

# **BUILDINGS OF THE FUTURE**

*Science fiction  
or science fact?*



# Welcome to the future

The world is changing at an exponential rate and science fiction is fast becoming science fact. We are moving toward an increasingly digital, interconnected society and with it comes the realisation that everything we know will change.

Compared to other industries, the built environment has been slower to react to this change. In some ways, we've been in 'catch-up' mode, clutching tightly to the 'status quo'. The reality is that operational and construction functions, activities and experiences, as well as expectations around performance are evolving and so too must the built environment. Disruptive technologies are also driving home the fact that we cannot predict the future, but we can ask the right questions.

To better understand how we can help our clients anticipate the journey towards Buildings of the Future, we spoke at length to a broad group of professionals across the built environment to imagine what Buildings of the Future might look like

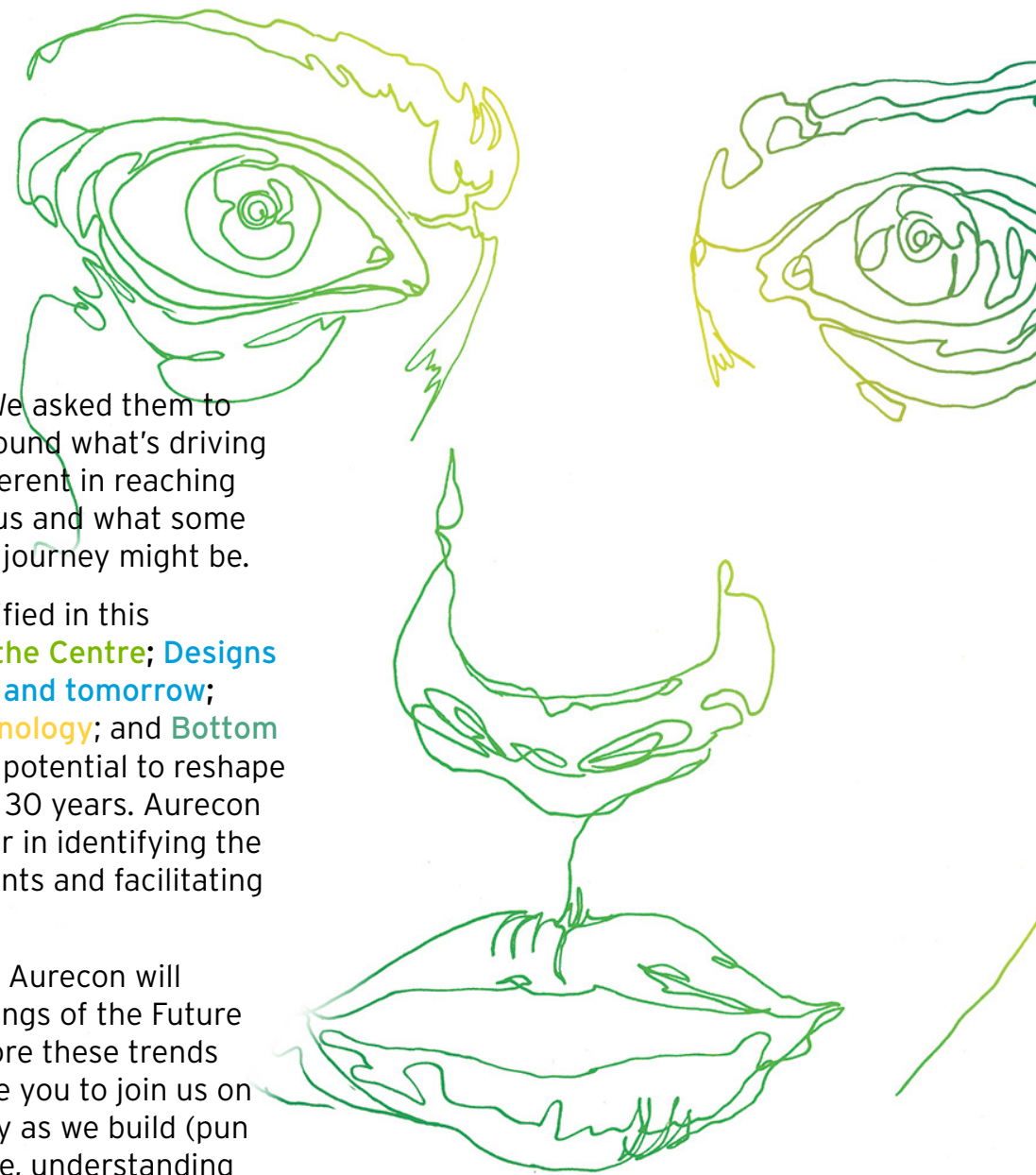
and might be created. We asked them to share their thoughts around what's driving demand, challenges inherent in reaching Intelligent Building status and what some of the next steps in this journey might be.

The major drivers identified in this eMagazine - **People at the Centre**; **Designs that make sense today and tomorrow**; **Easy life: complex technology**; and **Bottom line benefits** - have the potential to reshape our industry in the next 30 years. Aurecon wants to be a forerunner in identifying the opportunities this presents and facilitating these changes.

During the coming year, Aurecon will deliver a series of Buildings of the Future eMagazines which explore these trends in more detail. We invite you to join us on this journey of discovery as we build (pun intended) our knowledge, understanding and readiness.

**James Bennett**  
Managing Director  
Built Environment

**Peter Greaves**  
Buildings of the Future  
Leader



# People at the centre

## It's about people, not buildings or technology

Buildings of the Future will know how many of the workforce are in the building at any one time, and adjust services accordingly. Advancements in monitoring and security, building management system apps, information screens, WiFi, automated elevators, lighting and air conditioning will mean that services are adjusted before the worker even steps out of the Building of the Future elevator. Buildings will 'self-tune' on a continual basis.

Yet with the digital age upon us, it's important to remember that technology is not only about hardware or software, but about people. **Among the bits and bytes, let's not forget the flesh and bones.**



## Not technology for technology's sake

Critically, it is not technology that is driving change: it is how people are using Buildings of the Future, supported by technology, robotics, automation, new materials and new approaches to energy creation, use and storage.

Technology must have a purpose and remaining focused on the needs and expectations of your tenants and their workforce is key.

"INTELLIGENT BUILDINGS WERE ALREADY BEING TALKED ABOUT 30 YEARS AGO. THERE WAS A NIRVANA OF INTELLIGENT BUILDINGS THAT KNEW WHERE YOU SAT, WHICH FLOOR YOU WANTED TO GO TO AND WHERE LIGHTS SHOULD COME ON AUTOMATICALLY. IT WAS ALL POSSIBLE, BUT LABOUR INTENSIVE AND HARD TO MAINTAIN. THESE DAYS IT WOULD BE EASIER, BUT IRONICALLY THE WORKPLACE DESIGN HAS OVERTAKEN IT: THESE DAYS MANY WORKERS DON'T HAVE A DEFINED DESK OR LEVEL TO GO TO."





"THE WORKFORCE TODAY IS MOBILE. TASKS HAVE CHANGED AND THE WAY WE WORK NOW IS DIFFERENT FROM THE PAST, AND WILL CHANGE AGAIN IN THE FUTURE."



### Responding to a mobile workforce

Buildings of the Future would also do well to recognise that tomorrow's employee (particularly millennials) will be mobile. Increasingly, employees will value mobility, flexibility and remote connectivity to work. To support this, we'll see the continuing rise of collaborative technologies (including virtual and augmented reality), a shift to 'the cloud' and changing behaviours shaped by social media and mobile telephones.

In addition, we will also have to consider changes in transportation such as the advent of the autonomous vehicle or even car drones and how building design will accommodate these technologies.

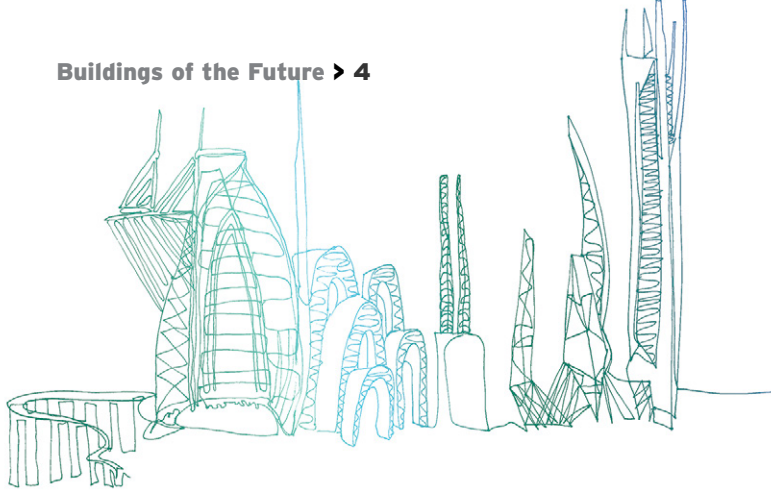


### Buildings of the Future, in particular offices, will be characterised by:

- **The sheer variety of spaces they offer** – including facilities for agile working, sitting and standing meeting rooms, creative spaces, coffee shops, couches, training areas, gathering areas as well as standard carrels.
- **Social context will also come into play** and buildings of the future will need to also cater for needs such as crèches.
- **Enhanced understanding of staff utilisation of space** – tracking staff to better understand the use of space and high traffic office areas will allow for a more agile work environment, drastically reducing inefficiencies in space, energy and workplace design.
- **On-demand services** – knowing where your building occupants are located gives rise to exciting possibilities, include on-demand ventilation, heating, ventilation and air conditioning (HVAC), lighting control, room bookings, emergency evacuation management, rental of space based on time used and greater sharing of spaces. Possible methods of measuring this includes WiFi tracking of connected devices, workstation login, card readers, occupancy sensors and beam counters.

The challenge for those in the building industry will be to respond to the changing requirements of tenants faster than ever before and to ensure our design of Buildings of the Future keep pace.



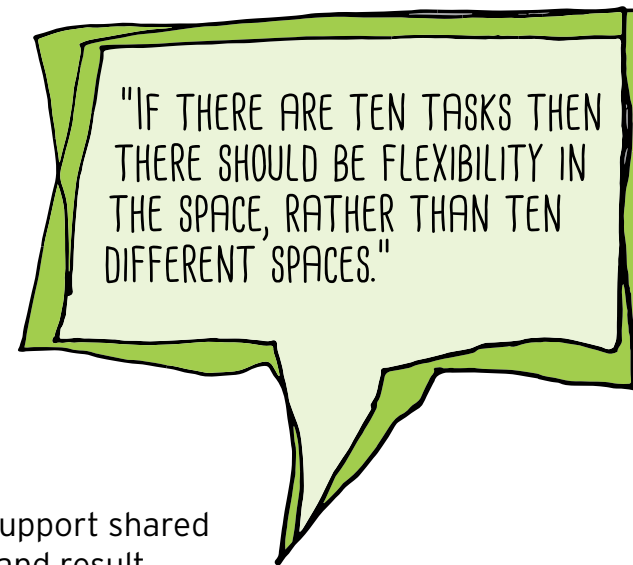


### Learning to share

Increasing mobility leads to the question: do tenants really need a large amount of space all of the time? The rapid rise of the shared economy through companies like Airbnb and Uber are set to become mainstream in the property industry too.

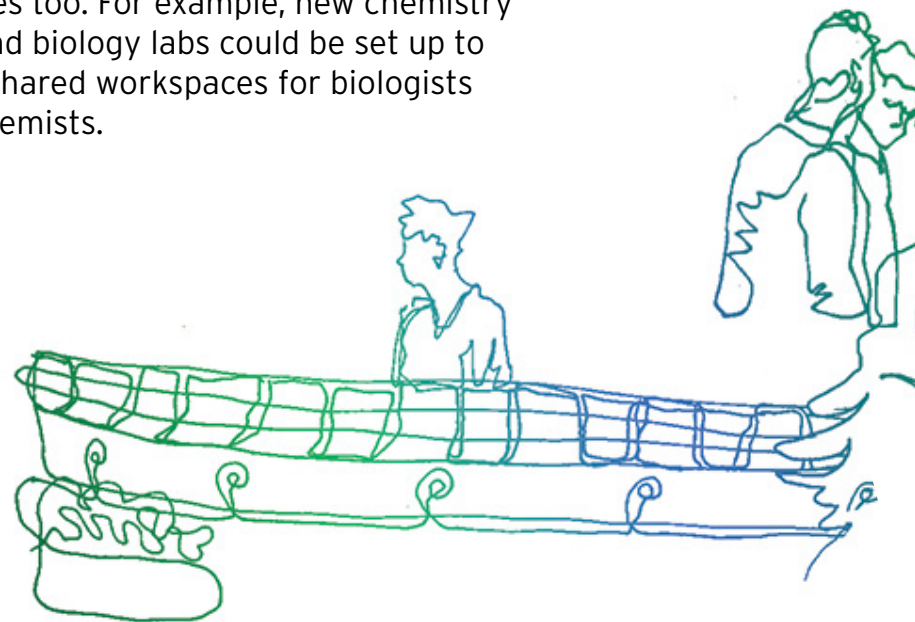
It's already common for small businesses to share office spaces, seating arrangements, leases, building layout and buildings maintenance, but there is potential to further expand the concept. In future, we might see smaller tenancies, but larger facilities; or end-to-end solutions where services and staff could be shared between environments and companies.


"NOW DAYS, WE ARE LOOKING TO CONTROL SYSTEMS REACTING TO THE PRESENCE OF A PERSON JUST BEING IN THE BUILDING, RATHER THAN SUPPORTING ONE PERMANENT LOCATION."



Buildings of the Future will support shared infrastructure and services, and result in better utilisation between companies, tenants and individual users.

This approach could work for educational facilities too. For example, new chemistry labs and biology labs could be set up to allow shared workspaces for biologists and chemists.





"WE MUST ACCEPT THAT IN PUBLIC BUILDINGS WE ARE RUN BY ECONOMIC FACTORS. PEOPLE, HOWEVER, HAVE BECOME MORE AWARE OF THEIR RIGHTS, SAFETY, HEALTH AND COMFORT REQUIREMENTS. WE ARE THEREFORE FORCED TO TAKE PEOPLE AS THE PRIMARY CONSIDERATION IN OUR PLANNING AND DESIGN: IF WE DON'T, WE WILL LOSE FINANCIALLY AND ECONOMICALLY."



"WE ARE SEEING A CHANGE IN TENANT DEMAND TOWARDS BUILDINGS THAT SUPPORT GOOD ENVIRONMENTAL PRACTICES AND AMENITIES."

### **I know what I want (and I want it, now!)**

If end-user behaviour has changed, so has end-user expectation. A future in which a facilities manager is required to provide live feeds about the performance of a tenant's building isn't far off.

Coupled to this, their environmental expectations have also increased. Today's tenant is environmentally savvy.

Tenants are increasingly interested in the details of shadow plans and their effect on solar energy capture, buildings that can exist off the grid, the provision of energy battery storage technology, developing self-sustaining ecosystems within their Building of the Future and opportunities to share power between buildings.

"BUILDINGS DON'T EXIST IN ISOLATION OF THEIR PRECINCT OR THEIR COMMUNITY. INTELLIGENT BUILDINGS OF THE FUTURE WILL BE INTEGRATED AND MORE EFFECTIVELY CONNECT WORK SPACES WITH LIVING SPACES (WHETHER THAT BE PHYSICALLY OR VIRTUALLY)."

Importantly, our environmental focus shouldn't be limited to our single buildings. No building operates in isolation and Buildings of the Future will need to integrate with the broader community. Smart buildings within a smart precinct will be the focus.

In future, innovative city management will form an alliance with major developers to drive smart precincts, and will require the right data, people movement monitoring and legislative frameworks.





## WHERE ARE WE HEADING?

**Aurecon sees this as a key opportunity for the built environment to develop shared services in facilities management. The first movers will be those who create building maintenance hubs. These hubs will be designed to provide facilities for all local buildings to centrally monitor electricity, water, energy production, common areas and integrate other aspects of maintenance.**

### WHAT SHOULD WE BE ASKING?

- AS ROBOTICS AND AUTOMATION ADVANCES, HOW WILL THIS SHAPE THE DESIGN OF BUILDINGS OF THE FUTURE? WILL WE STILL NEED AS MANY 'OFFICES'?
- WHAT WILL THE ENERGY SOURCE FOR BUILDINGS OF THE FUTURE BE? HOW WILL WE STORE IT? HOW WILL THIS ENERGY BE INTERCONNECTED?
- HOW WILL "ROSIE OR RAUL THE ROBOT" BE REALISED?



## Designs that make sense (& cents) today AND tomorrow

There is a growing call to ensure that the innovations we apply to Buildings of the Future today make sense tomorrow.

### Design trumps technology

At the heart of a Building of the Future is great design. Technology is the supporting act to design and one of the important tools that we use to achieve our aims, but it is great design that helps make optimal choices about technology solutions.

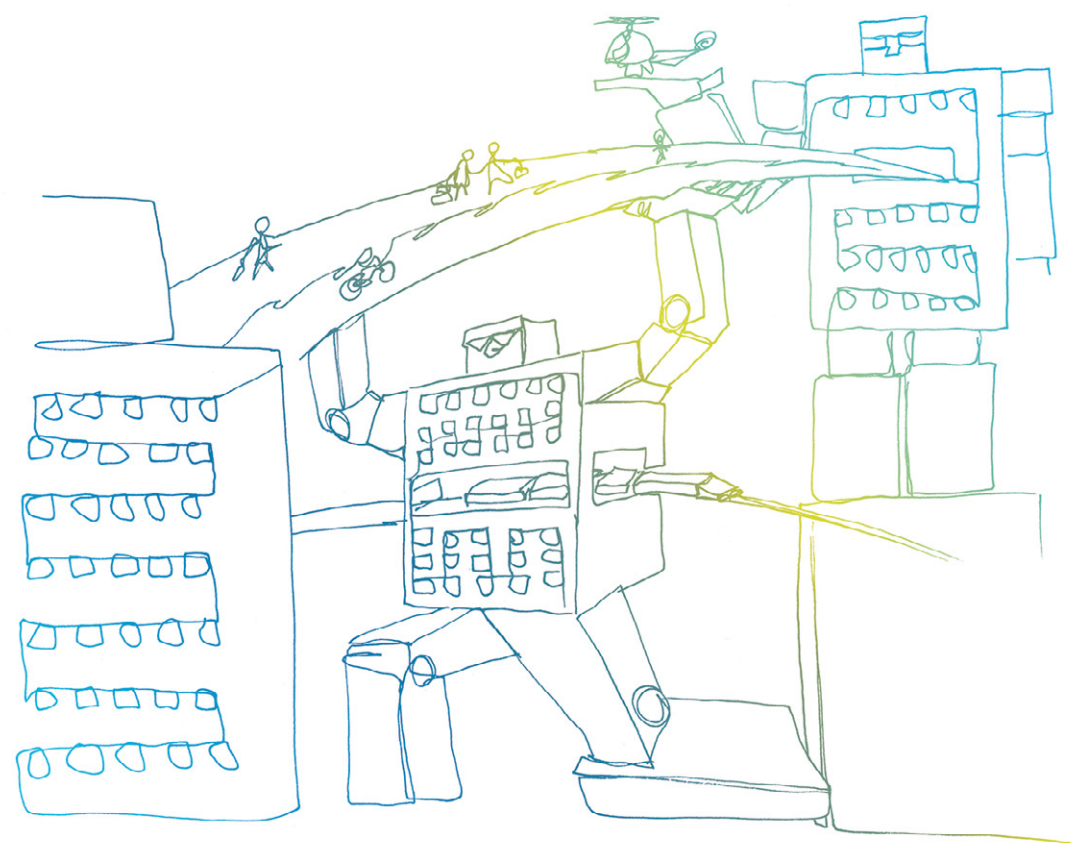
Designing Buildings of the Future will require a carefully considered balance between user experience and fit-for-purpose technology.

"THE EXPENSE OF CREATING ONE-OFFS IS A BARRIER. [WE SHOULD]... FOLLOW A 'FLAT PACK' APPROACH TO DESIGN, AS WE HAVE SEEN IN THE CAR INDUSTRY."

There are rising concerns that built-in technology will be out of date by the time it is constructed or, at least, by the time that a ten-year lease expires. To combat this, designing with flexibility in mind is key.

In future, we may see Buildings of the Future being mass-designed with flexibility in mind. Buildings of the Future will no longer be rigid structures that can't change: by design, they will adapt and their spaces will be adaptable without significant building modifications.

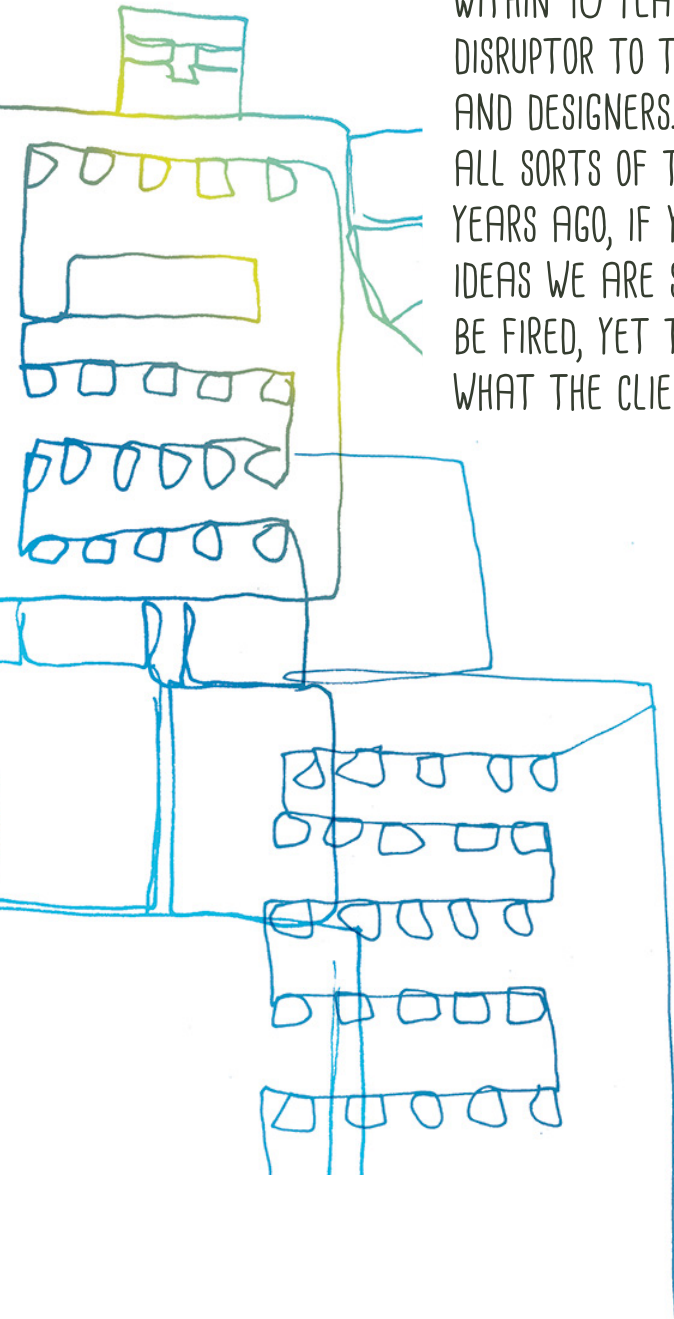
This could give rise to a greater degree of modular or off-site construction



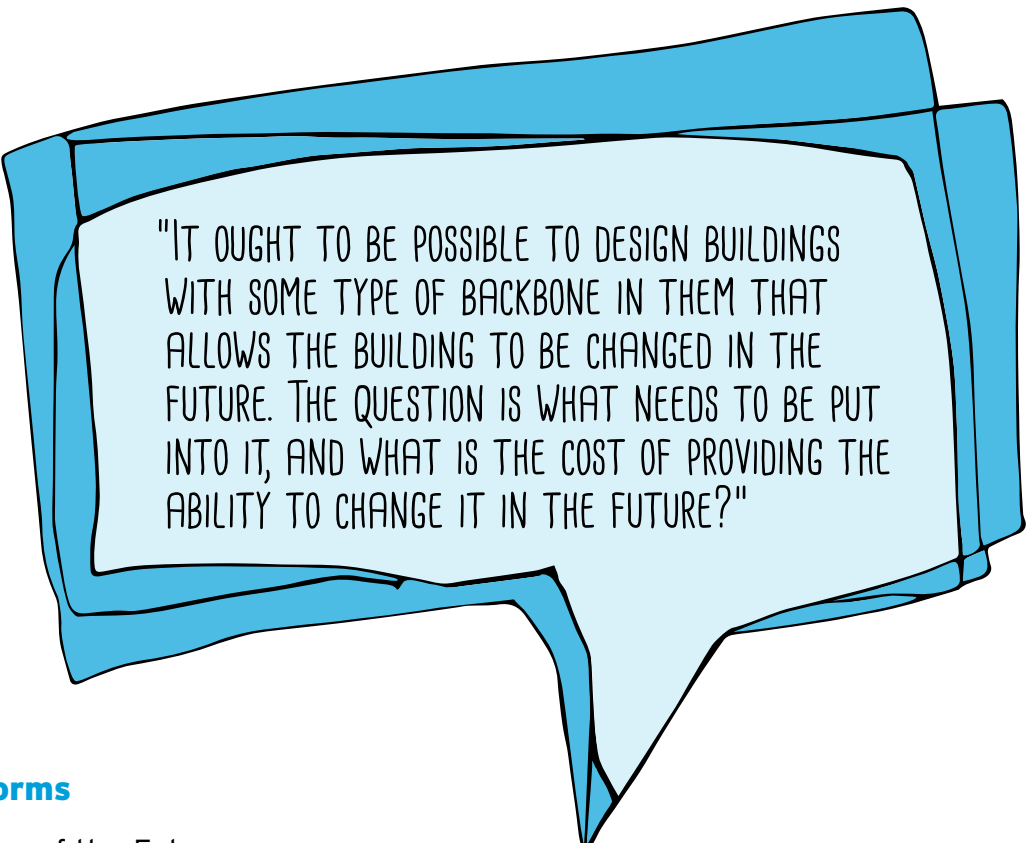
"I'VE SEEN LOTS OF KNOCKING HOLES IN THE FLOORS AND PUTTING IN INTERNAL STAIRCASES – IT REDUCES UTILISATION OF LIFTS AND CONNECTS THE BUSINESS MORE. THIS EXAMPLE SHOWS [THE VALUE OF] MOVING AWAY FROM TECHNOLOGY WHILST STILL USING CLEVER DESIGN."







"PRINTED BUILDINGS WILL BE THE FUTURE WITHIN 10 YEARS... THIS IS A POTENTIAL DISRUPTOR TO THE CONSTRUCTION INDUSTRY AND DESIGNERS. YOU'LL BE ABLE TO PRINT ALL SORTS OF TWISTED FORMS. TWENTY YEARS AGO, IF YOU WERE TO DRAW THE IDEAS WE ARE SEEING TODAY, YOU WOULD BE FIRED, YET TODAY THAT'S EXACTLY WHAT THE CLIENTS WANT."



"IT OUGHT TO BE POSSIBLE TO DESIGN BUILDINGS WITH SOME TYPE OF BACKBONE IN THEM THAT ALLOWS THE BUILDING TO BE CHANGED IN THE FUTURE. THE QUESTION IS WHAT NEEDS TO BE PUT INTO IT, AND WHAT IS THE COST OF PROVIDING THE ABILITY TO CHANGE IT IN THE FUTURE?"

### Seeing tomorrow's storms

Finite usage for Buildings of the Future aside, the engineering industry is also seeing the rise of building contracts which incorporate 50-year design-life clauses. This has significant implications, given the unknown impacts of climate change and increasingly extreme weather incidents.

Technologies addressing this have included incorporating floating buildings that have the ability to generate their own energy, and utilise the local eco system to cool and heat given finite energy resources.

In future, we'll see the increasing incorporation of underground facilities to utilise ground source heating and cooling, and the ability to generate, store and share energy through integrated systems. In addition, our definition of sustainability may change, and with the emergence of the shared economy, shift to what it means to be an active contributor to sustainable practices.



## WHERE ARE WE HEADING?

**Aurecon sees opportunity for buildings to be business enablers, not barriers. Business environments change rapidly and our buildings need to respond quickly and efficiently. In future, buildings will be designed to be simple to use and user-managed. Walls will move easily and essential engineering services will be 'plug and play' to allow for easy change and integration. Buildings will be a combination of 'flat pack furniture' (easy assembly) meets 'the car industry' (mass production of parts). Imagine what we can create!**

A 'one-size-fits-all' approach to Buildings of the Future is becoming less and less palatable. The use of new, flexible construction materials, including composite materials, additive manufacturing concrete, solar polymers and carbon fibre balsa, is fuelling new design approaches. These options are unlocking the architectural limitations of size, weight and shape that the building and construction industry works within today. To bring this to life, our thought processes and methods will have to evolve.

One of the biggest disruptors to the design engineering industry is that of new 3D printing technology. The 3D printer is significantly disrupting the traditional design role held by the structural engineer, but

at the same time, presents exciting new opportunities in how building designers create, relocate and shape Buildings of the Future.

3D printing offers ways to implement almost instant prototypes. The European Space Agency is using 3D printing to address the challenges of transporting materials to the moon to construct lunar habitations. Their study is investigating the use of lunar soil, known as regolith, as building matter. Layers of regolith are expected to be built up over the building on the moon by a robot-operated 3D printer.



"IF A BUILDING SHAPED LIKE A DONUT IS PRINTED, IT COULD BE ASSEMBLED LIKE LEGO BLOCKS. IF THE CLIENT DOES NOT LIKE THE RESULTS, THEY CAN BE TAKEN APART AND THE MODERN MATERIALS RESHAPED TO SUIT."

In addition, the ability of robotics to simplify and automate a diverse range of tasks is also set to revolutionise Buildings of the Future. Within the construction industry, robots are now available to lay pavers and bricks; and drones provide new surveying and security opportunities and are used to construct sculptures and houses. Right now, Japan is reverting to robotics to provide basic services in aged care homes to solve the dearth of care workers.



While the rate of uptake of robotics isn't certain, one thing is: those working on buildings in future will need to maintain an appetite for new and advanced technology, materials and methodologies if they want to stay relevant. We must continue to explore design opportunities for emerging technologies, and prototypes such as this are vital to a mature design approach.

### WHAT SHOULD WE BE ASKING?

- DO WE NEED TO EVOLVE THE ARCHITECT AND ENGINEERING PROFESSIONS TO KEEP UP WITH CHANGES IN THE INDUSTRY?
- WHO IS GOING TO BE THE BUILDING DESIGNER OF THE FUTURE?
- WILL WE EVOLVE INTO 3D MODELLERS AND SEND THROUGH MODELS FOR 3D PRINTING TO CLIENTS INSTEAD OF PLANS?
- DO WE NEED TO HAVE A GREATER UNDERSTANDING OF DESIGN FOR MANUFACTURING AND ASSEMBLY (DfMA)?





## Easy life: complex technology

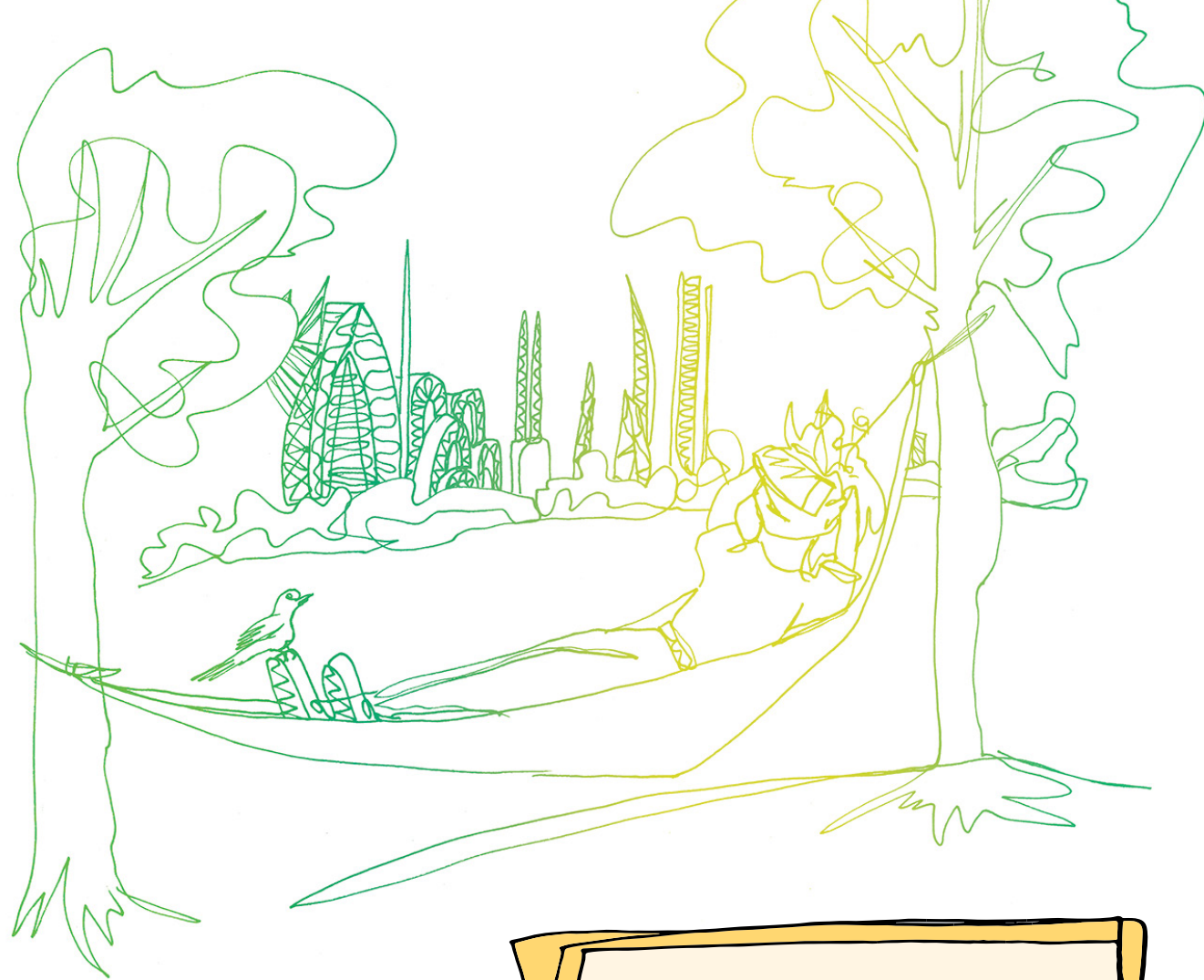
Famous author Arthur C Clark once said that sufficiently advanced technology is indistinguishable from magic. In a way – this captures the essence of what technology installed in Buildings of the Future should aim to achieve. **The technology should 'just work' without the user understanding how.**

### Technology as 'invisible'

The ultimate goal for technology is that the facilities management of the Building of the Future will self-manage, learn, anticipate, adapt and enhance: without the users being aware of it.

In future, it will be called upon to fulfil multiple roles, including that of smart device; concierge and scholar. In addition, technology such as robotics and 3D printing will revolutionise both how and what we build with.

"I DON'T CONSIDER IT A SUCCESS IF PEOPLE ARE TALKING ABOUT THE TECHNOLOGY, NOT HOW THEY FEEL."



"IDEALLY, TECHNOLOGY IN A BUILDING IS UNNOTICEABLE. ALL THE AUTOMATION IS HAPPENING WITHOUT ANY INPUT OR COMPREHENSION BY THE USER."





### Buildings – only smarter

Taken a step further, the Building Internet of Things (BIoT), or developing a building as a smart device able to transmit and receive data for the use and management of buildings, is a hot topic.

"IF YOU TALK ABOUT THE ATTRIBUTES OF THE NEW AGE BUILDING, I THINK IT IS THE FULL INTEGRATION OF SYSTEMS: THAT IS A REALLY EXCITING PIECE."

In the near future, the BIoT will involve an app with IP-based interface, which connects all sensors and equipment to a main backbone Building Management System that proactively optimises the operation of the building, including:

- **Centralised control** and maintenance of HVAC and lighting
- **Personalised comfort** conditions and collaboration opportunities
- **Monitored occupancy** and usage so that space can be adapted, reconfigured and rezoned depending on need
- **The delivery of energy** at the right time to the right place

In future, open software architecture and open protocol language will make our buildings 'hackable'!

### Need advice? Call the (building) concierge

Critically, the data our Buildings of the Future collect have the potential for far more than just facilities management.

In many airports, it's no longer necessary to stand in a queue to check in and people are expecting the same kind of easy, technology-driven check-ins at hotels. Thanks to technology, a guest's name can be displayed on the welcome desk at a digital check-in station; their food preferences or past purchases displayed in a digital room-service order system; and TV, movies and music provided on demand. This 'concierge in your pocket' concept is fast gaining popularity and also allows operators to include useful information such as surrounding entertainment venues; medical facilities; and similar services.





### A building as scholar

Beyond its influence on building management, some believe that the ultimate win would be technology that can self-manage, learn, anticipate, adapt and enhance, or at least tell you when there is a problem.

We might soon see 'intuitive' buildings emerge and the integration of artificial intelligence. Within this reality, a building facade 'intuitively' reacts when shadows are cast across it and adjusts its shades and solar panels accordingly.

"I WANT THE BUILDING TO KNOW ME; MY PREFERENCES, MY HABITS, MY BEHAVIOURS AND RESPOND TO THEM."



Taken a step further, data analytics systems are increasingly being utilised to analyse occupation, space utilisation and energy consumption, and these learnings will continue to be applied to a wide range of diverse applications.

Buildings of the Future will increasingly use data analytics to automatically deliver improvements in efficiency.

"IoT AND BIG DATA ARE INEXTRICABLY LINKED. THE TRUE VALUE OF THE IoT IS NOT THE CONNECTION OF DEVICES OR MACHINES, BUT MAKING SENSE OF WHAT IS REQUIRED TO MAKE A BUILDING INTELLIGENT".





## WHERE ARE WE HEADING?

**Aurecon understand that while the rate of uptake of robotics isn't certain, one thing is: those working on Buildings of the Future will need to maintain an appetite for new and advanced technology, materials and methodologies if they want to stay relevant.**

A centralised industry portal to share and purchase solutions and information within a global community may not be as out of reach as it initially appears. This could include a "Buildings of the Future" app store which complies with industry standard measures and sells bespoke apps or tools to build your own app, supported by your local IP precinct hub with access to IT, economic and data analytics advice. This would allow for entire precincts and cities to share and collaborate rather than operate in isolation.

We will also have to consider the influence of leapfrog technologies such as blockchain and cryptocurrencies which will make self-executing contracts possible. Facilities will, in effect, not only be run smarter, but run themselves. Public ledgers will bring greater transparency to supply chain records and the possibility of intelligent building parts will connect the physical and digital worlds.

Although we cannot predict the future, we'll need to stay one step ahead of these game changing technologies with a 'leapfrog' mindset.

## WHAT SHOULD WE BE ASKING?

- WHEN THE BIOT KICKS IN, HOW WILL WE MANAGE AND MAKE SENSE OF THE SHEER VOLUME OF DATA EMITTED?
- WHAT IS THE ORDER OF IMPORTANCE OF DATA AND WHAT DATA DO WE NOT NEED TO COLLABORATE/STORE?
- HOW WILL THE SHARING OF DATA TAKE PLACE AND WHO OWNS THE DATA?
- HOW DO NEW CONSTRUCTION PROCESSES AND MATERIALS BECOME MAINSTREAM WHEN THE INDUSTRY IS RESISTANT TO CHANGE?
- COULD BUILDINGS OF THE FUTURE HAVE LESS TECHNOLOGY?
- HOW WILL LEAPFROG TECHNOLOGY SUCH AS BLOCKCHAIN AND CRYPTOCURRENCIES CHANGE HOW BUILDINGS ARE MANAGED?



# Bottom line benefits

"Prove it..."

"OUR HUNGER FOR INNOVATION IS NOT QUITE ON PAR WITH THE ACCOMPANYING NEED TO PROVE THE VALUE OF THE INNOVATIONS WE APPLY."



It is often difficult to demonstrate an immediate return on investment for innovation. And many fear making a costly mistake.

Some important principles apply:

- **Taking a long-term view of investment is key:** with a client who takes a longer-term view, you seem to be more able to incorporate Intelligent Building concepts, compared with someone who is here for the short-term.

- **Returns on investment aren't always financial:** proving returns could be in the form of cost or energy savings, or successfully supporting corporate strategy (such as environmental responsibility or collaboration).
- **Proving value starts at the design phase:** the first step in proving the value of an innovation should start at the design stage. This involves working hand

in hand with a client to identify which innovations will provide real value and instilling a shared understanding of the vision. For example, space optimisation doesn't only involve asking "how small can we make the space?" Rather, it involves understanding a client's future space requirements and the need for flexible design which will minimise long-term operational costs.





"I, THE LANDLORD, WILL ALWAYS INVEST IN SOMETHING THAT DIFFERENTIATES MY BUILDING AND GIVES ME A BETTER RETURN."



### Digital strides forward in data analytics

"YOU CAN DESIGN AND BUILD A BUILDING REALLY WELL BUT IT CAN BE LET DOWN IF THE OPERATOR DOESN'T KNOW HOW TO USE IT TO THE FULLEST."

The use of technology to manage facilities is a key enabler of improved maintenance efficiency through real-time monitoring from remote locations. In the near future, apps will be used to monitor and analyse data and will aid the more effective management of services such as air conditioning and water management.

Critically, we are going to have to upskill facilities managers to take full advantage of the innovations in Buildings of the Future. Put plainly: there is no point in developing fancy technology if no one can or wants to use it.

### Solving the investment conundrum

"THE BIG ISSUE IS SOLVING THE CAPEX PROBLEM. GOOD INITIATIVES GET CULLED DURING THE SCHEMATIC DESIGN AND DESIGN DEVELOPMENT STAGES. FOR BUILDINGS OF THE FUTURE, FUNDAMENTAL, IDEALISTIC FINANCIAL MODELS ARE NECESSARY TO CONVEY THE MESSAGE."

Efficiencies in operations, building practices and response to climate change are at the heart of innovation in the building of the future. To solve the investment conundrum, we will need to focus on improving the tools we use to calculate the cost-value equation. We'll need to develop better metrics to support the business case for Buildings of the Future, and take advantage of government incentives to foster innovation in this field.





## WHERE ARE WE HEADING?

**Aurecon sees this as a key opportunity for the built environment to institute more specific measurement standards.**

These standards would carefully analyse the returns on investment from Buildings of the Future, including their achievement of occupant wellness, connection to local community, energy being delivered to the right place at the right time, as well as the integration of appropriate technology and new materials. Establishing these standards will require an ahistorical level of collaboration between innovative executives, HR and buildings professionals.

If the future is created by those who forge it, we need to evaluate where it is we want to be, and find more definite ways of measuring our progress.

## WHAT SHOULD WE BE ASKING?

- INNOVATION WORKS IF LEGISLATION FACILITATES IT. LEED, BREAM OR GREEN STAR ARE ONLY EFFECTIVE IF IT IS A MANDATORY REQUIREMENT. WILL THE STANDARDS EVOLVE TO ALLOW FOR NEW TECHNOLOGIES?
- WHERE WILL 3D PRINTING FIT IN?
- WILL THE KEY DRIVERS FOR THIS BE ECONOMIC, ENVIRONMENTAL OR EXPERIMENTAL?
- WHAT WILL BE THE BIG CHANGES IN OUR SURROUNDINGS THAT WILL CHANGE THE COST STRUCTURE OF BUILDINGS?

# Where to from here?

**We realise we have raised more questions than answers throughout this document.**

It may be counterintuitive, but we believe that therein lies the pathway forward. Those who shape Buildings of the Future will be those who, firstly, realise that our world is changing and have the boldness to not only let go of but question the status quo so that working with government and economic leaders, we might reimagine our physical spaces and infrastructure. Engineers need to lead these conversations.

With science fiction becoming science fact, it's time to embrace radical change.

