THE THINKING BUILDING

APAC EDITION

A COMPLETE GUIDE TO SMART BUILDINGS

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Foreword

Dan Bennett

Director
Building Automation

How Thinking Buildings can benefit people, the planet, and portfolios.

There is a lot of buzz about ‘smart buildings’ and ‘smart cities’ and even smart states and nations. But with so much hype, it can be challenging to understand what it means in a practical sense.

Because while the bold, innovative new projects and precincts are on centre stage, improving our built environment and its human habitats means we need to optimise the 90 per cent of assets that are already built. Our new guidebook, **The Thinking Building**, goes behind the catchphrases to explore and explain the pathways for any building to smarten up its performance and improve the occupant experience.

Authored by two of our talented building automation experts in APAC – Annie Nguyen and Michelle Ganley – **The Thinking Building** tackles some of the common questions and misconceptions, drawing on the extensive expertise of Cundall’s global team of multidisciplinary engineers, building automation experts and sustainability advisors.

The central message is, any building can benefit from smart building innovation and approaches, if thought is given to the most pressing needs of occupants and what will deliver the best value uplift and return on investment for owners and facilities managers. Some possibilities might surprise you. For example, how using a QR code-enabled system can save time, improve security and make life easier for visitors and tenants.

There are also case study examples of recent projects that have effectively utilised building controls, AI, automation, and other clever solutions to take a building from ordinary greatness to extraordinary performance.

The book also gives readers a glimpse into the smart future of precinct-scale connectivity and net zero energy places, and explains how digital innovation will bring us there, perhaps sooner than you imagined. For portfolio owners, investors and masterplanners this signposts how being future-ready is both achievable and a wonderful opportunity to deliver more in the way of spaces, services and experiences while using less energy and resources to do so.

I trust you will find The Thinking Building an inspiring, helpful and practical guide to the future we are creating together.

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About this guide

Annie Nguyen

Associate
Cundall, Singapore

The explosion of technology, interconnectivity of digital devices, new agile ways of working, and an expectation from staff and consumers of 'frictionless' user experiences, have combined to accelerate the growth of smart buildings.

But what exactly is a 'smart' building?

> Smart buildings save energy by automating controls and optimizing systems. Whereas an upgrade to a single component or isolated system can result in energy savings in existing buildings that are otherwise inefficient.
>
> *King & Perry American Council for an Energy-Efficient Economy*

Michelle Ganley

Principal Controls Engineer
Cundall, Australia

References to 'smart buildings' and 'smart cities' have become so ubiquitous within the property and infrastructure sectors that it can almost verge on 'techwash'. You may find yourself wondering, what does 'smart' actually amount to in practical terms?

Whilst a 'smart' building doesn't necessarily mean an all-encompassing and obvious difference in how a building looks and feels, it can mean a building has all the digital bells and whistles that give it a virtual mind. This can mean an asset capable of automatically adjusting lighting, temperature, vertical transportation, security, and other building services. It can mean a building with Wi-Fi throughout, where even the desks and the coffee machines and the concierge are part of a connected Internet of Things.

Ultimately, we consider a smart building is one where people have made thoughtful decisions about incorporating technology to improve how a building operates and the experience of occupants.

Those thoughtful decisions include the use of appropriate, scalable, and effective digital and automation technologies that meet the objectives of the asset owner, building manager and, ultimately, the community within and around the building.

This guide is designed to explain what a smart building is, how it becomes smart and why this can be beneficial for the humans who own, manage and interact with these places. It considers the functional, environmental, and future-proofing aspects of technology-enabled assets and what the main considerations are in terms of design, delivery, commissioning and ongoing management. And finally, we take a look at how this concept applies on a mega-scale within the context of 'smart cities'.

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Contents

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The four stages of ‘smart’

Smart buildings are not an all-or-nothing proposition.

The evolution of a building into full technology-enabled capabilities is a staged process that starts with understanding how the building currently operates. From this position, a roadmap to improve the asset performance and the occupant experience – through the judicious integration of technology – can be created. This approach also looks ahead to the emerging future of technology and the transition to precinct, city, and even regional scaling of Smart assets.

But first, let’s start where you are right now.

STEP ONE

Smart ready

No matter what type of building, the first stage of making an asset smarter is undertaking a thorough audit of all the existing systems, including:

- heating, ventilation and air conditioning (HVAC)
- lighting
- water and gas metering
- building management system (BMS)
- energy management system (EMS)
- electrical power monitoring system (EPMS)
- vertical transportation
- fire protection
- security systems such as CCTV and access controls, and
- internet + communications (ICT) infrastructure.

> One thing we always advise to clients is it’s not about necessarily buying every sensor and buying every system from day one. But you should at least be setting it up that you’ve got the future capability to connect all these devices on to it.
>
> *Michelle Ganley*

A thorough audit will provide valuable insights to guide an understanding of **which** existing systems can become part of an interconnected and digitally-optimised building management system. From here, a roadmap begins to emerge of **what** technology or equipment will need to be installed, **how** this will be achieved, and a schedule of **when** it should be done.

Other important considerations of this first-stage step include:

- Ensuring all building systems can share data by auditing any existing sensor and control systems to validate they are using – or could use – an open protocol and be part of a converged network.
- For new buildings, major refurbishments or upgrades, ensure a tagging philosophy is developed and implemented for all systems to facilitate future connection into a unified smart building platform.

STEP TWO

Smart Integration

At this point, every individual system becomes part of an interconnected, coordinated whole that provides real-time insight for the building manager, facility management (FM) team and others. Each system is individually controllable from a central, digital building platform and/or dashboard, but also each element of building services can utilise automation to make building operations as seamless and efficient as possible.

This not only frees up time and focus for FMs, it also allows practices such as predictive maintenance, energy monitoring, regular performance verification and tuning, exception reporting and early fault detection to be more efficiently implemented.

For office managers and FMs, technologies like occupancy sensors and platforms connected via apps on devices enable them to see how space is being used. That is valuable insight to inform decisions ranging from furniture configurations and fine-tune cleaning regimes through to planning for recovering value from areas of a tenancy or a building that are currently rarely utilised.

Data within the smart systems platform can also be used to benchmark building performance for an Australian NABERS rating or Singapore's BCA energy efficiency rating system. Where the asset owner and/or tenants have strong ESG (Environmental, Social and Governance) policies and targets for achieving net zero emissions, integrated smart systems can also provide the data around building energy use-related emissions that is required for accurate carbon accounting.

People often wonder

Why should we invest in making our building smarter?

An important part of developing a pathway for making a building smart is calculating the expected return on investment. Metrics matter!

For example, the plan may estimate how much will be saved on energy costs if sensors and automated controls are added to the HVAC system so operation is tailored to actual occupancy and indoor conditions, rather than just being switched on for specific times and set points.

Given HVAC accounts for up to 50% of the energy use in a commercial building, and even small and simple smart systems can reduce that energy consumption by up to 50%[1], the math really stacks up.

STEP THREE

Smart Optimisation

Ultimately our built environment exists to provide places for people to live, work, shop, socialise, and heal. And the smart optimisation process puts the human experience at the centre of all assets. It includes functionality that connects people to aspects of the building they engage with such as vertical transportation, amenities, hospitality, hot desking allocation, shared vehicle bookings, and security arrangements.

It might include an app that workers in a building have on their device that checks them in when they enter the building and lets them order a coffee before they jump in the lift that automatically takes them to the correct floor. An app can reserve a personal locker and a workstation, book them into the building gym and let them give feedback on whether the office is feeling too hot or too cold.

STEP FOUR

Smart Future

Technology changes constantly, and it also generally becomes cheaper, faster and grows in functionality . We only have to compare the desktop computers of the 1990s with the notebooks accessing software as a service via the cloud we have in the 2020s to see how capabilities evolve.

The final stage of individual building smarts is ensuring they are future-ready for technologies that are already emerging such as quantum computing, artificial intelligence, cloud-control of assets, machine learning that supports operational feedback loops for continuous operational improvement, and full integration of building networks with wider networks such as smart transport networks, district microgrids, demand response, energy trading... and the technologies that have not yet seen the light of day.

This makes it important to use open access protocols for building smart systems. These are digital systems that can integrate across different platforms and software providers and ensure interoperability. They also position an asset and its systems to be able to evolve as technology does.

CASE STUDY

© ISG

This site occupies approximately 30,000 sqft and features a teaching area, office area, and school library. Using Building Information Modelling (BIM) as the catalyst, Cundall provided building services, IT/AV, acoustics, and security consultancy to achieve the clients' sustainability objects and COVID-19 health and safety requirements.

The challenge of COVID-19 was transformed into an opportunity to improve building operations and the functionality and user experience with elements such as touchless sensors for toilets and doors, UV sterilisers in the fresh air ventilation system and live streaming and recording systems. Used in integration with other IT/AV systems, this technology enabled agile remote teaching and learning options. Digital modelling studies on carbon emissions reduction and energy efficiency informed lighting and HVAC solutions, with the final optimised energy efficiency solutions including smart lighting control systems and scheduled HVAC operation via a Building Management System (BMS).

University of Wollongong College - Hong Kong

Australia's University of Wollongong expanded its global network by opening a new campus in Hong Kong.

> Our project teams in Australia and Hong Kong worked closely with the local UOW user group in order to align our design approaches. This involved hosting numerous workshops and presentations to monitor our progress and to log any risk items. These collaborative processes enabled our teams to meet our clients' ambitions by designing and implementing innovative solutions.
>
> *Joe Tang, Cundall*

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The business case for a smart building

Whilst the case for smart building features that reduce operational spend can be calculated with a reasonable degree of precision, it is harder to put a dollar value on an improved occupant experience.

Often the return on investment of those experiential building features gets queried during the new building design stage. However, it is worth noting that aesthetic and sometimes expensive architectural features which also improve the human experience are not challenged as frequently.

Research by Canada's Continental Automated Buildings Council (CABA) looked at the influence of smart building features on a major line item for many companies – staff retention and staff productivity. The research found that there is a clear link between the increased comfort experienced through features such as smart lighting control, thermal controls, ventilation and the level of productivity and satisfaction reported by both managers and workers.

People often wonder

How does smart translate to maintenance cost savings?

In a conventional building, the FM or building manager generally finds out a building service is not working properly because the fault is glaringly obvious. The HVAC stops working properly, the lift doesn't arrive or the lights are flickering.

Sometimes the fault is quick to diagnose, but this is not always the case, so the maintenance or repair trade spends costly time fault-finding even before the cost of repair goes on the bill.

Predictive maintenance uses the smart system of connected sensors and a central digital building analytics platform to detect and diagnose faults at a granular level, and often before a noticeable failure of the specific system occurs. This means targeted and timely maintenance can be undertaken - saving time, saving costs and saving inconvenience for occupants.

> The wrong environmental conditions can keep people away from work and can reduce their effectiveness when present.
>
> *CABA Intelligent and Integrated Buildings Council*

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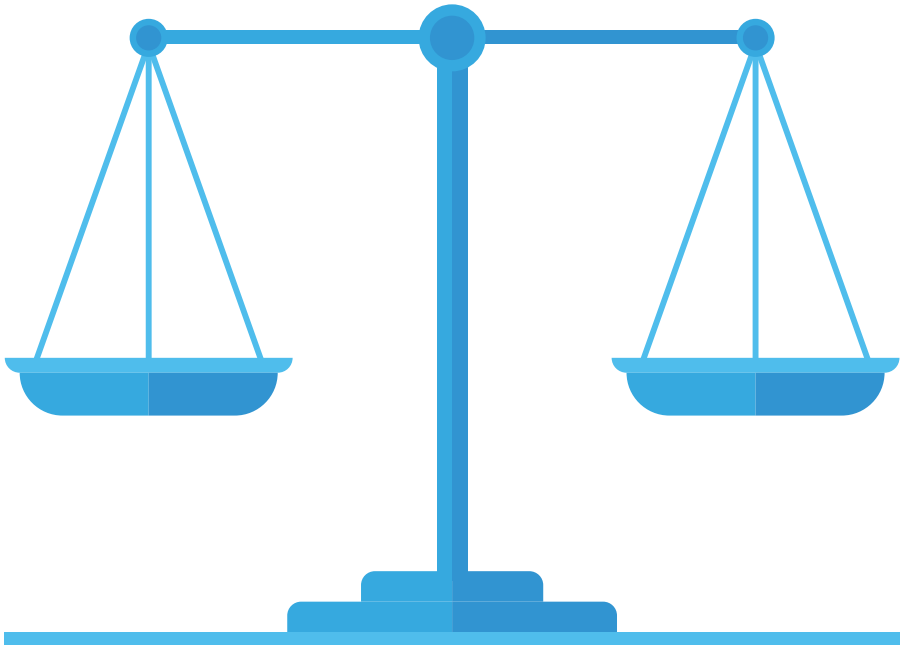
The business case for a smart building



As JLL noted in a 2017 white paper, Are Smart Buildings Smart for Business[iii], in a market where there is fierce competition to recruit and retain the best talent, smart building features are becoming a magnetic attraction. JLL points out that for asset owners, tenants that have happier and more productive staff are also likely to pay higher rents and remain in place for longer. All of which makes bottom-line sense.

A final piece of evidence comes from the Australian HR Institute's 2018 Survey of Turnover and Retention[iv]. It found that turnover of staff is rising, and that the costs of turnover to businesses can be substantial once the immediate productivity loss, payment of recruitment and on-costs, training and disbursement of departing staff's entitlements are added together. Dissatisfaction with the workplace environment can be a primary reason for someone to head out the door, according to respondents.

Some of the strategies these businesses reported using to slow the brain drain can be aligned with smart building features. These include health and wellbeing initiatives; improving work-life balance; facilitating flexible work arrangements and improving workplace culture.

> One way to look at the value proposition is to recognise the capex spend on smart features not only delivers an ongoing opex saving for energy and maintenance costs, it also adds value to the way occupants experience the building. In competitive markets like commercial property, retail and hospitality, tenants are coming to expect and value an enhanced building. So, the features that attract and retain tenants do, in fact, have a tangible bottom-line benefit.
>
> *Benny Cheah, Critical Systems Expert, Cundall Australia.*

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People often wonder

How do we decide what to do?

Deciding which smart features will deliver the best value for a building starts with talking to the people who own, operate and use the building, to find out what they need. The decision-making process is also different depending on when smart features are being considered. A basic decision-making matrix addresses some of the factors in this table.

When it happens	Who it benefits	What is the opportunity	The payoff
Base build design stage	Owner FM Occupants	Smart building strategy and smart elements in detailed design	Lower operational costs, enhanced building management, improved company brand, future-ready and increased asset value and rental returns
Fit-out design stage	FM Occupants	Smart features that enhance the occupant experience while not requiring substantial alterations to the base building	Lower energy bills, more productive and satisfied staff, a more customised office environment
Upgrade or refurbishment	Owner FM Occupants, current/future	Smart features that improve performance of HVAC, lighting, security, mobility and user experience	Lower operating costs and improved maintenance efficiency, increased building value and an optimised experience for occupants

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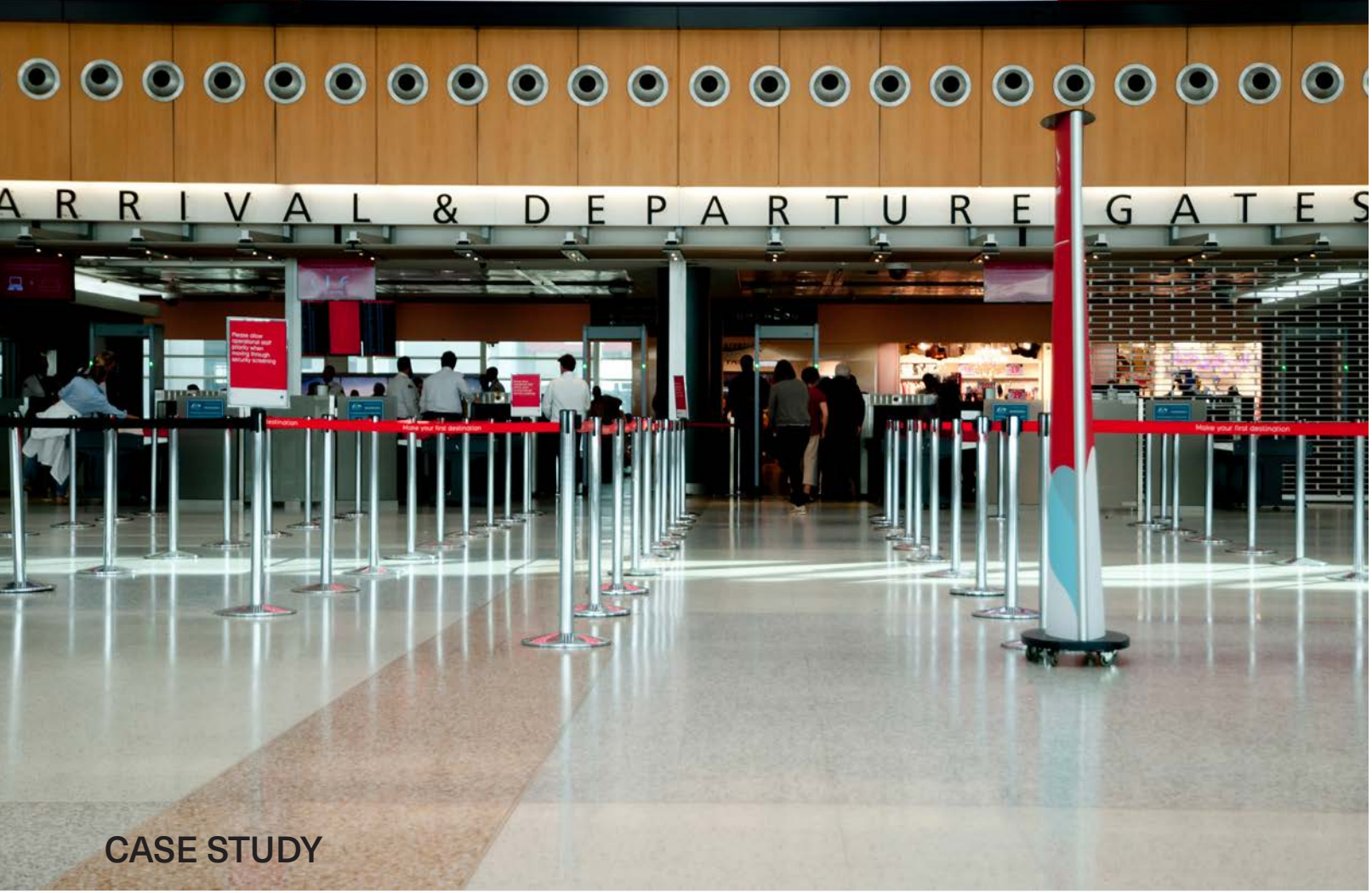

CASE STUDY

Seamless Traveller

Perth Airport was the prototype location for an advanced, high-technology approach to border control and enhanced passenger experience.

Seamless Traveller is the next generation of contactless passenger SmartGates and biometric border control processes. The intuitive and seamless technology enables Australian Border Force and airport security to utilise facial recognition technology to ensure persons of interest are directed to an appropriate location for interview whilst allowing low-risk passengers to efficiently pass through without queuing.

In designing building services and lighting for a world-first technology, Cundall applied a first principles approach to both spatial and operational aspects of electrical, fire systems, IT, communications. We also advised on HVAC modification and enabling of works for the final installation of SmartGates. High-level coordination was required with both Australian Border Force and Perth International Airport to ensure the successful implementation and delivery.

> Engaging in cross-disciplinary innovation to deliver something entirely game-changing is the type of challenge we relish as engineers.
>
> *Mohammad Ali*

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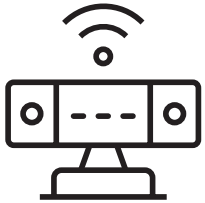
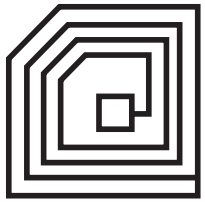
Demystifying the technology

There are many acronyms and buzzwords and tech-speak terms floating around in most discussions about smart buildings {and often loads of impressive-sounding adjectives}. You might wonder what do they all mean, and what is it they actually do?

Here is an explanation of the eight main types of technology involved in a smart building or smart precinct.

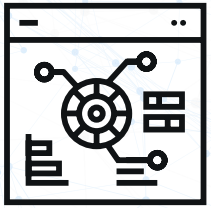


Sensors: sensors deliver feedback to the central Building Management System on aspects such as light levels, occupancy, energy use, CO_2 levels, water consumption, temperature, humidity, the presence of smoke, and the behaviour/operation of key components within building systems such as pumps within the HVAC system.



RFID tags: digital tags with Wi-Fi connectivity for loose furniture items and equipment that enables its use and location to be tracked and monitored via a digital, online platform. New Royal Adelaide Hospital, for example, has RFID tags on mobile trolleys and other medical equipment so the items can be quickly found by staff.

Building Operation System: coordinates all incoming data from sensors and building systems and automates building services and functions according to pre-determined rules; also enables direct control of building services. An important element of setting up the BMS for a Smart Building is the protocols for naming and tagging of systems and equipment. It is also optimal to use an Open Protocol system so a variety of technologies and software systems can easily be integrated. No-one wants a building that is confined to a single vendor's operating systems.



Platforms and dashboards: these are the human user interfaces and the cloud-hosted platforms and applications that seamlessly coordinate all data inputs and system command and control functions. They ensure all building Smart systems can communicate as necessary and by unifying every element prevent a kind of "Frankenstack" of technologies. Dashboards and platforms can be tailored and optimised for the needs and goals of the individual asset owner or manager.

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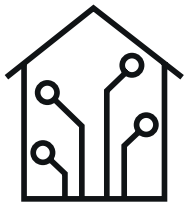
Demystifying the technology

People often wonder

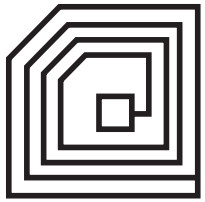
Can only new buildings be smart?

Any building of any age can become a smart building, and there are many advantages to adding some ‘brains’.

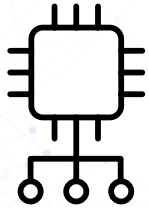
For example, an older building that gets a lighting upgrade that incorporates LED lighting, occupant sensors, daylighting sensors and a smart lighting control system that can be managed via an app or digital platform is likely to consume less energy that a conventional manual switch-based fluorescent office lighting system.



Internet of Things (IoT): This refers to the connected network of smart devices, sensors and control technologies that all communicate via the internet/Wi-Fi as part of an integrated whole.



Artificial Intelligence: Any non-human system that can receive information and then make decisions based on that information, or that codifies a body of data, information or knowledge in a logical and purposeful way is a form of Artificial Intelligence (AI). For example, an interactive map, a Google Nest and an automated lighting system that dims in response to the amount of daylight in a space are all forms of AI.



Machine Learning: This type of information architecture enables a platform or software package to make changes to its operations or information processing outputs based on what data and information it takes in. A good example is the way auto-suggest on a smart phone will start suggesting words the device owner uses frequently, even if they are not part of the original dictionary. On a building scale, this might mean HVAC system controls adjust automatically to the occupancy patterns within a tenancy over time.

Analytics: Having streams of real-time data on energy use, indoor environment quality, water consumption and occupancy patterns is only part of the Smart story – the other part is establishing data frameworks and functions that make that data meaningful and useful for the asset owner, managers and technical staff. Analytics is both the human process of investigating data to find the useful information, and also the IT architecture process of ensuring the right data goes to the right place to generate the desired information.

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IQVIA (Quintiles) Shanghai Fit-out

Sensor-enabled building systems contribute to achieving LEED Platinum.

IQVIA (formerly Quintiles), the world's largest provider of biopharmaceutical development and commercial outsourcing services, relocated its regional headquarters in Shanghai to Fenglin Life Science Park. The project comprised over 4,000 sqm of commercial space spanning two storeys and was designed to provide exceptional quality workspaces for 450 staff. The final fit-out achieved LEED-C1 Platinum Certification.

The design of the building services and incorporation on smart building features to enhance operational efficiency and the occupant experience were instrumental in attaining the world-class sustainability rating. Specific initiatives include a high efficiency VRV (Variable Refrigerant Volume) system with advanced automated occupancy controls, and LED lighting linked to smart occupancy and daylight sensor controls.

> Achieving the world-leading sustainability benchmark of LEED-CI Platinum is an important reflection of our how technology is key to facilitating leading sustainable outcomes.
>
> *Joe Tang, Cundall*

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Digital twins

According to the global Digital Twin Consortium, “a digital twin is a virtual representation of real-world entities and processes, synchronized at a specified frequency and fidelity.”

In plain language, this means a Digital Twin integrates all the relevant location, spatial, building systems and occupant data in real-time to give a complete picture of how a building is operating at a very detailed and granular level.

> A digital twin utilizes spatial data to provide the core framework, equipment and engineering data to understand the systems, and IoT with sensors to capture real time data. This enables the physical building to adapt to human needs, instead of the human conforming to the building’s limitations.
>
> *CABA Intelligent and Integrated Buildings Council*

People often wonder

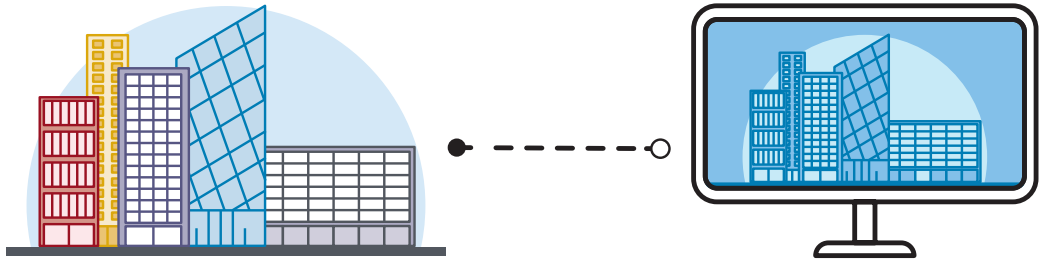
Can everything in a building be automated?

The brief answer is yes. But the real question is do people actually WANT everything automated?

In our experience there are some things people prefer to do for themselves or to have control over. For example, while automated blinds control solar glare and heat entering an office might sound like an excellent idea to reduce the amount of HVAC used to keep cool, many people appreciate having the view outside when they are working. Automating blinds might be a better choice for rooms that are only infrequently used such as private meeting rooms, to reduce the amount of pre-cooling needed before it gets used.

On the other hand, most people are happy to have smart features like contactless taps and flushing amenities, smart access controls that negate the need for keys or key card and the destination-controlled lifts that reduce waiting times.

Another approach is to incorporate use smarts to improve individual control via the digital twin or smart building platform. For example, an app that building occupants have on their device that allows them to customise lighting intensity and temperature in their personal work zone.



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Digital twins

The information provided by a digital twin and accessed through tools including a building management and operations dashboard, can tell a Building Manager (BM), for example, that there are currently high CO_2 levels in the main boardroom. It can also tell the BM that a meeting is due to commence in that room in 30 minutes time, and that the reason the CO_2 levels are too high is the ventilation system has not been working at optimum efficiency. The BM can then take appropriate action to:

- contact someone to open windows to flush the air in the room before the meeting
- instruct the ventilation system to increase fresh air flow into the room
- call a repair technician if the twin data shows the air handling unit isn't working due to a parts failure
- alert the occupants that they may wish to change the venue for the meeting.

A digital twin platform can also help the BM, FM or others see when a tenancy or common area is experiencing repeated building services issues, and if so, which part of the building services system is most likely to blame.

This data streams in real time from a network of sensors installed within building services including lighting, hydraulics, HVAC, security, IAQ monitoring and so forth that communicate via the building's wireless network as part of a connected Internet of Things in the building. The sensors can deliver data including energy consumption, water consumption, temperature, CO_2 levels, level of daylight, space occupancy, lift movements, current generation of any installed renewable energy technology, EV charging use, and so forth.

In an extremely detailed twin, other information within the platform might also indicate who installed a system, who designed it, its warranty period, recommended maintenance, supplier of the original parts and previous repair and/or maintenance activities.

The point here is that a digital twin can be as detailed as the asset owner or building design and operations team need it to be.

PHYSICAL ASSET

INFORMATION

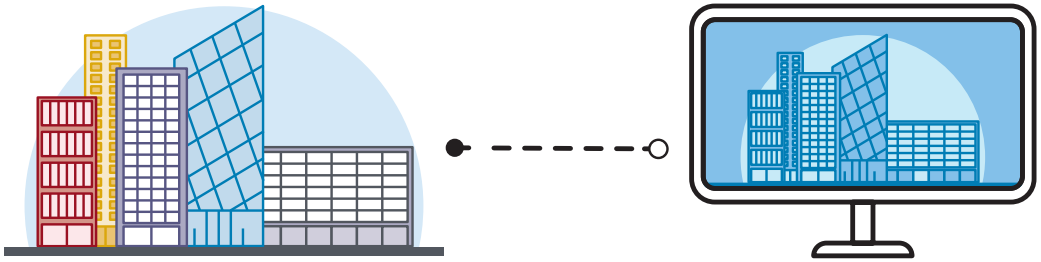
Asset tags
Work orders
Maintenance records
Inspection records

OPERATIONS

IoT feeds
Sensors
Drones
Cameras
LiDAR
Point clouds

ENGINEERING

Specs
Drawings
Documents
BIM models
Analyses
Geotech
OEM specs



DIGITAL TWIN

AI/ML

Analytics visibility

4D

Timeline of change

3D/XR

Immersive visualisation

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CASE STUDY

Entry-level smart for seamless visitor management

Scanning QR Codes is familiar to most of us now, thanks to Covid check-in requirements, however, they can also be an extremely nimble smart building technology.

Here's how it can work:

Imagine someone has an appointment or is attending a meeting in your building. As part of the invitation or appointment confirmation, they are sent a QR code. If they are driving, this acts as a time-bounded pass to the carpark, and the system behind the QR code guides them to the closest and most convenient free parking spot. It also notifies reception and the staff member the person will be liaising with that the visitor has arrived.

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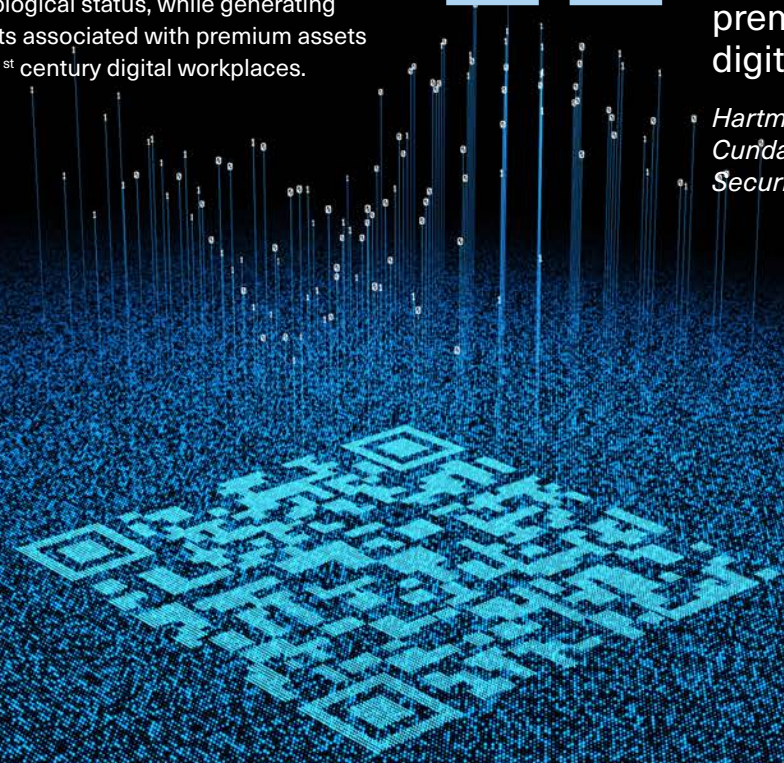
CASE STUDY

The system then guides the visitor towards the right entry, and there is no further security check-in required as the QR code has established their credentials and identity. When the visitor arrives at reception, they can be greeted by name, making for a vastly improved and more personal (and professional) start to the encounter. If someone arrives via public transport or on foot, a QR code reader at the public entrance can also serve to alert the relevant personnel the visitor is on their way.

From a building security perspective this system also helps address the liability aspects of being aware of who is in a building at any given time. Asset owners, FMs and individual tenants also have a duty of care for those on their premises – and in the event of an emergency, knowing exactly who is in the building is critical to ensure safe evacuation of all persons.

The best part from an asset owner or building manager perspective – there is very little hardware required beyond a QR code reader. The functionality of the system is based on open-protocol platforms and dashboards that can reside on the same platform that controls all the other building systems including video management systems (CCTV), lighting, other access controls, fire protection and fire/smoke detection.

So, this is a smart approach that can be introduced to any building of any age or technological status, while generating benefits associated with premium assets and 21st century digital workplaces.



> This is a smart approach that can be introduced to any building of any age or technological status, while generating benefits associated with premium assets and 21st century digital workplaces.
>
> *Hartmut Kraft,*
> *Cundall Lead Consultant,*
> *Security, Singapore*

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Security and data sovereignty

Developing a robust cyber security strategy is essential for Smart buildings, along with processes and protocols that ensure it is adhered to throughout operation. Sometimes people think an Open Protocol system is somehow vulnerable, but they are as capable of being secured as a proprietary software system.

One of the crucial parts of the security strategy is ensuring all systems including the BMS are kept up-to-date so all relevant security patches are current and functional. There also needs to be a system that firewalls the building Smart systems from tenant or occupant business systems, so any cross-system incursions or security breaches are prevented.

Another common concern is the “single point of failure”, that is, whether one element within the system malfunctioning can cause every system in the building to grind to a halt. Robust system design, commissioning and maintenance ensures this cannot occur. More broadly, ensuring the control systems are resilient is aligned with overall building resilience in that ensuring uninterrupted power supplies is vital.

This matters even for conventional buildings in the event of a blackout or other event to ensure emergency lighting, fire protection, vertical transportation and access control systems remain operational. Options include on-site renewable energy storage with automated switching capabilities, back-up generators and other fail-safe equipment.

> Cyber security should be the first consideration when designing a digital building platform. In fact, creating a cyber-security policy and program, before selecting any hardware or software providers, should be the priority.
>
> *Michelle Ganley*[vi]

> Cyber security is a major concern for owners and asset operators, and is always front and centre from the outset.
>
> *Michelle Ganley*

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The Smart Precinct

There is already a shift underway to apply the same smart buildings methodology on a much larger scale such as a precinct, a city or even an entire region.

At the precinct level, Curtin University is developing a smart Masterplan for its Bentley campus that is putting it on track to achieve net zero for energy and carbon. The 30-year plan does not only include the buildings, it also embraces enhancements to the safety and sustainability of public spaces and universal accessibility including autonomous electric buses for transport.

At the other end of the scale, the ASEAN Smart Cities network that launched in 2018 is bringing together 10 ASEAN Member States in a collaborative knowledge-sharing and capacity building partnership to advance the implementation of smart approaches to buildings, precincts, transport, services and the human urban experience and quality of life.

> The ASEAN Smart Cities Network provides the sort of open platform needed to drive the smart city agenda. Cities find it quite useful, especially as Singapore has been able to draw in several first rate partners. Different cities are at different levels of developments and "smartness" and ASEAN's diversity is well suited for such a network that allows for cities to learn from one another.
>
> *Taimur Khilji, United Nations Development Programme (UNDP)*[vii]

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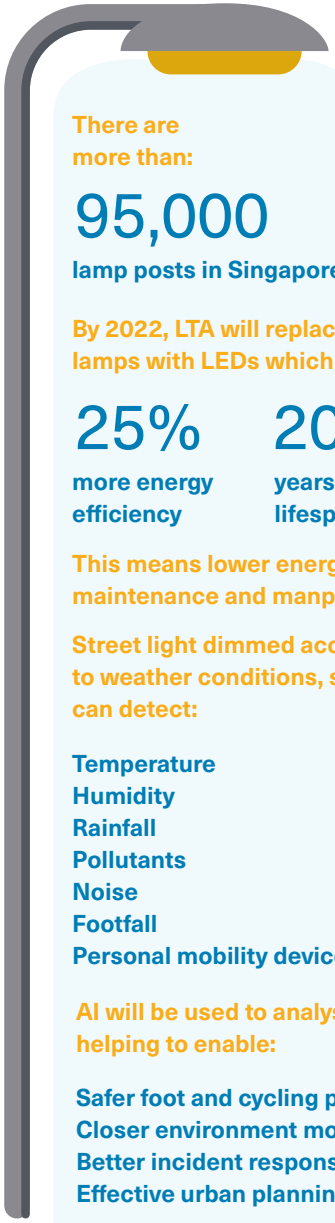
The Smart Precinct

Research by the CRC for Low Carbon Living has identified ways in which Precinct Information Modelling (PIM) can improve operations, add value and deliver measurable benefits in resource efficiency. It brings together the spatial information associated with the built forms and locations of things such as roads, energy infrastructure and water infrastructure into a platform that also incorporates live data from energy monitoring, mobility data such as public transport trip records, water supply monitoring, temperature and so forth. As the old saying goes, what gets measured can be managed.

So those data streams can reveal where investment needs to be made or management practices improved. It can provide the data to quantify the impact of an initiative such as supplementing local renewable power supply or installing storage. A network of IoT sensors can also enhance stormwater management by enabling automated discharge from rainwater harvesting tanks ahead of a rain event to create additional capacity for runoff, or mobility data may indicate where additional shared low-carbon transport such as autonomous electric buses could be most productively deployed.

The smart precinct approach can also facilitate innovations such as district heating and cooling, peer-to-peer blockchain energy trading, automated waste recycling systems and improved human experiences such as enhanced security, or combining street lighting with public Wi-Fi, smart wayfinding and better emergency responses.

> A PIM provides the means for more efficient procurement and development, but more importantly much enhanced operations and management based on the integrated data gathered over the procurement and acquisition processes and fed by continuous data collection in operation. PIM provides a precise data framework linking objects to performance.
>
> *Newton and Taylor (2019)*[viii]



Smart lamp posts for a brighter future

There are more than:

95,000

lamp posts in Singapore

By 2022, LTA will replace all street lamps with LEDs which are:

25%
more energy efficiency

20
years average lifespan

This means lower energy, maintenance and manpower costs

Street light dimmed according to weather conditions, sensors can detect:

- **Temperature**
- **Humidity**
- **Rainfall**
- **Pollutants**
- **Noise**
- **Footfall**
- **Personal mobility devices**

AI will be used to analyse data, helping to enable:

- **Safer foot and cycling paths +roads for pedestrians**
- **Closer environment monitoring**
- **Better incident response**
- **Effective urban planning**

As part of Singapore's Smart Nation rollout, in 2019 the government started installing sensors on the nation's approximately 95, 000 public lamp posts. The sensors collect data on temperature, air quality, rainfall and footfall and this will be used to inform urban planning measures including making footpaths safer.

At the same time, the government began concerting all luminaires in the lamp posts to LEDs and understanding local climate change impacts, which will cut energy use and associated energy costs by around 25% plus the lightbulbs last around 20 years, cutting maintenance costs.

A smart control system is also being installed that will enable lights to be dimmed or brightened in response to weather conditions.

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> We have only begun to scratch the surface in what we can achieve as an industry when it comes to analysing data and applying data-driven approaches to how we design, construct and operate our low carbon buildings of the future.

Gavin Bonner,
Cundall Digital Engineering Lead

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Making it happen: what smarts and where?

The first question for any Smart building or Smart precinct scoping plan is, “what do you need it to do?”

> The development of Smart approaches requires a close collaboration with all stakeholders, so we can develop the system requirements that best fit the client.
>
> *Annie Nguyen – Controls Lead, Cundall*

As we said at the outset, thoughtful design that puts the needs of the owners, asset managers and occupants at the heart of decision-making is the starting point.

Then the planning process considers where the best opportunities are for technology and digitisation to deliver quantifiable gains in relation to energy efficiency, reducing carbon emissions, improving indoor air quality, streamlining building operations and management, and enhancing occupant experience.

Constraints also need to be considered.

For example, some asset owners or tenants may have specific considerations that such as security needs or privacy needs that make systems such as shared access controls or integrating CCTV within the lighting unsuitable.

A lifecycle approach to implementing ‘Smart’

Choice

Engagement

Efficiency – business case, scoping, installation, commissioning

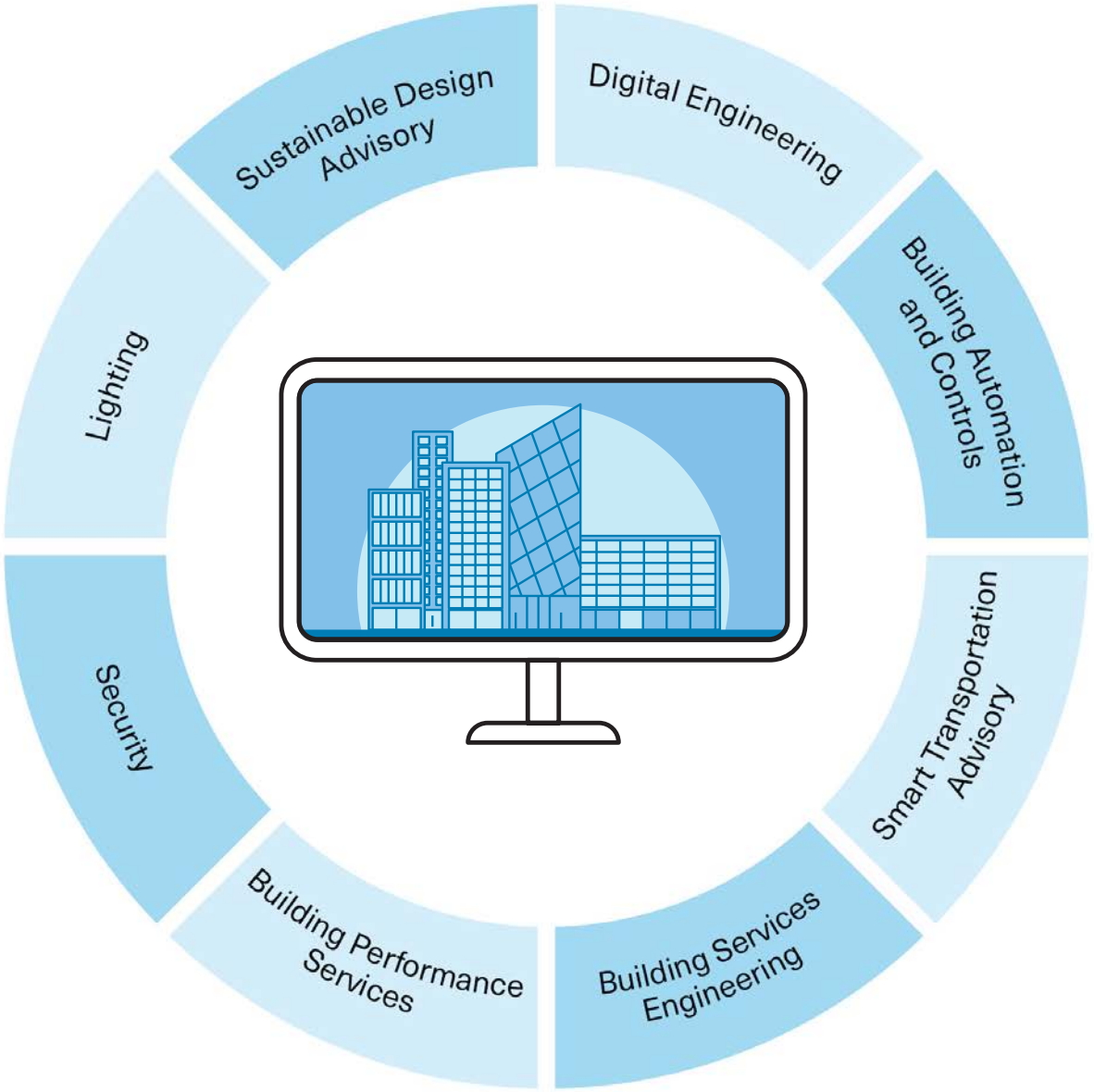
Navigation – post-commissioning support; documentation

Post-occupancy Evaluation and ongoing performance verification/tuning

Important considerations

1. Platforms and dashboards must be user-friendly and intuitive, supported by clear documentation and backed by on-call technical expertise.
2. Smart system design needs to be considered in conjunction with climate change future-proofing, resilience and occupant safety and wellbeing.
3. Technology needs to be robust and verified as meeting applicable standards and codes.
4. The Building or precinct ICT infrastructure must be fit-for-purpose – the WIRED Score and SMART Score rating systems can be used to benchmark ICT and Smart building systems for functional building systems purposes and for the degree of connectivity available for occupants and visitors.

Cundall APAC Smart Buildings holistic approach



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About the authors

Annie Nguyen

Annie has over a decade of experience in the design, delivery and commissioning of specialist control systems, automation, and AI applications in the built environment. What fascinates Annie is finding ways to enhance how things work, creating solutions that reduce energy use, streamline user experiences and optimise the performance of places and assets.

As Cundall's Building Automation lead in Asia, Annie has contributed her expertise to a range of demanding projects including bespoke new developments, large scale data centres and smart building upgrades for existing properties.

> I always consider how micro details at an asset level are converging with macro trends such as Smart City and Smart Nation policies. This then informs meaningful, innovative and practical advice to our clients.

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Michelle Ganley

Building on her qualifications in electrical engineering, Michelle is a controls and automation specialist who has worked on complex projects including the London Crossrail project and Facebook data centres in Odense (Denmark) and in Singapore.

As a Principal Engineer working from Cundall's Melbourne Office, her talent for design and commissioning of open-protocol smart asset operations systems are instrumental for the integration of multi-disciplinary building services engineering innovation within a smart building architecture.

> My experience with BMS controls, PLC controls and analytics platforms allows me to develop use-cases and smart pathways for existing buildings. For our clients, this means improving their asset performance into alignment with WIREDScore and SMARTScore frameworks.

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About Cundall

As multi-disciplinary engineers and sustainability consultants we see how the relationships between people and places can be improved through integrated innovation.

Smart building approaches are part of our core business: we enhance how buildings function and optimise the experience of those who live, work, play and stay in them. Our teams collaborate across the globe to find ways new and existing buildings, precincts and portfolios can perform better, use less energy, and reduce the impact of our built environment. We were the first global engineering consultancy to achieve carbon neutral certification – our aim is to bring every client along on the journey to a net zero world.

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