the falling cost of data connections, the amount of raw data that can be linked to a digital twin is growing exponentially. Therefore, a digital twin platform must be able to handle that size, both now and in the future.

Cloud services are critical for addressing scalability. With cloud integration, a digital twin is not constrained by local hardware resources and is accessible by different devices, anytime and anywhere. As the use of digital twins in the infrastructure sector escalates, so will the benefits of cloud integration.

"Digital twins are allowing our project teams to visualize data in ways we never imagined. One of our biggest challenges has been collaborating between multiple disciplines that all use different authoring tools. The iTwin environment allows us to build a fully federated model married with reality data. The advantage is removing the need to convert data that typically results in a loss of relevant information."

— *Jack Riley, Senior Technology and Innovation Consultant, Burns & McDonnell*

Vendor-neutral

Closely related to openness, vendor-neutrality is crucial for the long-term health of digital twins. Vendor-neutral means that the digital twin platform accommodates a wide range of data formats, providing the means for extracting and linking data in its native form and then making it available in an open, non-proprietary standard.

Vendor-neutral also means that the underlying digital twin development platform uses open and flexible software standards. This allows an ecosystem of developers to build compatible software components more easily for the digital twin environment, which results in increased capabilities and functionality.

iTwin Platform

One thing we hear most from our users is that changes in design remain a considerable challenge. By partnering with Bentley on digital twin projects, companies can increase operational efficiency and reduce manual change management from weeks to days.

The iTwin Platform lets you synchronize your data assets, usually created using a diverse set of design tools, from any source, into a digital twin. Consider including sources such as observational data, sampled or surveyed in the past, or real-time data, such as IoT sensors, control systems, ERPs, or emergency response systems. Data sources are continuously synchronized, ensuring your digital twin is constantly updated with the most recent changes regardless of source.

The iTwin Platform's web-accessible environment provides instant access to these large-scale datasets for visualization and insights, enabling you to better manage infrastructure assets and projects.

"...without needing to change current BIM workflows. iModelHub cloud services provide the solution for many infrastructure engineering challenges where BIM modeling has created the potential for advancement, but where information misalignment has limited its value. Indeed, we have engineered the iModel 2.0 cloud platform to instill digital alignment, change-based accountability and synchronization, and immersive visibility as its core tenants."

— Keith Bentley, Founder and CTO, Bentley Systems

Why Digital Twins?

Digital twins enable you to visualize the asset, track change, and perform analysis to bettter understand and optimize asset performance.

The core tenants of the iTwin Platform include digital alignment, change-based accountability, and synchronization. In this manner, the iTwin Platform helps infrastructure engineering firms overcome the state of affairs where BIM has created the potential for advancement, but information misalignment has limited BIM's

value. In addition, users can visualize and track these changes, including those based on real-world conditions from IoT-connected devices, such as sensors and drones.

Whether firms want to standardize digital data formats for their own project workflow efficiencies or create digital twin solutions for their projects and clients, the iTwin Platform offers unique opportunities for engineering firms to advance and enhance their digital transformation.
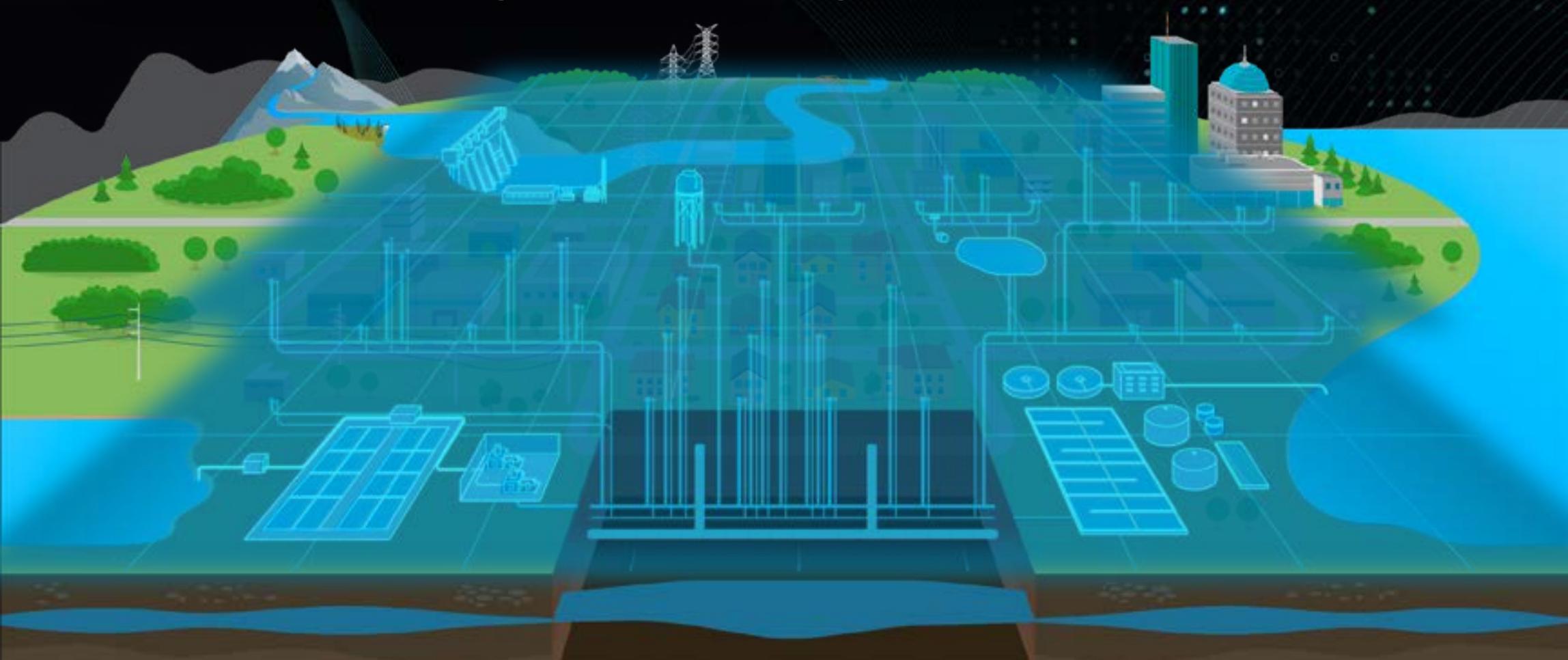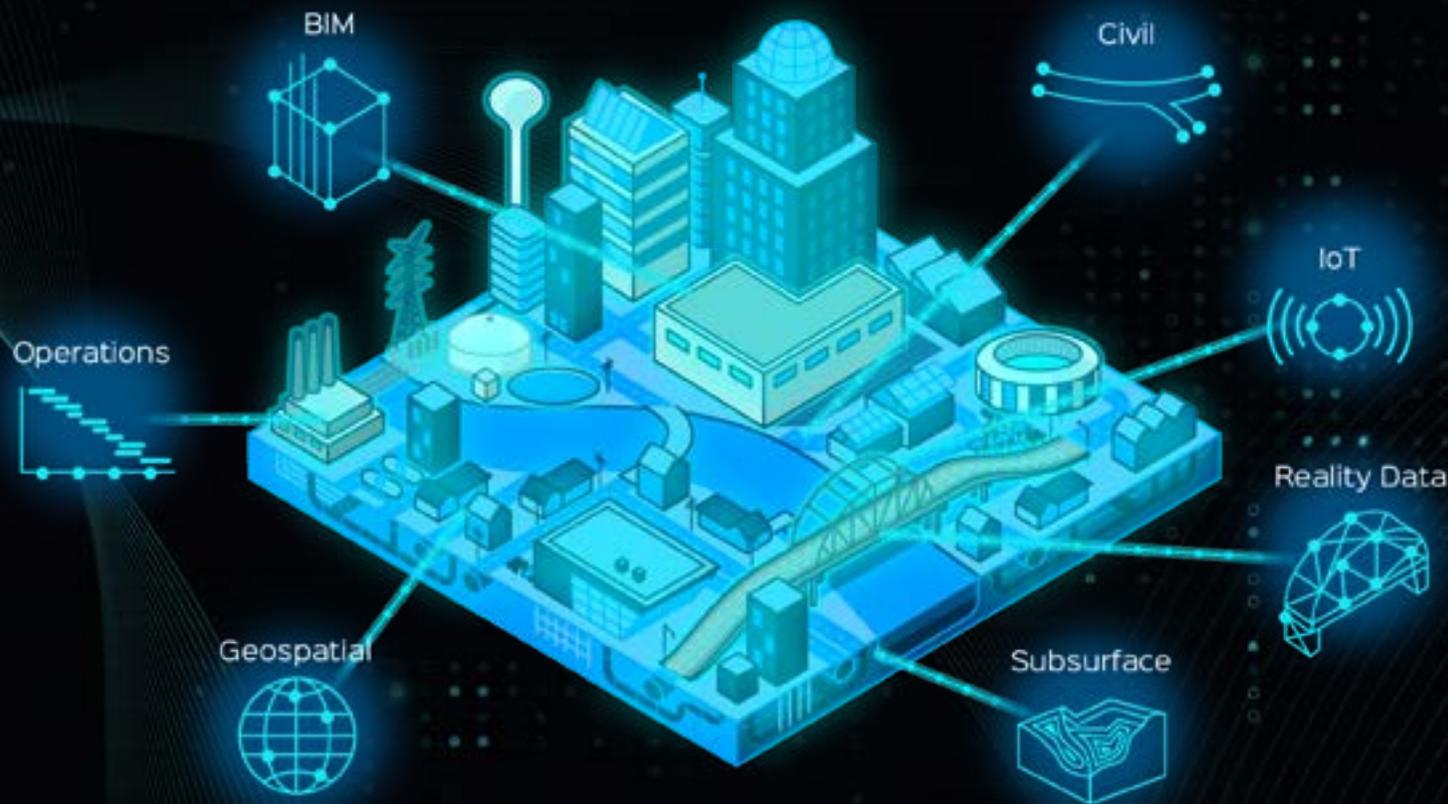
Open functionality allows designers and engineers to continue to use their authoring tool of choice while synchronizing seamlessly with multidiscipline, multivendor, multifirm infrastructure projects.

This functionality features "connectors" that synchronize with the most popular engineering and BIM formats (such as IFC, AutoCAD, Revit, SketchUp, AVEVA, and many others) and APIs that developers can use to create their own connectors. Currently, the iTwin Platform is used internally on SaaS products and with external firms and vendors to add digital twin capabilities to a broader ecosystem. Unilaterally, sensor integration has been the largest area of focus within the infrastructure industry. There have also been "secret sauce" applications made by firms and our organization around modeling, simulation, project delivery, and asset performance.

For example, Bentley leverages the iTwin Platform to create cloud application/services, powered by iTwin, for ProjectWise®, SYNCHRO™, and AssetWise®. Bentley also uses the platform to create new solutions, such as PlantSight and WaterSight®.

The iTwin Platform fosters a thriving ecosystem of digital twin developers by helping promote digital twin solutions built on its open-source platform.

In addition, Bentley's iTwin applications—iTwin Experience, iTwin Capture, and iTwin IoT, and applications powered by iTwin such as Bentley Infrastructure Cloud, SYNCHRO, and ProjectWise—participate in digital twin workflows and interact with other applications and services that are powered by iTwin—including those from other third parties, such as SmartViz, EarthCam, Phocaz, and Digital Energy—who use the iTwin Platform to develop their own solutions.

It is important to note that the openness of the iTwin Platform allows a digital twin to be created for one specific purpose, and to be used and expanded upon for many different purposes. Those purposes could be delivered via an application Bentley builds, via an application built by a third-party independent software vendor, or via functionality that an engineering firm or system integrator builds. This network effect substantially improves the ability to future-proof digital twins for scalability.

Within your digital twin environment, add data from IoT sensors giving access to real-time asset performance information and a unified view of structure condition and performance of highways, bridges, utility systems and dams—such as tracking river flow data and bridge changes in a flood-prone area or providing automated and continuous condition monitoring of dams.

Where to start?

Organizations should choose carefully when selecting the partners, technologies, and platforms to develop valuable and sustainable solutions for infrastructure digital twins. Openness, scalability, and vendor neutrality should be at the top of any must-have list.

The first step is an honest evaluation of a firm's digital transformation agenda. How aggressive are they? Do they have developers in-house? Is their primary focus selling digital twin technology and solutions, or is improving internal processes the main goal? The answers to these questions will dictate a starting point and direction.

Engineering firms need to truly evaluate where they are as a company with their digital transformation. What is their "pace of possible?" Do they have developers in-house? Do they want to get into the business of selling technology or are they more focused on improving internal processes?

Digital twins are powered by digital integration and built on data to deliver business value. To realize that value, companies should **identify specific, intended uses**, such as quantity take offs, core sampling, or flood control, and intended outcomes, such as reducing cost or increasing reliability, for their digital twin implementation. For example, engineering firms can draw upon their domain and technology knowledge to identify target use cases most suited for digital transformation initiatives.

And don't be afraid to start small. Integrating a limited amount of data sources and engineering information into an expandable digital twin format, such as the iTwin Viewer, can showcase leadership in digital technologies and provide a launchpad for larger digital transformation initiatives. The advantage of an

open, scalable digital twin platform is that firms can start with a single use case and a few data sources. Then, the digital twin can be augmented with additional data sources and capabilities over time and as needs arrive.

"One key importance of having a digital twin is the ability to combine real-time asset/site data with physical dependency models, and intelligence from different platforms to more accurately scope future projects, reducing project risk from using erroneous records drawings."

— *John Sullens, Senior Technology and Innovation Consultant, Burns & McDonnell*
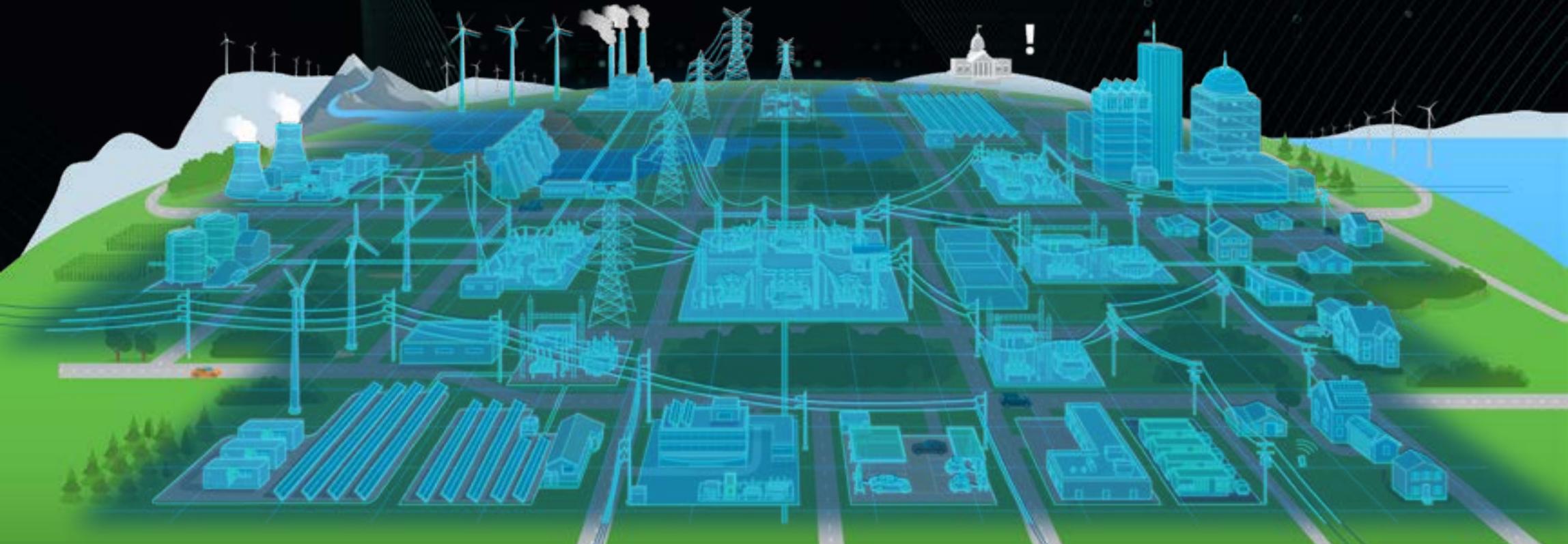
Assess

Firms are on many different levels of digital maturity. No matter where you are, take time to assess and ensure that you rest on a solid foundation of sound cybersecurity practices.

2D/3D Usage   **3D Implementation**   **Digital Maturity**

Review

Identify specific, intended uses and intended outcomes for your digital twin implementation. For example, WSP challenged everyone to work collaboratively, bringing clarity and vision to the complex challenges faced on PRTP.

Train - Accreditation

Accelerate the ecosystem and learn how to quickly and efficiently use the iTwin Platform.

The Associate level course includes topics such as data federation and synchronization, visualization, writing queries, UI customization, and more.

Develop

Join the ecosystem and bring your ideas to market faster with the help of developer.bentley.com. Connect with Bentley developers and project managers behind the iTwin Platform.

developer.bentley.com

Infrastructure is everywhere. We all depend on it.

Image courtesy of HDR

iTwin
Partner Program

Digital twins are creating exciting new opportunities. The goal of the iTwin Partner Program is to promote a community of organizations with a shared vision of creating an open ecosystem for infrastructure digital twins. To advance this goal, Bentley Systems is not only supporting the development of applications built on the iTwin Platform, but also enabling organizations to take their digital twin applications to market.

Partnerships

SmartViz · Microsoft · SIEMENS

EarthCam Webcam Technology · Cohesive · L&T Technology Services · Digital Construction Works · One Click LCA · EVERCAM Construction Cameras · Agile Handover · AKULAR

PHOCAZ · ALLVISION · BEYOND CAD · CCTech · ClimaTwin · Hepta · INESS 360 · M2X.ai

DIGITAL ENERGY · neARabl · RE scan · SILO.ai · WAVEO · NIV · XMPRO · wipro

POWERED BY iTwin

2021 *Going Digital Awards in Infrastructure* for
Project Delivery Information Management

Port of Melbourne - Port Rail Transformation Project
WSP | *Melbourne, Victoria, Australia*

WSP challenged everyone to work collaboratively, bringing clarity and vision to the complex challenges faced on PRTP. Bentley's integrated web-based technology provided an open-source platform with extractable data, creating a single source of truth that was easily accessible, driving collaborative digital workflows and information management, transforming digital project delivery for WSP and within the industry.
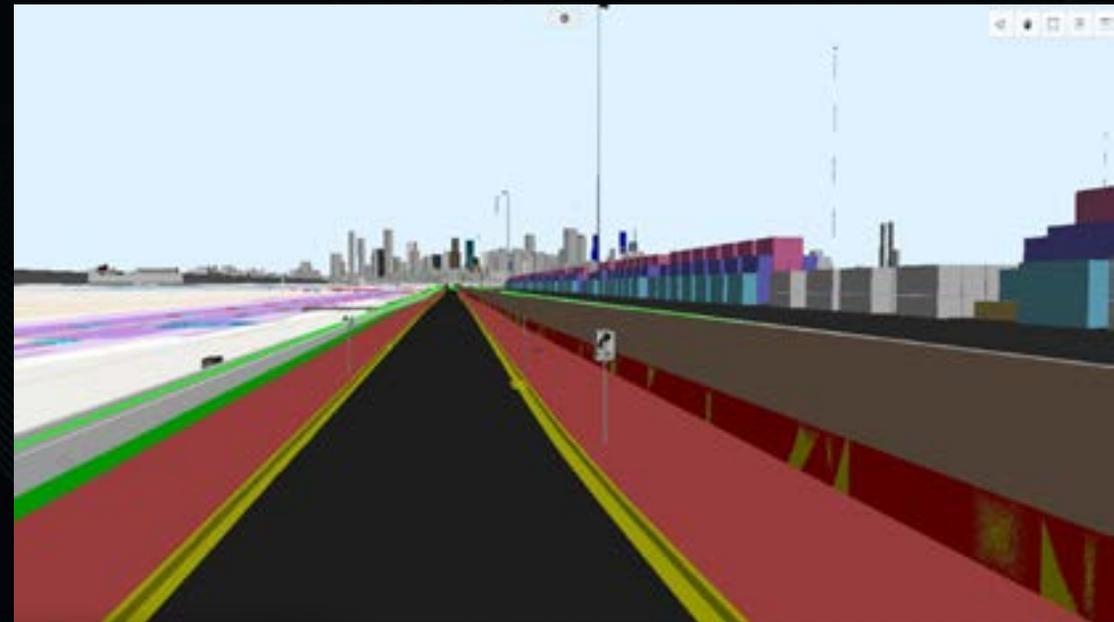

Image courtesy of WSP

Image courtesy of WSP

POWERED BY iTwin®

DC Water's Digital Twin Solution
Improving Operational and Financial Resilience by Implementing a Water Infrastructure Digital Twin

Utilities are employing a variety of digital strategies to address urgent risks, as well as meet the requirements for digital transformation aligned to strategic investments in water systems. One very compelling digital strategy that water utilities are adopting is a digital twin. Digital twins of water infrastructure can help utilities get the most out of their data to improve their decision-making. Most utilities have the key building blocks in place to make digital twins economically feasible as a short-term strategy with long-term benefits.
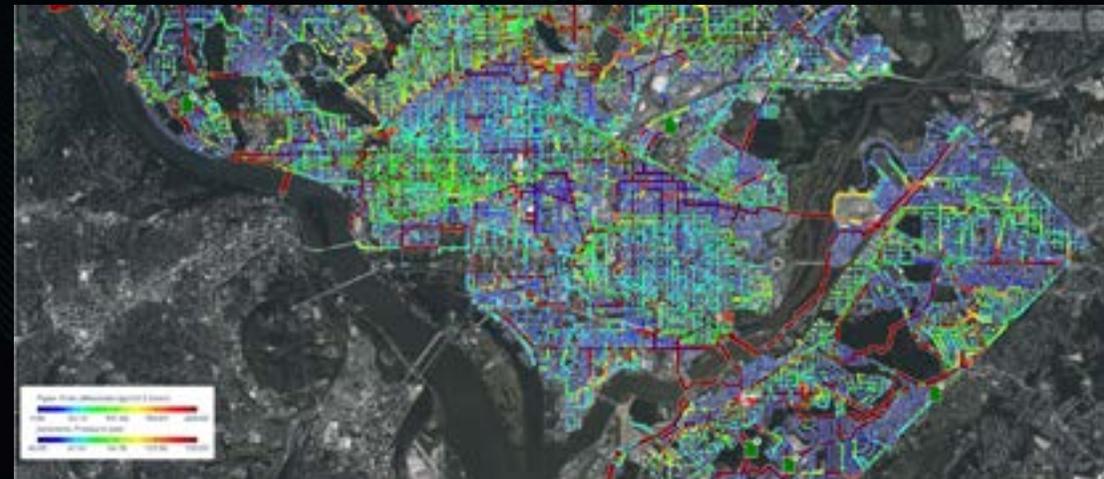

Image courtesy of DC Water

Image courtesy of DC Water

POWERED BY iTwin
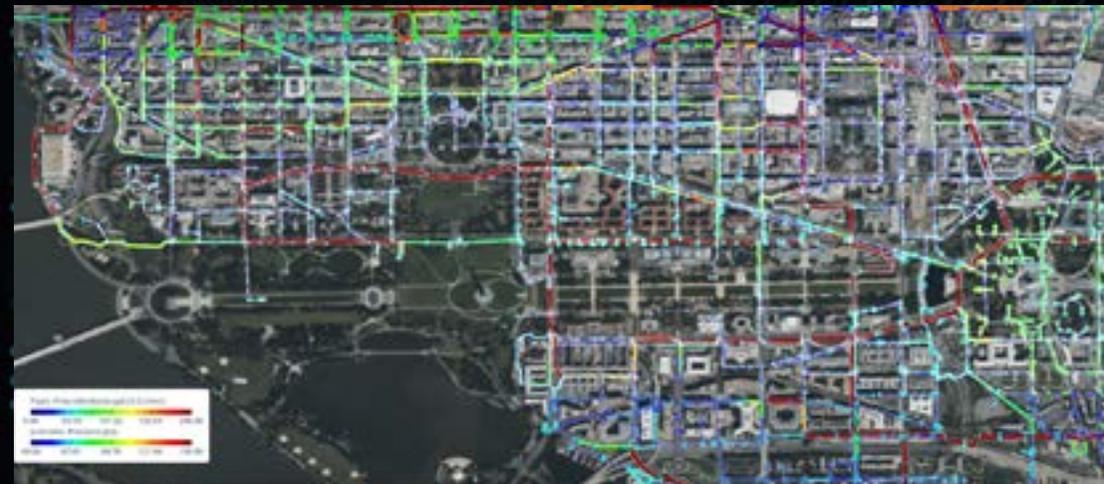
Deliver More Value

42% of *Going Digital* Awards finalists use iTwin. Are you? Get the right information to the right people at the right time to make more informed and timely decisions. Create, curate, and use digital twins in engineering workflows, construction, operations, and maintenance.

Dare to be Data-centric

Data is the key to understanding. The new Bentley Infrastructure Cloud helps you meet all these complexities across the entire asset lifecycle and ecosystem—from design, to construction, to operations, to maintenance and decommissioning—by focusing on the value of data and empowering the productivity of your workforce across the entire supply chain.

Bentley®