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The Innovation issue

Eight trends shaping our industry's future.

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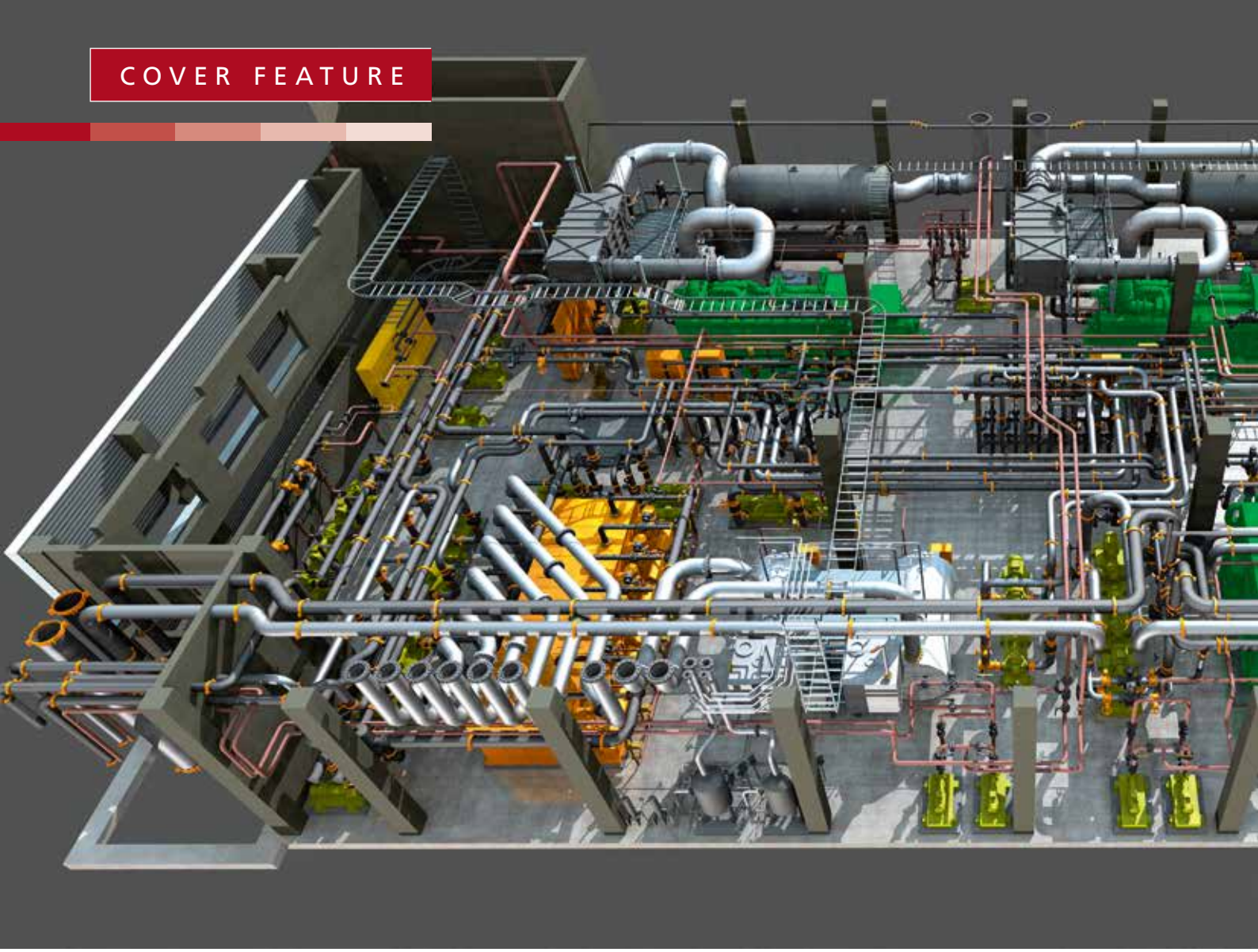


Deep impact

If you were asked to list the key attributes of the HVAC&R industry, the words adaptation and innovation would be high on the list. This month, Ecolibrium future-casts the innovations set to change the way we work with four of our industry's leaders – Lauren Clay, M.AIRAH, building physics engineer at Arup; Matthew Webb, M.AIRAH, sustainability consultant at Umow Lai; Anthony Marklund, ESD principal at FLOTH; and Bryon Price, F.AIRAH strategic development director at A.G. Coombs Group.

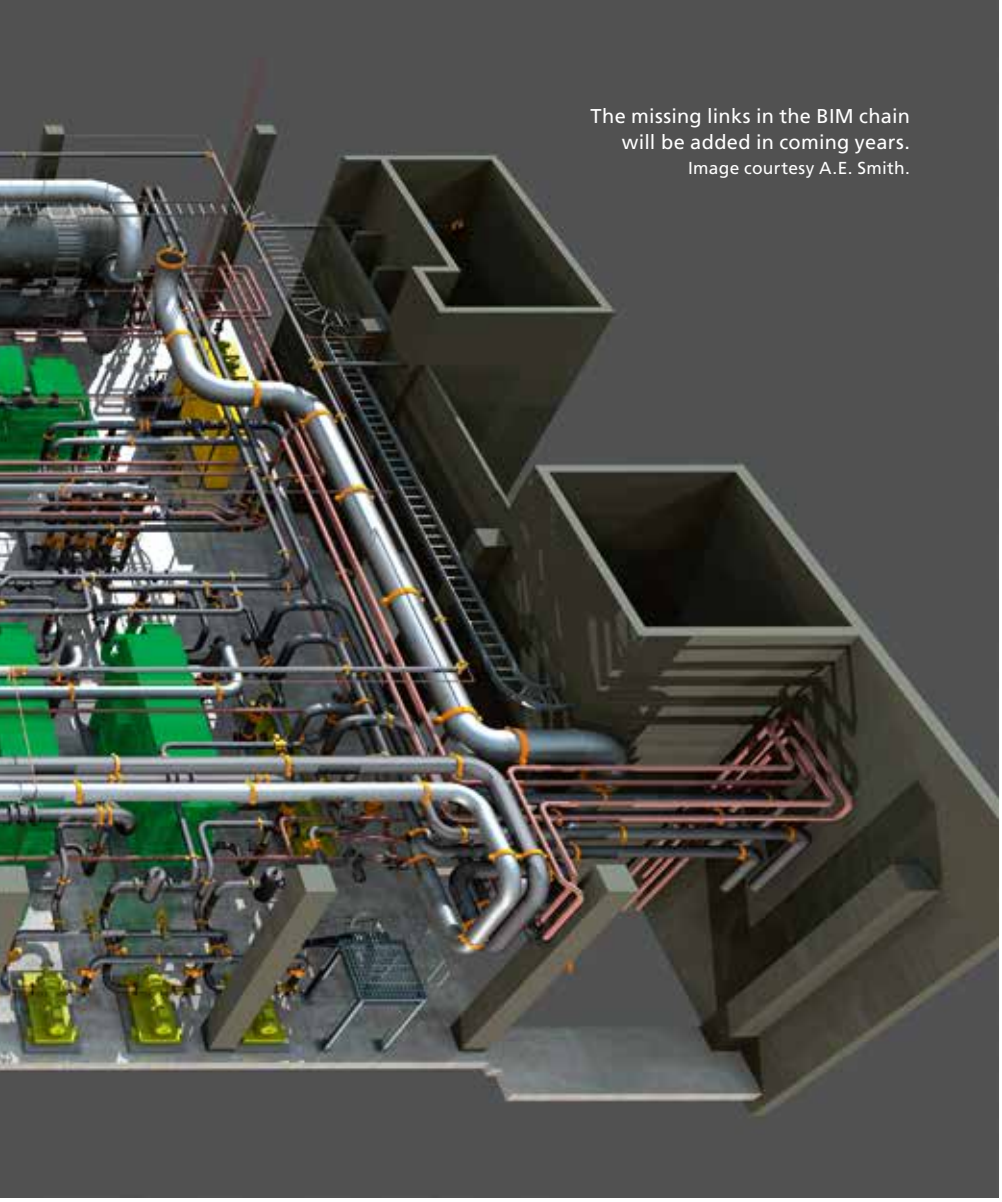
Ours is an industry that has come to not only accept change, but embrace it.

Just think how we've championed energy efficiency in the built environment, or managed to adjust to the phase-outs of refrigerants that had become ingrained across the HVAC&R industry. Even the coming and going of carbon trading we've taken (for the most part) in our stride.

Although our focus on the environment is likely to only intensify in the future, what other trends will impact the way the industry meets the challenges of the future?

What follows are eight trends that our panel expects to impact the HVAC&R industry in coming years. Some are already on our doorstep, while others are only in their embryonic stages.

And the first won't be a surprise to anyone.



The missing links in the BIM chain will be added in coming years.
Image courtesy A.E. Smith.

TREND **1**

BIG DATA, DIGITISATION AND MACHINE LEARNING

As a society, we continue to collect data more than ever. But the building and construction industry, and the resulting built environment, is one of the last bastions of human activity to be digitised.

Though everyone has heard of big data, analytics or whatever the latest term is to describe the abundance of data available, the key question remains – can you do anything useful with it?

"BIM, design modelling, modular and offsite construction, big data analytics (leading to rules-based and machine learning driven control systems, digital asset management, remote diagnostics and building controls are all enabled by this digitisation process," says Bryon Price, F.AIRAH, from A.G. Coombs Group.

"Importantly, how we as humans are interacting with the built environment and technology is also changing, through the ability of buildings to sense our presence, and identify and learn our particular requirements. Access to space, amenity, temperature and lighting are all enabled by digitisation."

But humans can only process so much information, so the challenge for everyone – the building industry included – is to capture the right data at the right time and present it in a way that allows the user to make a meaningful, timely decision with it.

"There is a lot of interest across the industry, with respect to machine learning, and this also applies in other similar sectors such as the big four accounting firms," says Arup's Lauren Clay, M.AIRAH.

"As with other aspects of our industry, other services sectors continue to tap into our traditional areas of work and vice versa."

> "In the future, we may be able to design a building envelope that changes colour depending on the season"

What will it mean?

An improvement in the flow of data has already had a significant impact on the building industry. The use of BIM in design has allowed the cross-flow of information through the design team in ways that had not been possible before.

"I expect that missing or weaker links in the BIM chain to be added and strengthened in coming years, as models flow through more readily to sustainability energy modelling and post-construction, into facility management," says Umow Lai's Matthew Webb, M.AIRAH.

As well as lending itself to improvements in building performance monitoring and facility management, the availability of data and building monitoring will also lead to greater automation.

"While most modern buildings are equipped with sophisticated building management and control systems (BMCS), there is a further level of automation for adaptability and flexibility that isn't yet being achieved," adds Webb.

He points to the continuing evolution of building features that change according to conditions. Examples include macroscopic and microscopic shading schemes that manoeuvre in response to prevailing solar conditions; or modular air conditioning that switches off in response to occupancy sensors.

"Big improvements can be made where building systems and components intrinsically control themselves," he says, "without the need for a central processing hub.

"In the future, we may be able to design a building envelope that changes colour depending on the season.

Lauren Clay, M.AIRAH

Matthew Webb, M.AIRAH

Anthony Marklund

Bryon Price, F.AIRAH

While this example will obviously require some radical changes to construction materials, it's the kind of technique that becomes an option when we collect the right data."

But such innovations will require the industry to keep abreast of technological developments both inside and outside of our own industry.

"Paying attention and seeking to understand will help us see the future of this technology and its implications," says Price. "This is the only way that the technology and its applications will be practical, and will deliver the outcomes we require, while avoiding unwanted implications."

TREND **2**

LARGE PV ARRAYS

Large photovoltaic (PV) arrays covering entire commercial building roofs are becoming increasingly common, which is fantastic from a sustainability perspective. So too are building-integrated photovoltaics (BIPV), but both bring about a whole range of additional considerations for the industry.

What will it mean?

Policy changes are likely to be required to support large-scale PV arrays, which also address greater input into the grid and how this might be worthwhile too, or problematic for building owners.

It also raises a lot of questions about the "right to light" – a topic that has been very prominent with respect to daylighting amenity but not so much in terms of conflicts regarding the overshadowing of PV arrays.

Every project should consider the opportunities offered by large-scale PV arrays; however, this shouldn't remove the focus from passive design strategies and/or high-performance facades.

PV shouldn't be implemented in order to mitigate poor design.

Lauren Clay, Arup

TREND **3**

MODULAR CONSTRUCTION AND OFFSITE PREFABRICATION

Buildings are one of the few remaining "products" created largely in-situ and bespoke.

But this is changing – mainly enabled by digitisation and driven by the desire to reduce costs, lessen construction time and address the construction safety environment – such that offsite construction is revolutionising how we design and create our buildings.

If you put this emerging trend together with the potential for on-site additive manufacturing techniques (think 3D concrete printing) and robotic construction and installation methods, you really do have an exciting vision of construction in the not-too-distant future.

What does it mean?

To date, modular construction approaches have been limited to particular, high-intensity components such as bathrooms, and by and large building services prefabrication solutions have been applied within the conventional construction process (such as vertical and horizontal services risers and zones, and plantroom components).

PV arrays covering entire buildings are becoming more common.

The trend towards modular construction will only grow.
Image courtesy A.G. Coombs.

The move to full modular construction with the great majority of the building form constructed off-site will significantly change how building services are incorporated into the built form. This may challenge the industry's specialist role in some aspects of our work (e.g., elements of ductwork, pipework and sub-system installation) or it may offer up significant opportunities to take up a more converged "all-of-technical services" responsibility in a range of settings.

But it will require substantial adjustment to our design and off-site prefabrication thinking. There are multiple modular "technology paths" being tracked by various organisations in Australia, applying different approaches to modularisation and even using alternative materials, etc.

It is important that our industry fully engages in this process to not only support the effective integration of our systems but also to help ensure that the outcomes are better buildings for their occupants, owners and operators – not just buildings built a better way.

Bryon Price, A.G. Coombs Group

TREND 4

FOURTH INDUSTRIAL REVOLUTION

The current wave of emerging and merging physical, digital and biological technologies has been dubbed the Fourth Industrial Revolution. Think quantum computing, robotics, 3D printing, artificial intelligence, the Internet of Things, autonomous vehicles and nanotechnology.

This is a disruptive time of great promise. In particular, the rapidly advancing information technologies have almost limitless potential to connect people and things to each other and the Cloud, with effective use of big data enabling significant improvements in the efficiency of organisations and their built assets.

What does it mean?

Individuals and organisations will need to adapt quickly to best harness and realise the benefits, and to safely negotiate the potential pitfalls.

Automatic BIM design is in development and may reasonably be expected to extend into the operational phase and all parts of the building life-cycle. The main role of the HVAC design professional will be in the generation of the product data files and interaction protocols, and in the key design and delivery aspects that cannot be automated, such as the setting of design criteria and concept design. The creation of the fully specified design (and potentially the modular, robot-constructed or 3D-printed building with prefabricated plug-and-play services) may be performance modelled, progressed, life-cycle analysed and documented by machine under the professional's guidance (or coercion).

Building operators will have customised and analysed feedback from plant. Similarly, permanently connected automated "occupant feedback" systems can be expected to be fully integrated and into buildings and services. All due skill and care will be required to artfully balance increased user expectations, the required levels of performance, efficiency and resource conservation, and perhaps most tellingly, practicality and cost.

Anthony Marklund, FLOTH

TREND 5

VIRTUAL REALITY

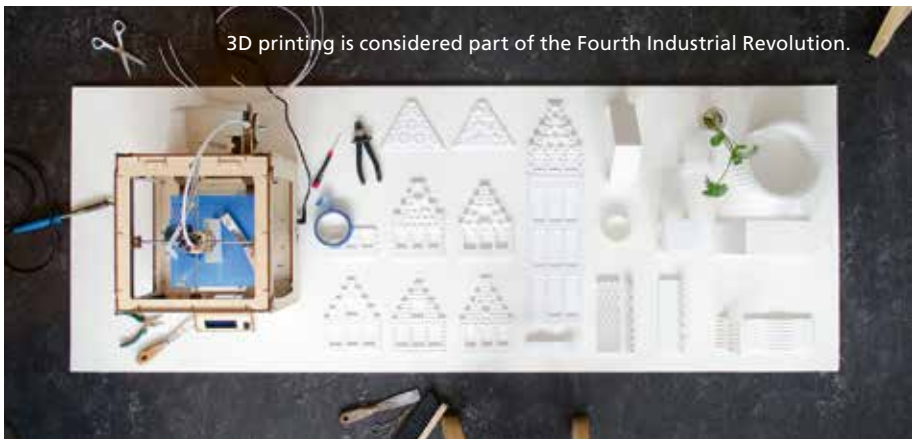
A huge opportunity exists to integrate virtual reality into work streams. It's a technology that continues to evolve and develop, even in just the last few years.

What does it mean?

There are endless options as to how the technology can be utilised. These could include communication, digital feedback, virtual meetings, coordination, building analysis results presentation, training, setting out on construction sites, remote working, construction sequencing, space planning and facilities management – to name just a few.

It's an engaging and interesting technology that can quite often by used as part of examples and then sometimes not to be taken any further. The focus needs to be on finding relevant and tangible applications to implement the technology.

Lauren Clay, Arup



3D printing is considered part of the Fourth Industrial Revolution.

UNDERSTANDING BACKGROUND TRENDS

According to Bryon Price, F.AIRAH, strategic development director at A.G. Coombs Group, there are many wider trends that can have a significant influence on the HVAC&R industry.

He says understanding trends in disruptive technology, urbanisation, sustainability, population profile, infrastructure and investment, and how they influence our world and the built environment, can be useful in forecasting the future of our industry.

Disruptive technologies

"Disruptive technologies are rapidly changing the operating environment of business and are impacting building and infrastructure construction, ownership and use," Price says. "The potential for change and the unknown effects, as well as the rate at which this is happening, is unsettling for many."

Urbanisation

"By 2030, over 60 per cent of the world's population will live in urban areas, and this creates increasing pressure to plan for and accommodate much denser populations," Price says. "Even now, this is causing increasing issues around access for construction and maintenance."

Sustainability

"Sustainability is now an imperative for governments, investors and consumers," Price says, "who demand clear standards to improve environmental and social outcomes."

Aging population

Australia's changing population profile will also influence the fortunes or otherwise of our industry.

We have a growing population, which at the same time is becoming older and more urbanised. By 2042, the number of Australian over 65 years of age will have reached 6.2 million, compared to just 2.5 million in 2002. This changing profile is already impacting on infrastructure, and will continue to do so in more profound and long-lasting ways.

"An aging populating requires different housing solutions and increases the demand for greater healthcare support services. And it is also resulting in an aging workforce, and one that is shrinking relative to total population."

Infrastructure

Price says urbanisation and population growth are also driving the need for improved productivity, creating a strong demand for greater infrastructure at both social and economic levels.

"In Australia, it is well recognised that we now have an infrastructure deficit," he says. "And we are now starting to see very significant government investment in public infrastructure."

Ownership

And tellingly, we are also continuing to experience a strong trend in the ownership of infrastructure, with the consolidation of built asset ownership by superannuation and growth funds a significant global trend that is sure to continue.

"Large superannuation and growth funds are now the dominant investor in the built environment globally," he says. "Their requirement to provide both asset value growth and ongoing returns heavily influences how these assets are constructed, operated and maintained."

TREND **6**

CARBON-NEUTRAL BUILDINGS

Reinvigorating a trend started by innovators in the noughties, which somewhat lost momentum following the GFC, the COP21 outcomes seem to have galvanised a number of sustainable development peak bodies and governments to further progress on a number of fronts, including various takes on "low-carbon", "net-zero", "zero-carbon" and "carbon-neutral" development.

In 2016, ASBEC launched the *Low Carbon, High Performance* report and the City of Sydney commissioned a study into *Accelerating Net-Zero High-Rise Residential Buildings in Australia*. In February 2017 Brisbane City Council became the first government in Australia to claim carbon-neutral status in line with the Australian government's National Carbon Offset Standard (NCOS), which is currently limited to products, organisations and services.

No doubt coordinated with the Green Building Council of Australia's (GBCA) Carbon Positive Roadmap, which is in final consultation, the World Green Building Council launched its report *From Thousands to Billions – Coordinated Action towards 100% Net Zero Carbon Buildings By 2050* in late May. This calls for all new buildings to be net-zero-carbon from 2030 and 100 per cent of buildings to be net-zero carbon by 2050.

What does it mean?

Watch this space! We can reasonably expect an inexorably growing emphasis on life-cycle analysis; on low-carbon decision-making in design, construction and operation; and more widespread uptake of zero-carbon energy generation and storage, both on-site and off-site.

Anthony Marklund, FLOTH

TREND **7**

DIGITAL ASSET MANAGEMENT

The increasing capabilities and reducing cost of digital information technologies will support the widespread digitisation of the existing built environment, and in particular highly maintained and critical building services.

While a lot of attention has been paid to creating 3D spatial models and BIM of existing buildings, the really exciting shift is the emerging ability to digitally "soak up" all the important details about the technical assets and systems in buildings using low-cost methods, and create very detailed, accurate and really useful databases that are ideally linked to spatial models. In operation, 3D models will support this information-rich environment, not the other way around.

In addition to this are the new capabilities in "operational analytics". Using software to continuously extract large volumes of relevant real-time data from BMCS and other services instrumentation, to apply rules-based analysis to identify current and future operational issues, is allowing us to be "present and watching" 24/7. This will enable a much more focused and proactive approach to operational support and maintenance.

What does it mean?

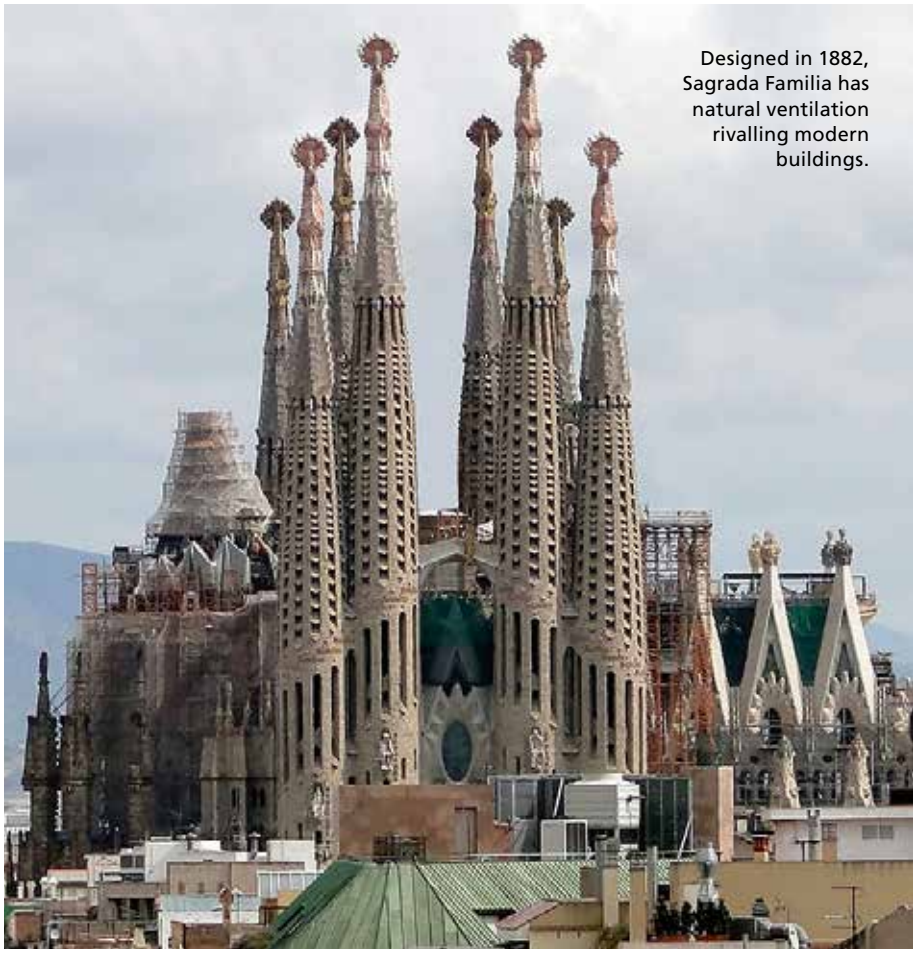
This is now beginning to facilitate a significant shift in the building services industry from what has basically been rote task-based maintenance, to a much more sophisticated proactive asset-based maintenance approach.

Using analytics to assess these asset information databases, we are now able to ensure maintenance activities are focused on the particular asset's needs as determined by its purpose within the buildings systems, duty, age, condition and design along with regulatory requirements. We are able to compile detailed historical information about the asset – its performance, reliability, costs to maintain, repair or replace, energy usage, etc.

This in turn is starting to deliver significant improvements in performance and reliability, reactive maintenance cost reductions, energy efficiency, increased surety in budget planning and improvements in expected asset life, and thereby uplift in current asset value. Combined with the additional insights available from real-time operational analytics, the prescience that this provides will enable us to deliver truly proactive preventative maintenance and operational support in a least-cost best-outcome framework.

Ultimately these insights will also yield significant improvements in system and component design and selection as we compile and learn from life-cycle knowledge. It will also have implications for compliance-driven maintenance activities (e.g., essential safety maintenance). As we develop an empirical database on what is really required to support the availability of these systems we will be able in many instances to review and potentially rationalise the maintenance that is currently prescribed by regulation.

Bryon Price, A.G. Coombs Group



Designed in 1882, Sagrada Familia has natural ventilation rivalling modern buildings.

TREND **8**

LIVING BUILDINGS

The WELL Building Standard is being talked up for no small reason.

Apologies to Abraham Lincoln, but at the end of the day buildings are of the people, by the people, for the people. Beyond this though, both WELL and the Living Building Challenge have cottoned onto something that, at least to me, resonates towards the future – living, green buildings that capture humankind's affiliation with life, or "biophilia".

Arguably, the same rating tool's "beauty and spirit" aspects, which consider human delight, celebration of culture, spirit and place, belong here too.

What does it mean?

Our new buildings will be intelligently and passively designed to work with the environment rather than against it. Many virtuous cycles are already being harnessed – generating and storing energy from sunlight, recovering water, recycling organic waste to produce food, etc. Additional living building elements will enhance and further encourage healthy, productive occupants that are more connected with nature and humanity.

Living building elements such as green roofs, vertical gardens and technologies such as OLED and photochemical-dye PV and algae facades, can all be considered part of this biomimetic design trend. This is a natural progression of biomorphism and organic architecture further into engineering.

For inspiration take Gaudi's Sagrada Familia in Barcelona. Its internal structure replicates a forest of trees, with the ceiling evoking the canopy. Remarkably, this building, which began construction in 1882, has efficiency of structure and natural ventilation rivalling buildings designed today, including night ventilation to pre-cool highly articulated thermal mass elements. ▮

Anthony Marklund, FLOTH