Enabling the Airports of Tomorrow with Digital Twins

By Steve Cockerell, acting industry marketing director, cities and campuses, Bentley Systems

Supporting more than 87 million jobs around the world, the aviation industry contributes well over 4% of global GDP. Working 24/7, 365 days of the year, our airports are critical links within the global transportation systems that connect countries, communities, and businesses.

Faced with changing demand, different operating conditions, and increasing costs, the quality of services that airport owners and their supply chains provide is a crucial factor for the passenger experience. As travel restrictions are lifted and people's concerns about flying slowly ease, many airports are congested, while few are over-built or have space to spare.

Aligned with other transportation owner-operators, airports are moving toward being "data-driven" organizations, where access to trusted information, a clear understanding of the context of data being managed, and the impact of changes to it are critical to proper decision-making when working to deliver efficient operations, timely expansion of existing facilities, or new airports.

With this complex set of challenges, owners and their supply chains must remain agile and responsive. In this dynamic environment, future-ready technology—including digital twin solutions, which support the highly collaborative processes essential to their owners' balancing of passenger satisfaction, capacity fluctuation, and ongoing profitability—will be key.

Is Data the Cause or the Cure?

The huge volume, diversity, and maturity of data that exists—and, therefore, needs to be managed across the lifecycle of assets, processes, and systems within an airport campus—is an indicator of the size of opportunity harnessing it and the technology that digital twins provide.

However, with much of that data residing in siloed systems, the ability to manage, access, and validate the different data types and sources involved is a significant challenge. This task often requires multiple tools, which can present the organizations and teams involved with IT headaches and ongoing costs way beyond those directly linked to their primary role of transporting passengers and/or freight around the world.

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Image Caption: Diverse User Profiles. *Image courtesy of Sydney Airport.*

Compounding this situation is the reality that the teams working across any airport, large or small, are made up of a diverse mix of technical and commercial expertise. Engineers and surveyors responsible for delivering new or maintaining existing infrastructure assets will be familiar with terms like BIM and construction simulation, as well as being used to handling GIS data and 3D modeling. But for retail or property managers, as well as those within the C-suite, it can be like a foreign language. Therefore, it is important that every user, regardless of role or function, can lay their hands on data they can trust, in a way that makes sense to them and the task at hand.

As the world becomes more digitally connected—including through IoT devices that can now readily provide near or real-time updates on project status, asset condition, and performance—both the size of the challenge and the opportunity to deliver improved business outcomes increases exponentially. So, is data the cause or the cure?

Like all kinds of digital tools and technology, overcoming the types of data challenges that I have highlighted is only a means to an end. However, when coupled with the latest in data analytics and computer simulation through digital twins, users gain the increased visibility and insight that they need to improve decision-making across all aspects of the airport lifecycle, and for every one of the disciplines and stakeholders involved, including members of the public.

What is a Digital Twin?

To explore the potential that airport digital twins provide, it is important to first understand what a digital twin is. For many, the default definition of a digital twin will be a 3D model of a physical asset, for example a runway, terminal building, bridge, or tunnel. However, without a connection between the digital version and its physical counterpart in the real world, it is only a digital snapshot of the asset at a given point in time.

In this scenario, whether that snapshot is a model, a report, maintenance record, or set of operational instructions, the users of this information run the risk of it being out of sync with the other, resulting in rework, delay, and/or increased cost. In addition, they also lose the ability to see the information behind the asset's design, construction schedule, or historical maintenance, and cannot use that valuable insight to enable better decisions.

Bentley defines a digital twin as a realistic and dynamic digital representation of a physical asset, process, or system in the built or natural environment. A digital twin, therefore, connects the physical and digital worlds so that the digital dynamically reflects changes in the physical, representing its physical counterparts near or real-time status, working condition, or position.

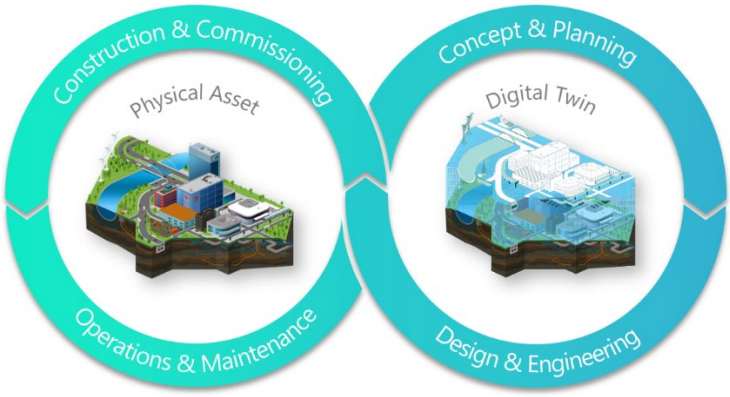

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Image Caption: A digital twin connects the physical and digital worlds so that the digital dynamically reflects changes in the physical. *Image courtesy of Bentley Systems.*

Moving beyond the BIM workflows and standards that have become common place over the past 20 years, and due to the number of assets and disciplines involved across the lifecycle of an airport campus, it is that connection between the physical and digital worlds, made possible through our latest digital twin technology, that really makes the difference.

Enabling the Airports of Tomorrow

Of course, none of us "know what we don't know," so with the different types and amount of data, plus technology evolving so fast, it is very difficult to predict what a digital twin of an airport will include or might enable in the future. However, I think that we can pick out some of the key phases of the lifecycle, and look at the experience of other industries, to have a go.

For example, imagine if, as an airport planner, you could simulate future traffic flows and/or pedestrian movement, on related transportation assets or within proposed terminals, to inform and optimize the location and design of new facilities.

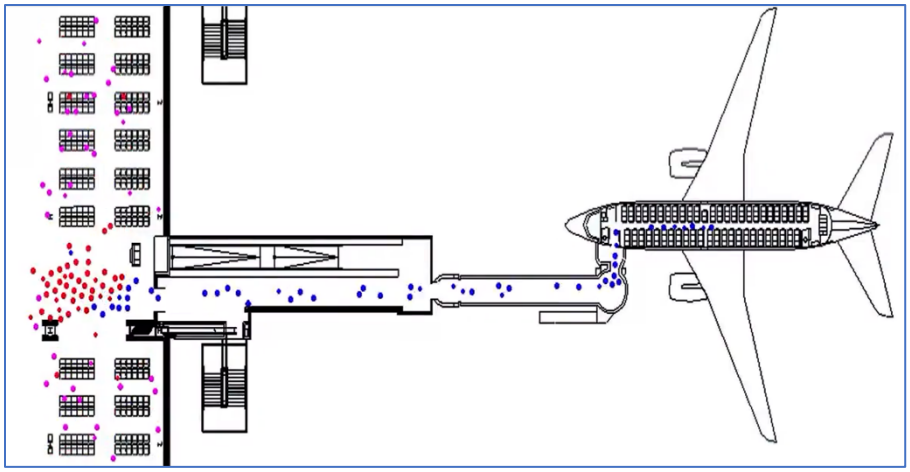

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Image Caption: Modeling pedestrian movement using LEGION Simulator. *Image courtesy of Bentley Systems.*

If your multidiscipline design and engineering team could collaborate seamlessly wherever they are located, they could exchange data to explore different alternatives, simulate and optimize construction schedules, and then hand over "construction-ready" data to contractors on site.

Taking it a step further, digital twins already help monitor the delivery of road and rail projects, so it is not a huge leap to expect project managers using them to track progress on site across an airfield to ensure that ongoing works do not adversely impact operations or put airport users at risk.

Moving to airport operations specifically, imagine if maintenance engineers could remotely monitor runway pavement deterioration, including looking at trends in the data and using machine learning to look at cracks at risk of becoming unsafe, and then use that data to target resurfacing work in the right place at the right time.

Imagine if IoT connected sensors on assets in terminal buildings were delivering real-time data on energy consumption or environmental conditions to airport managers, enabling them to predict or respond to severe or unexpected changes in temperature or humidity, and in turn adjust comfort levels for staff and passengers.

While these scenarios might seem like they are use cases for enabling the airports of tomorrow with digital twins in years to come, the reality is that they are all possible today. To realize the full potential of digital twins in an airport scenario, we should also look beyond the boundary of the airfield, at related infrastructure assets—for example, at the rapid/mass transit system serving it.

Here, digital twins may already be helping track maintenance engineers to optimize budget and resources, to improve service, safety, and reliability. However, as part of a connected ecosystem of digital twins, visibility of data in the railways digital twin could inform airport operations

managers when the network is becoming congested or out of service, with the potential to put the timely arrival of passengers, and departure of flights, at risk.

Using proven technology in concert with data many owners already own, as well as leveraging workflows that they rely on to deliver current service levels, the availability of digital twins means that at anytime, anywhere, their users can view, monitor, and gather the insight they need to let the data drive better decisions. Decisions that can lead to greater efficiency, reliability, safety, and sustainability, as well as enhancing the customer experience for users of the airport campus.

Digital Twins for Airport Operations and Expansion

As demonstrated through our *Going Digital* Awards entries in recent years, the evidence that the benefits of digital twins far outweigh their cost—particularly when calculated across an asset's whole life—is getting clearer all the time.

In this year's Facilities, Campuses, and Cities category, Sydney Airport is a finalist with Maps@SYD, and describes many instances where the use of digital twin technology is saving time and resource hours, improving productivity, design efficiency, and the quality of deliverables, as well as reducing costs.

One of the oldest airports in the world and Australia's busiest, Sydney Airport is situated on 906 hectares in Botany Bay. Home to three runways, three terminals, and over 400 buildings, the team at Sydney Airport has started its journey toward the development of their digital twin using Bentley's OpenCities, known internally as Maps@SYD.

Promoted as the "Google Maps" of Sydney Airport, Maps@SYD is a gateway to historical and real-time data from multiple sources, providing its over 200 current users with a comprehensive picture of the airport campus, without the need for specialized software on every computer across the organization.

Using Maps@SYD, project managers have instant access to all developments, current and planned, together with the ability to overlay flood studies, environmentally significant areas, and heritage sites, helping them understand the potential impact on proposed work, and saving the spatial team around 65 resource hours per week.

Maps@SYD can overlay data from financial applications onto GIS data, giving the airport's commercial leasing team visually intuitive and up-to-date access to tenant names, lease expiry dates, sales per square meter, and liquor license details, eliminating the need to visit the digital print room or request data from the spatial team.

Maps@SYD has also enhanced workflows for regular audits of fire-fighting equipment, flight information screens, and confined spaces. Previously contractors recorded information on paper during walkthroughs and uploaded these into CAD files, which could introduce errors. Today, audits are conducted using tablets, with information updated directly in the spatial information system, reducing the time needed for standard audits from 133 hours to 56 hours.

Another example is from last year when Clark Construction was our winner in the Digital Construction category for its work on the Sea Tac Airport International Arrivals Facility, the most complex capital development project in the history of the 69-year-old Seattle airport.

Located in one of the busiest airports in the Pacific Northwest, the project included constructing a three-story building, an elevated sterile corridor, and the world's longest pedestrian walkway over an active airport taxi lane. The most complicated aspect of the project included remotely assembling a 3-million-pound, 320-foot-long center-span pedestrian bridge and then transporting it to the project location.

By leveraging BIM and reality modeling technology with Bentley's SYNCHRO 4D, Clark Construction linked the model with the construction schedule, thereby developing a digital twin to fully visualize the construction sequencing.

The digital twin helped the team coordinate planning and was easily adaptable as plans changed during discussions. They used the application to simulate transport of the bridge across three miles through an active airport, enabling precise planning and execution.

Despite the transport needing to occur in one night and in poor weather, the team safely delivered the bridge, successfully installing and fitting the iconic walkway within three-eighths of an inch—all while not causing airport disruptions. Moving forward, the digital twin will be used by the Port of Seattle for future facilities management purposes.

Embracing Digital Twins Today for a Better Tomorrow

Harnessing data and technology through digital twins to improve how we work and what we deliver across every phase of the asset lifecycle will not always be a straightforward process.

Digital twins are the next big digital disruption in our industry, and that disturbance is happening right now for airport owners and their supply chains around the world.

If digital twins are, as we and many others believe they will, to be part of the "new normal," then every organization needs to invest in, as well as have a clear strategy for, their adoption and deployment soon. As with previous examples of disruptive technology, those that do not invest in making and managing this digital transformation look more likely to fail.

Digital twins and the processes they enable must be embraced to deliver the improved business outcomes demanded in our changing world, and, while I recognize it is early days for many, it is clear in my mind that alongside many other infrastructure sectors, with our users leading the way, they will re-write the way we plan, design, build, and operate our airports of tomorrow.

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