

# EcoLibrium



## Big data

How analytics are impacting the HVAC&R world.



# Big data

This year's buzzword, "big data" comes with the promise of business transformation – from restaurants who want to better know their client preferences, to building owners seeking to minimise operating costs. **Sean McGowan** gets the low-down on what big data means for our industry, with our panel including NDY senior associate **Jonathan Clarke, M.AIRAH**; Hiflow Industries managing director **Brett Saunders, Affil.AIRAH**; BUENO managing director **Leon Wurfel, Affil.AIRAH**; Buildings Alive CEO **Craig Roussac, App.AIRAH**; CSIRO Intelligent Building Controls Research Leader **Dr Josh Wall, M.AIRAH**; and Crown Resorts group manager for sustainability **Jonathan Wood, M.AIRAH**.



**Ecolibrium:** Big data is regularly described as a fast-flowing river of unstructured data and information. What is your definition of the term?

**Saunders:** I agree with your description; however, to add some more to this I believe that big data is a collaboration of data that is then utilised to provide insightful business advantages via analytics. This then gives the data some structure and purpose.

**Wall:** Getting past all the hype and marketing speak, big data is really just the aggregation of traditionally isolated or disparate data sets, which represents a greater source for ongoing discovery and analysis.

**Clarke:** Big data is a generic term, and depending on where you look gets a slightly different definition. But all definitions suggest that it is

large or complex data sets beyond the capabilities of traditional data processing.

**Roussac:** I can't think of another term that's moved so quickly to cliché. There's no line where data sets flip from being small to big – it's all relative.

The key thing to appreciate is that traditional data processing methods and applications can't extract a lot of the value that's in these data sets, hence the emergence of data science. Data science is about extracting information from very large and complicated data sets.

**Wurfel:** Big data is a relative term. If you imagine a data tap and data sink, then big data is whenever historically, the data tap has been on but there has been no plug in the sink. Whatever data has been going down the drain in our industries is because it has been too hard to extract value from it – due to silo-ing or ability to process. That is big data.

It's relative because big data in the technology space is really orders of magnitude bigger than what we typically talk about in buildings. So the big part is relative for sure, but the framework is the same no matter what.

**Wood:** Instead of the term big data, we use the terms “building optimisation system (BOS)” or “fault detection and diagnosis”.

I personally prefer BOS, as it more accurately captures a holistic approach to what we're trying to achieve – i.e. getting the most out of our buildings with all the systems we currently have.

A BOS is a semi-automated mechanism for identifying faults and opportunities in the built environment, prioritising them, addressing them and providing a feedback loop for continuous improvement.

**Ecolibrium:** Touching on all the hype around the subject, does big data represent a revolution or an evolution?

**Wood:** I would say an evolution.

Most, if not all, industries are going through a process of automation, and this is a logical next step in the built environment. We are just starting to realise the potential of big data, and its adoption won't occur overnight. While I expect most buildings – excluding single dwellings – to have some form of BOS installed in the future,

this process will take decades and the level of sophistication of these systems will continue to evolve during this time.

**Clarke:** The hype surrounding big data is causing a bit of both, especially in our industry. There is a revolution going on with analytics systems providers in a race to get products out into the marketplace; however, the market is in its infancy and these products are very much evolving.

**Wurfel:** Big data is both an evolution and a revolution. The thing is the term is getting thrown around as the holy grail of business solutions just like cloud computing was five years ago, and M2M was before that.

In reality, big data is a tool, and it's going to be incorporated into “business as usual” for most businesses. The people that don't figure out how to make it work for their businesses are going to be playing catch-up when everyone else turns it into a competitive advantage.

**Wall:** Big data is not really all that new; however, it is evolving more rapidly of late due to the prevalence of open-systems connectivity and communications technology, cloud-based storage and security, and advanced data-visualisation techniques.

**Roussac:** It's an evolution.

Last year while I was at Lawrence Berkeley National Laboratory, I attended a lunchtime lecture by Saul Perlmutter, who won the 2011 Nobel Prize in Physics for his discovery with the ANU's Brian Schmidt that the universe is expanding at an accelerating rate. He did this by observing back in 1998 that galaxies are spreading apart from one another faster now than they were billions of years ago. And he did that by observing just three supernovas using a telescope. That is, three points on a graph spanning billions of years!

Nowadays, scientists working in the field have technology that's scanning the universe constantly to pick up changes in billions of stars. They've found data from thousands of supernovas that support Perlmutter's hypothesis, but they're fundamentally doing similar stuff with better tools.

Perlmutter's advice for a young scientist is to get very good data.

**Saunders:** Big data is evolving in the current marketplace across multiple industries and sectors. There is a wave



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of big data feeds now being utilised to improve all aspects of business. As companies continue to strive for improved performance, profitability and efficiencies, evolution is inevitable to continue providing greater results for stakeholders. Through big data this can now be easily achieved – it is easy to access most data due to an advancement in technology and open-protocol platforms, and this allows free-flowing data to be shared and analysed.

It is also a real revolution, growing at an expedient rate and continuing to expand throughout multiple industries.

**Ecolibrium:** From an HVAC perspective, what can big data reveal that we don't already know?

**Wurfel:** Big data techniques like analytics can be an MRI for your building.

If done well, they can tell you every single issue with the operation of your building. The hard part is then having the domain experts that are familiar with analytics who can provide the pathway to actually doing something with all this information. This is a key part of the equation that is missed by most big data and analytics companies.

Providing the tech is only half of the solution – the MRI is no good without the prescription.

Analytics need to be supported with talented domain expertise to get the value and the outcomes for the clients, owners and FMs. If you give someone technology, you've added to their to-do list. But if you give them technology and services you take things off their to-do list, and probably get a better outcome.

**Saunders:** Currently, HVAC systems rely on the BMS control systems to operate the HVAC plant – there are no real-time metrics, no live efficiencies and no live running costs. It is a very reactive way of managing your plant.

With real-time analytics accessing big data, we have the ability to identify live inefficiencies, and more importantly, where they are located, the cause, the solution and how much it's costing our clients. Basically, we are providing greater visibility with factual data to improve the building's performance while taking away the guess-work.

**Clarke:** Big data in the HVAC industry is being associated with understanding the performance of buildings, typically by collecting BMCS data and energy metering data. We already know most of the problems that are inherent in our

buildings with poor commissioning and controls. Using big data from the BMCS provides an opportunity to go beyond typical reporting capabilities and delve into the cracks between the traditional alarms and trend logs.

**Roussac:** Like any research, what we're able to learn depends on the way we frame our questions. It requires a research mindset and openness to considering unexpected findings.

I'm not an HVAC practitioner, and it might be a little unfair of me to say that I think the HVAC industry is mostly focused on the laws of physics and rules of thumb. But human behaviour – of both operators and occupants – doesn't fit easily into engineering models.

We're arriving at a point where we can begin to deeply understand the gaps between design and reality, theory and practice – how big these gaps are, what causes them and how to close them.

**Wall:** One key feature being enabled is that of automated prognostics or predictive maintenance, where big data can be analysed in a way that provides meaningful insights into the longer term performance degradation of HVAC systems and equipment. It can even estimate time to failure for the more efficient scheduling of maintenance calls.

**Ecolibrium:** What is the business case for big data, particularly in HVAC? Do the rewards outweigh the costs?

**Roussac:** Absolutely.

It's amazing how much of the best technology for scalable machine learning is actually open source. In fact, if you check out Kaggle ([www.kaggle.com](http://www.kaggle.com)) you'll see an array of big data competitions, with some of the brightest minds in data science working on them just for the fun, practice and prestige of it.

Some of the biggest problems in science are being tackled and solved this way.

**Wood:** This will depend on the system you choose. However, for Crown the answer is a resounding "yes". The payback for the system installation is less than two years, and the ongoing savings – energy and maintenance – far outweigh the operational costs (managed service and additional resources).

**Wall:** If big data is an enabler for things like automatic fault detection and diagnostics (AFDD), and accurate yet inexpensive data-driven models for improving measurement and verification baseline predictions, predictive optimal controls and self-calibration of sensors, then I would say the rewards would most definitely outweigh the costs.

**Wurfel:** If executed well the rewards will definitely outweigh the costs.

The "general business case" takes into account improved energy efficiency, improved maintenance efficiency through

automated maintenance tasking and reductions in repair and maintenance costs over time – after an initial spike to fix all the important latent issues. There is also the benefit of improved tenant comfort.

But then there can be project-specific drivers for an application of analytics, like getting the best value out of a DLP (defects liability period) or some specific operational issue with a building.

**Saunders:** The rewards most certainly outweigh the costs. You don't know what you don't know.

Most clients aren't even aware of the potential impact that not having big data analytics is having on their business. Their buildings are running blind, therefore can't tangibly see the benefits. However, if they implement the correct analytics platform, in most cases there are major savings in energy consumption, reduced energy bills, improved building energy ratings, improved plant operation and life-cycle.

Ultimately this is beneficial for the environment by reducing greenhouse gas emissions and also for the stakeholders with increased profit margins.

**Clarke:** There are benefits of using systems data at an analytical level, but it's a bit too early to understand the ROI. The largest cost is the initial set-up mapping of all the data points and understanding each point's relationship in the building.

**Ecolibrium: What are some of the challenges around the integration of big data analytics in the HVAC field?**

**Wall:** A key challenge that exists is ensuring analytics solutions are not too sensitive so as to create an overwhelming number of results or false alarms, but sensitive enough not to miss critical issues.

Another challenge is ensuring that identified faults and operational issues are prioritised and presented in a way that facilitates actual remedial actions

and outcomes for improved operational performance.

**Roussac:** The biggest challenge is getting access to the data in the first place. Too many HVAC monitoring and control systems, and the business models that sit behind them, are deliberately built to constrain access to data. Ironically, this is just driving a whole lot of innovation that will ultimately democratise access to data in the same way that open-source technologies and crowd-sourced computing and analysis is transforming technology generally.

**Clarke:** We have just about come through the "open systems" era, establishing communications standards to allow different control systems to share data, and now there's another battle: naming wars.

To create analytical algorithms we need to understand what the data points in a control system are designed to do.

If the points do not have meaningful names, implementing the analytic becomes a very tedious and long-winded process.

There are naming conventions currently being developed, but these are not mandatory unless specified by the designers, and are not comprehensive. Another challenge is applying analytics to older systems that are proprietary, or do not conform the open communications standards.

**Saunders:** There are multiple challenges – the biggest issue being the integrity of the data being analysed. All you need are some data points to be slightly out of calibration and your analytics is incorrect. Your analytics is only as good as the data provided.

We have overcome this by triangulating our data. This ensures that we have multiple reference points to prove that the integrity of the data is correct. We have developed an extremely cost-effective wireless sensor solution to integrate throughout the HVAC plant that improves the overall analytics performance.

**Wood:** Once you have selected your preferred BOS, a significant amount of resources – internal and external – must be allocated to the implementation process. Improper implementation could lead to increased work, with limited reward.

The reporting systems must be customised to meet end-user requirements and come with a user-friendly interface to enable data interrogation. Time must also be spent fine-tuning and developing BOS algorithms to match the particular environment being monitored.

Most importantly, a system for categorising and prioritising the identified faults and opportunities must be developed. If not, you will end up with the fast-flowing river of unstructured data and information you described earlier. The major challenge is streamlining the analytics process in order to maintain the enthusiasm of those involved and avoid optimisation fatigue.

**Wurfel:** For BUENO, we have solved a lot of the technical problems around integration, curating the data and doing something meaningful with it. But the real issues are around stakeholder education and engagement in operation.

## KEY QUESTIONS

**Crown Resorts' group manager for sustainability, Jonathan Wood, M.AIRAH, provides an insight into the key questions professionals should be asking when considering the relative merits of an analytics platform.**

"Not all analytics platforms available on the market today can provide the full suite of capability that should be provided with such a system," says Wood.

He says some of the questions professionals should be asking themselves include:

- Can the system pinpoint the source of failure at the equipment level?
- Can it integrate the BMS with other systems such as utility management, lifts, security and car parking?
- What are the hidden costs?
- Does it provide the flexibility to adopt new technology such as advanced trend analysis, predictive fault finding and intelligence software?

"Building optimisation systems will allow maintenance contracts to be re-written by removing unnecessary preventative maintenance activities and directing resources to where they are required," he says of the changes big data analytics is creating.

"Integration with work-order systems will remove manual handling, and fast-track rectification works. This process will yield benefits that we are only just starting to comprehend but will significantly reduce operating costs and refocus human resources to higher-level, value-add activities."

Some people we talk to just get it immediately, but with others it doesn't matter how many hours you spend explaining it or showing them examples, they just don't understand what they're missing by not using their data better.

Then whenever we get started with a site, an interesting dynamic plays out where the FMs might think that we're there to make them look bad, or the controls contractor feels like we are there to take their work. We haven't figured out the magic ingredient to get things up and running from day one without this feeling-out period.

**Ecolibrium:** How will access to external data sources influence the future of HVAC design and analytics? Will it force the industry to be more outward looking?

**Roussac:** Like the real-time happiness of building occupants? That would be a good one!

At Buildings Alive we do a lot with Bureau of Meteorology weather station data and utility smart meter data. Ultimately, the broader the range

of reliable independent data sources, the more robust any analysis will be, and the more interesting the questions and answers will be.

**Wall:** Further use of big data and seldom-used data sources will most definitely influence HVAC design and operation.

Big data from the performance of building stock will provide valuable decision support for informing policy, energy-efficiency investment decisions, and improving modelling and design through large-scale simulation studies. Localised high-resolution weather data, solar irradiance and real-time occupant comfort feedback will be imperative for the next generation of predictive optimal controls.

**Saunders:** Marc Andreessen said it best when he said software is taking over the world.

Engineers and building managers should get comfortable with more IT folks coming into their world. It happened in marketing, accounting, finance, HR etcetera so this is ultimately the last true

frontier that has been relatively untapped. But as the CFOs find out that there are bottom line dollars going to waste, they will have a keen interest to capture that through real time analytics technology.

**Wood:** Despite the already-existing vast amount of data available from current building automation systems, there is a disconnect between HVAC design and what works in practice. The systems and equipment specified and the control algorithms adopted are typically far from ideal. Adding more information to the pile will not address this issue.

There is a significant opportunity for HVAC design engineers to broaden their practical knowledge through direct involvement in building optimisation systems. This can only be achieved by on-site experience and working with facilities management personnel. This will hopefully close the loop in the continuous improvement process.

**Wurfel:** The first frontier is just for businesses to access their own data first.

There are so many areas where the data tap is on and it's all just going down the drain. Once that is set up then we can start using the data to close loops in design where specifications are rarely field tested, or in operation where blind benchmarking could be used to understand where the broader issues are with sites relative to the rest of the market.

**Ecolibrium: How should readers prepare for the big data revolution?**

**Wurfel:** Recognise that while it doesn't happen often to the property industry, a real paradigm shift or disruption is coming.

A lot of manual hours are going to be replaced with automation. This means that the quality of people's lives will improve because they can just worry about solving problems (fun stuff) rather than looking for them in the first place (dumb stuff).

However, for business models that rely on labour hire to do the dumb stuff, this is going to be a challenge. These businesses will need to find a way to evolve to start delivering on quality rather than just selling dumb hours.

**Wall:** With a plethora of building energy-related services and solutions now claiming to offer some form of advanced analytics or fault detection,

it is important to understand the key features to look out for and how to differentiate those solutions that can really add value to improving building operational performance.

When considering such solutions, be sure to have an understanding of the underlying algorithm or automated techniques employed – as opposed to just manual investigation by domain experts – and how the results can be integrated and used to facilitate improved O&M without information overload to FM staff.

In addition, AFDD (arc fault detection device) systems or services that use machine-learning and/or hierarchical rule sets with inherent knowledge of inter-system dependencies can help in more accurately detecting equipment and system faults, and with less false alarms.

**Wood:** Over the next five to 10 years, all buildings with automation control will incorporate a BOS. Choosing the right system that can integrate existing building information systems at minimal cost is paramount for future-proofing the building and the businesses that operate within it. Understanding how this process works and how it will evolve is paramount for HVAC professionals staying at the forefront of their industry.

**Roussac:** I would encourage any HVAC professional to sign up for one of the massive open online courses (MOOCs) on data analysis. They provide amazing professional development.

Make no mistake, it's complex and challenging stuff. But even for novices like me it really is fascinating to get a glimpse of what's possible. And there's a clear pathway from novice to expert to top-ranking Kaggle for anyone who wants to put in the effort. There are no barriers these days.

**Saunders:** Generally, the building engineering environment has been very locked in their ways of doing things for many years. Like any industry or profession, those that adapt will survive and those that don't will be left behind.

I believe that all industry professionals should keep an open mind and embrace the new developments and evolution of our industry.

Change is inevitable, so why not embrace it? ■