



Design and architecture

Bhutan's Gelephu International Airport was designed by the Bjarke Ingels Group (BIG).
Image: BIG



Innovation built in

Technology integration is a critical part of designing an airport. Grace Hardy speaks to industry experts to discuss futureproofing, smart airports, and the use of AI in design.

When it comes to airport design, it's not uncommon to get caught up in beautiful bright, open spaces, eye-catching architecture and sustainable materials. While the aesthetics of an airport are undeniably important, airport design has an undercurrent of complex planning that is vital in ensuring operational efficiency. Technology must be woven into the design from the initial plans, not as an afterthought, and futureproofing is critical for maintaining adaptability and scalability as technology, mandates and passenger needs evolve. In turn, the biggest challenges faced by airports – congestion, bottlenecks, and capacity during peak periods – can be prepared for well before they become a problem.

SHIFT IN PASSENGER BEHAVIOUR

With the emergence of biometric security, smart lighting, sustainability initiatives or even 5G integration, complex architectural and engineering

elements are required – such as structured cabling, high-bandwidth fibre connections, rack space, and sufficient power availability.

By bringing in this infrastructure early, costly modifications and disruption can be avoided.

SSOE Group is a full-service architecture and engineering firm. It has decades of experience working with over 30 airports, including Hartsfield-Jackson Atlanta International Airport and Birmingham-Shuttlesworth International in Alabama.

David Willoughby, Senior Architect and Business Leader at SSOE Group, has seen a major shift towards simplification when it comes to airport design. This he attributes to the post-Covid induced decline in business travel, which has made leisure travel the primary target.

He says: "Unlike business travellers, who tend to prioritise speed and efficiency, leisure guests tend to spend

more time in the airport and place greater value on comfort, experience, and ease of navigation. Airports are now focusing more on intuitive wayfinding, calming environments, and stress-reducing features."

Regional airports present their own set of challenges and benefits. However, when it comes to a simplified travel experience, with the upside of convenience and shorter waiting times, smaller airports certainly have the upper hand and are gaining in popularity.

Aviation consultancy NACO (Netherlands Airport Consultants) specialises in airport design, redesign and expansion, with over 75 years of experience and 700 airport projects.

NACO has worked with many regional airports, including Gelephu International Airport in Bhutan and Red Sea Airport in Saudi Arabia.

Peter Rieff, Senior Airport Architect at NACO, sees sustainability, local identity,



LiDAR sensors can be used to track passenger movement in the terminal. Image: Veovo

and operational adaptability as the key design factors for regional airports, with an emphasis on character, locally sourced materials and native landscaping.

AIRCRAFT TRENDS AND AI

One of the biggest changes for regional airports has been the arrival of narrowbody long-haul aircraft, which are expanding the potential for international routes for these hubs.

While these aircraft generate higher passenger numbers, they also impact the small capacity of these facilities. Flexibility is crucial for this changing landscape, and this can be achieved through the clever integration of technology, machine learning, and AI software.

Veovo provides a modular airport management platform that is designed to help airports adapt and grow, including solutions for managing flight operations, gates, stands, belts, and passenger flow at check-in, security, and borders.

James Williamson, CEO of Veovo, says: "Tech doesn't replace design thinking, it

enhances it. It ensures that terminals can flex with behavioural shifts, new regulations, or operational disruptions, without being redesigned from scratch.

"It is essential that airport design builds intelligence into the very fabric of the building. For example, ensuring coverage of the terminal with sensors such as LiDAR for passenger movement tracking, high-speed wireless networking for connectivity, and IoT (Internet of Things) devices."

With solutions such as those offered by Veovo, airports can create a flexible space that can handle passenger flow and prevent crowding, which in turn optimises passenger wellbeing.

OPTIMISING OPERATIONS

Copenhagen Optimization is a consultancy and provider of the Better Airport solution, a cloud-based management software-as-a-service platform that gives airports a simpler way to run core operations, such as the allocation of check-in counters, baggage infrastructure, and optimal staffing at security and immigration checkpoints.

The solution can also be used to help existing airports adapt to fast-growing post-pandemic passenger numbers by identifying how their operations can be more efficient without needing to build new infrastructure.

While Better Airport can be implemented at any planning stage, Copenhagen Optimization echoes the importance of forward-thinking.

Rasmus Kaster, the company's Chief Growth Officer, says: "We see first-hand how airports can take an over-simplistic approach to capacity planning when designing new terminals, leading to passenger facilities not suited for the Concept of Operations that will eventually be in place when the facility opens."

However, Kaster highlights an important differentiation between "high tech" and "smart" and emphasises that change management is the main challenge when integrating technology into design.

While airports can install new, advanced technologies, they won't naturally improve operations, and intelligent systems that generate data are only as good as the decision-making behind that data. This is where the idea of a smart airport comes in.

DATA AND TECHNOLOGY

A smart airport is one that uses data and technology to continuously monitor and adapt; a responsive and connected environment that serves to enhance the passenger experience.

With an ecosystem of sensors, machine learning, connected systems, and advanced technologies such as biometric security, smart airports can improve performance and asset management.

According to Williamson: "A smart airport sees problems before they happen. It adjusts gate allocations based on live conditions. It predicts how a schedule change will impact baggage. It balances capacity across terminals, not just checkpoints."

By planning for an airport to be a smart airport from the beginning, the design

can be optimised for tech solutions in a way that enhances the technology itself.

As Kaster iterates, smart airports aren't about having robots at check-in desks and AI integrated everywhere, it's a much more straightforward concept, using what the airport already has and ensuring it is reaching its full potential.

A big part of this is IoT devices, a term that encapsulates a network of physical objects that are fitted with sensors, software, and other technologies to exchange data. These can help airports to monitor systems, automate maintenance and allocate staff to high traffic areas in real time.

Katherine McKeever, Electrical Engineer at SSOE Group, says that with smart airports a key consideration should be cybersecurity.

"Airports are high-value targets, so protecting sensitive data and infrastructure has to be a top priority," she says.

FUTUREPROOFING AIRPORTS

Retrofitting technology is no easy feat, making futureproofing an essential part of airport design to prevent costly additions further down the line.

An example of technology impacting design is the upcoming Entry/Exit System (EES), which requires automated biometric border checks for non-EU travellers.

Incoming regulations such as this have a huge impact on airports, especially regional airports with limited space, and so EES has shown the value of anticipating these large-scale tech implementations.

Veovo considers its solution to be perfect for futureproofing with two core



Smart airports need to work to protect sensitive data and infrastructure. Image: Getty

factors: evolution and connectivity. The company's solution evolves with the airport, but also connects with new data sources (ground vehicles, sensors) and enables the operator to scale operations, simulate impacts, and make non-disruptive changes.

Copenhagen Optimization's software is also at the forefront of futureproofing, allowing airports to understand whether expansion is needed or how to change operations with their current resources with the ability to generate planning scenarios for forecasting decisions.

Kaster says: "Typically, we're approached when airports are already feeling the pressure of capacity constraints. But change is harder to implement once ways of working that might not be the most appropriate have become firmly embedded."

Looking ahead to advanced technologies such as autonomous passenger processing or robotics, Clint

Nous, Digital Lead of Aviation at NACO, says: "Their successful implementation depends on having a scalable and well-planned digital backbone. By designing with future adaptability in mind – through expandable utility routes, technical spaces with spare capacity, and provisions for future connectivity – it ensures that the airport remains responsive to technological advancements."

Ultimately, by creating a design that is scalable and flexible enough to handle unpredictable new technologies or regulations, airports build resilience into the infrastructure itself, and will save money and time in the long run.

As SSOE Group's McKeever concludes: "We always emphasise that technology isn't just a layer, it's a framework. When we integrate advanced systems into airport design, we're not just improving operations – we're shaping the entire passenger experience. But it's not just about the hardware, it's about how those systems talk to each other, how they're maintained, and how they evolve. We design with interoperability in mind, so airports aren't locked into one vendor or platform. That flexibility is what allows airports to stay competitive, responsive, and resilient in a rapidly changing industry." ■

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Clint Nous, Digital Lead of Aviation, NACO Consultants.



Building WSI: Smart airport design in the making

Western Sydney International (Nancy-Bird Walton) Airport (WSI) is currently under development. Designed to alleviate some of the traffic from the main Sydney Kingsford Smith Airport, it will offer 24-hour operations, a 10 million passenger capacity per year, and modern, sustainable infrastructure.

Simon Hickey, CEO of WSI, says: “We have brought together the best elements of airports around the world at WSI, setting a new standard for Australian and international airports and giving customers and airlines alike the benefits of proven technologies and processes.”

WSI was developed in partnership with Bechtel, an engineering, construction and project management company, while COX Architecture and Zaha Hadid Architects developed the initial design concepts. Multiplex and Woods Bagot handled the design and construction among other partners.

As Australia’s first greenfield airport in over 50 years, WSI is primed for the latest technology for an optimal operational and passenger experience, including a next-generation Vanderlande baggage handling system that allows passengers to drop off bags ahead of time, as well as a modern CAT III-B instrument landing system on

the runway that enables aircraft to continue operations in foggy conditions. Overall, WSI’s technology framework allows over 70 technology systems to communicate with each other.

Hickey says: “Our world-leading check-in and baggage handling approach means less time in queues, less risk of lost baggage and more choice around how and when passengers prepare for their flight. Technology like fine-tuned security screening and high-speed, accurate baggage tracking are all part of an end-to-end experience that’s more secure and efficient.”

The new airport will be the first in Australia to not have a traditional air traffic control tower, operating instead as a digitised aerodrome comprising 20 high-resolution cameras to monitor the airport and airspace and 3,000 aeronautical ground lights that are futureproofed for “Follow the Greens” wayfinding.

‘SUSTAINABLE BY DESIGN’

Flexibility is a big part of WSI’s design, especially with the placement of the terminal in the midfield area, allowing for room to develop additional terminal buildings in a modular way.

Equally, international and domestic terminals are co-located under one roof, enabling evolution for passenger demand

over time and permitting shorter transfers and shared facilities, such as baggage handling and check-in systems.

Some can even be shared using swing facilities, like boarding gates or security screening, to cover seasonal or daily peaks.

Hickey says: “We’ve also taken advantage of our unique opportunity to incorporate sustainability into every aspect of design and operation, including the future use of 100 per cent renewable energy. WSI was sustainable by design well before the first shovel dug into the ground. The way in which we have built a new greenfield airport today means we are ready for the challenges of tomorrow, and we’ve built in efficiency at every step to accomplish this.”

WSI is built upon and filled with sustainability initiatives, some of which include chargers for an all-electric ground services fleet, SAF delivery capability, an efficient airfield design that is expected to see taxi times of around five minutes, a 117-hectare Environmental Conservation Zone, and a terminal roof and external walkway canopies that can generate 4.5 megawatts of solar power and harvest rainwater for use in the airport.



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