PASSENGER
TERMINAL*WORLD*

APRIL 2022

Wayfinding
Digital solutions are helping ensure hassle-free journeys through the airport

Digital twins
Technology to simulate and fine-tune every aspect of airport operations

Land leasing
Airports can maximize non-aeronautical revenues and diversify risk through leasing their land

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HOW CONTACTLESS RETAIL TECHNOLOGY IS TRANSFORMING THE SHOPPING EXPERIENCE IN NORTH AMERICAN AIRPORTS

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Passenger Terminal EXPO 2022

See page 84

MODEL
example

Fully functional digital twins enable airport operators to simulate and fine-tune every aspect of their current and future activity

Airports near dense urban centers – where land is expensive and the planning process is fraught with lengthy legal challenges – are likely to struggle to physically expand quickly enough to cope with a post-pandemic surge in passenger traffic. Instead, they are turning to 'digital twins' – virtual replicas of every aspect of an airport's performance – to maximize efficiency and increase capacity in a more timely and cost-effective way.

Amsterdam's Schiphol Airport in the Netherlands and Hong Kong International Airport were early pioneers of the technology, which was first used to streamline maintenance and engineering issues. Progress has been slower in North America but has accelerated in recent years, with San Francisco International (SFO) and Vancouver Airport (YVR) fully embracing the technology.

At YVR, the development was particularly rapid: "We started to think about our twin only just before Christmas 2020, when passenger volumes were significantly decreased," says Lynette DuJohn, YVR's CIO and VP of innovation. "We knew we needed to become a different airport coming through Covid-19. We started to work on the data capture when there wasn't much activity on the airfield, and went live in September 2021. Already our operations teams are seeing multiple benefits."

Pre-pandemic, 2020 was scheduled to be the biggest year of investment in YVR's history, with around C$650m (US$512m) of expenditure set aside (and in the three years leading up to the pandemic, the airport had an average capital program of C$580m [US$456m]). But when Covid-19 shut down many operations, YVR had to reduce its capital program accordingly, and instead shifted its focus to efficiency and optimization.

YVR's digital twin was born out of this fundamental change in mindset. "It was a small investment relative to the costs of construction, just pennies on the dollar. And it means we can use existing assets without needing a lot of upgrades," notes DuJohn.

In less than a year, YVR's partner, Vancouver-based GeoSim Cities, produced full 3D maps of Sea Island, where the airport is situated, as well as operations on the ground and inside the terminal, using five high-fidelity cameras and lidar. Other sensors, such as passive RFID and Bluetooth, are being considered for specific future cases. There is also a 2D digital twin used as a situational awareness tool. It enables operations teams to understand how passengers are moving through the terminal and compare the picture with predicted numbers.

"The twin alerts us to anticipated problems throughout the day and flags the operations people so they can address it," says DuJohn. "It pinpoints where delays are, so we can understand precisely the problems passengers are facing. Our maintenance staff will soon have access to maps on handheld devices, enabling them to be directed precisely to where repairs are needed. Once in the correct location, they will get detailed information about what to fix and the appliance's history. This tool will also be able to send other work orders in the same area, to save time. This increases efficiency a lot, as airports are large, complex buildings."

Another pilot scheme that also benefits from the digital twin involves sending automatic alerts if there are unattended vehicles at the curb. Previously, one individual monitored the entire curb; now, cameras and algorithms take care of the process.

One of the most important goals for YVR is to significantly improve the passenger experience and

ABOVE
Digital twins enable stakeholders to add digital layers to 'as built' models for future design and system testing

The twin alerts us to anticipated problems throughout the day and flags the operations people so they can address it

Lynette DuJohn, Vancouver Airport

operating efficiency. "The digital twin will advance our situational awareness by tracking process flows for connections, pre-board screening, customs and safety and security. Better decision making is where we want to be throughout the passenger journey. This includes how we streamline baggage. Currently, we are working with Vanderlande, a global leader in logistics automation, on incorporating our baggage system into the digital twin."

In addition to practical benefits, the digital tool can help YVR fulfill its remit to support local communities. "For example, people with autism can have a stressful experience at an airport. We are working to ensure that the twin will enable them to experience their journey virtually before they arrive. We're also planning for the digital twin to be the learning ground through which YVR connects and collaborates with local businesses and our community to lead the post-pandemic recovery."

The biggest advantage of the twin, however, is its capacity to model the future. YVR has a target of net zero emissions by 2030, for example, and is using the twin to model all aircraft movements and activity on the airfield. This provides insights into the sources of GHG emissions from airport vehicles and ground support equipment.

"Once modeling is complete, we will run machine learning to figure out how to run operations more

Kansas City

Pennsylvania-based Arora Engineers is providing a complete digital representation of the new US$1.5bn terminal at Kansas City Airport, scheduled to open in early 2023 (for more details see *Duty of Care*, January 2022, p14-18*). The company says its data interoperability services product is the foundation stone for the development of a digital twin.

"It's essential to ask at the outset what the airport wants the digital twin to do," says Brian Benedict, Arora's development director of enterprise solutions. "That ensures all the data required is captured by smart building systems and sensors. The first step is to capture data during the construction and engineering process, then to integrate data from all the operations and facilities management. The problem is it can be all over the place in different formats, including legacy spreadsheets hidden in cabinets, BIM models and outdated CAD drawings. But legacy systems need to be brought in at the same level as new ones."

Benedict says that by the time it opens, Kansas City will have integrated all the data with the enterprise asset management system. "When they cannonball into the pool, they will have invested a bit more money but they'll be ready to deploy whatever digital twin they desire. On day one, technicians will be able to navigate the entire facility virtually and pull up information about every asset."

Scott Yates, the COO of Arora Engineers' subsidiary company, Electronic Data, Inc., believes the digital revolution is leading airports inexorably toward the adoption of augmented reality and wearable technologies. But most organizations in aviation lack the capacity to capture enough data.

"Most people in the industry believe that is the direction of travel. But it will be a huge paradigm shift that requires a virtual, data-rich spatial representation of the built facility. And most organizations still don't have the foundations to capture all their data or the staff trained to produce and maintain it," he says. "The danger is not integrating the data and ending up with 30 different digital twins. You want one digital twin at enterprise level that takes data from all systems."

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effectively to reduce GHG emissions," says DuJohn. "It will also help create a better flow in operations, leading to smoother passenger experiences."

Geography lessons

Schiphol Airport, one of the pioneers of the digital twin concept in aviation, used building information management (BIM) software to create a 3D digital representation of its assets' physical and functional characteristics. In the US, SFO has used BIM to capture detailed building plans and data. It has also combined this BIM data with the landscape-scale understanding provided by a geographic information system (GIS). These two digital tools are the foundation of SFO's digital twin, which provides a detailed map of the whole airport.

Also in the US, the FAA has made it mandatory for airports to provide data in a GIS format. But the FAA is mainly interested in detailed awareness of runways, taxiways and pavements, whereas SFO is using GIS to understand the interiors in order to support construction, maintenance and security. For example, for interior maintenance, GIS provides detailed information about assets, such as the manufacturer, model numbers, date of installation, materials and color.

"The digital twin means we control every square foot of the airport. I can point cameras at it; I can plug sensors into it; I can listen to it; I can take its temperature," explains Ian Law, SFO's CIO. "We already have environmental sensors, ambient noise sensors and gunshot detectors. And we keep coming up with new sensors that provide more information about the square foot."

Once the sensor data has been gathered, the key question is what to do with it all. For one thing, it's valuable to control SFO's carbon footprint. AI

Vancouver Airport's digital twin will help it meet its **net zero emissions** target by 2030

cameras detect aircraft usage at the gate and sensors monitor particulate matter in every square foot.

Like Vancouver, SFO is also using the digital twin to increase operational efficiency. "We're able in real time to monitor the airplanes parking, the fueling trucks coming and going and the unloading and loading of bags. For example, we can know instantly if someone working on the apron isn't wearing a yellow safety vest, or ensure bag crews are at the gates in plenty of time. Within the terminal, an interesting application of the twin is location detection. For example, it's useful to track where all the wheelchairs are because there is a big demand for a finite number."

Software compatibility

Major airports like SFO are in a constant state of flux and now every time there is new work on a terminal, runway or taxiway, the construction company must hand over data to inform the digital map of the facility. "Every company gives it to you in a different format," notes Law. "It's essential to develop standards to join it all together and create a holistic view of the airport."

BELOW
SITA built a digital twin for LaGuardia Airport Terminal B that provides information in real time to enable the airport to better visualize and manage the terminal

> It's essential to develop standards to join it all together and **create a holistic view** of the airport

Ian Law, San Francisco International Airport

Perhaps British transport technology company Aurrigo's Auto-Sim software could offer a solution. It has been selected by Gerald R. Ford International Airport (GRF) in Grand Rapids, Michigan, to create digital twins of the airside operations and the inside of the terminal. Aurrigo says its airside model covers roads, intersections, stands and all operational vehicle types and movements. One of the aims is to develop the foundations for how GRF could implement autonomous vehicle operations in the future.

"GRF has been battered for two years financially and has to claw back some money," explains Chris Keefe, Aurrigo's VP of autonomous programs North America. "They set up an innovation fund and we pitched our software as a way of streamlining operations. Creating the twin is a three-month project and will be fully complete in May. But the feedback it has provided has already caused the airport to redesign the terminal layouts. The simulations made them realize how they were creating bottlenecks."

Aurrigo has deployed its software in several airports over the past two years, including Heathrow in London, Changi in Singapore, and several lesser-known ones. Keefe says many airports still use primitive methods to track assets, including storing such information on spreadsheets.

A digital twin stores the data more efficiently and permits simulations. "It's an environment where you can put anything in, or take anything out, and see the effects," Keefe explains. "Basically, you move slider bars around and simulate the ripple effects on the whole airport. It's like video games such as SimCity. For example, if we remove the 900 tugs currently pumping out diesel at Heathrow T5 and replace them with automated electric vehicles, what would it mean for the bottom line, efficiencies and operations, as well as pollution levels? Or we can start moving sliders around to see what would happen if we put a Starbucks here based on passenger movements? Such internal simulations determine the best way to fit out an airport."

GRF is the first cold-weather airport to deploy Aurrigo's software. The twin includes models of the movements of snow plows, de-icing patterns and local weather data from the past 20 years. "We can run simulations about what would happen in a huge snowstorm. Will the airport be closed? How many employees will you need on-site? How long does it take to clean the place up and bring people back to work?"

Keefe says he hasn't yet seen an organization that is ready to leverage digital twins at enterprise level at scale. The technology to develop digital twins exists, but there is a lack of sufficient data. At Vancouver Airport, DuJohn
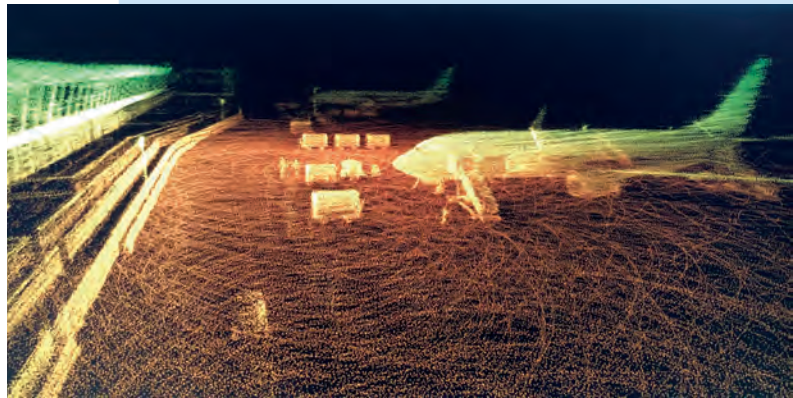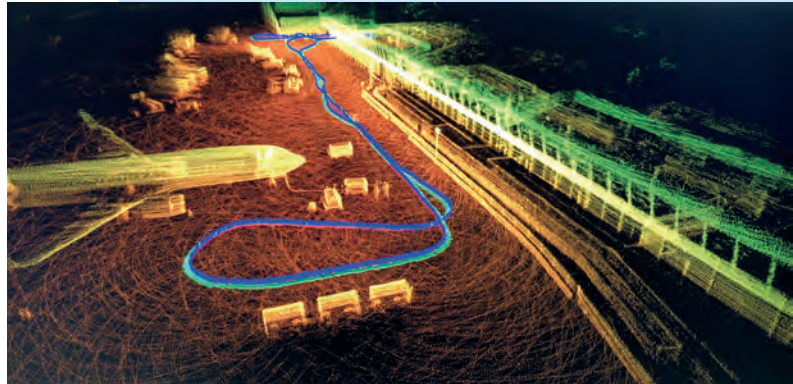
It will take **three months to create a digital twin** of Gerald R Ford International Airport

agrees that data is the base of a digital twin. "For any organization looking to build a digital twin, it's imperative to have that strong data infrastructure. From there, you build specific use cases that add value to the organization. A digital twin won't create data in and of itself."

Clear strategy

Back at SFO, Law believes there are five keys to a successful digital twin. The most important factor, he says, is clarity of ambition. With so many options available, consensus and understanding across the airport's leadership are critical. Otherwise, there is a danger that results will be disappointing. Above all, the spirit of open communication needs to extend across all stakeholders. "Airports are complex, multistakeholder environments," he points out. "All the partners need to work together to establish clear ambitions and targets for the digital twin."

Law's four other fundamentals for a digital twin implementation are: invest in keeping good airport maps and building information models; use every opportunity to upgrade building data networks; work with startups and innovators to develop new uses of space-related digital information; and finally, be clear on privacy policies and other public privacy protections.

Looking further forward, Law believes the concept of digital twins is in harmony with wider discussions about future 'meta universes'. "One example is we could use it to create a virtual shopping center that extends hugely the physical asset we currently have. It could have 40 times the number of shops but still be recognizable as SFO, where the visitor navigates and gains access to the extra facilities through the use of augmented reality headsets," he adds. ■