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Get smart

Converting modern buildings into intelligent spaces.

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Smarter than smart

By completion new buildings often suffer from compressed commissioning, poor performance and ongoing issues. The challenges for those new smart buildings are numerous: Will they really save us money and time and be as comfortable as promised? **Jonathan Clarke, M.AIRAH**, has taken a deep dive into the world of smart buildings, exploring the challenges that must be overcome to convert a building that is simply "modern" into an "intelligent" building.

The terms "intelligent" building or "smart building" have been bounced around over the years but what do they mean? IoT, big data, analytics, artificial intelligence, augmented reality, BIM and gaming engines are all working their way from nerdy buzzword to reality, adding a complex layer of technology to a building with a vision to attain the accolade "smart building".

BACKGROUND

We are surrounded by huge amounts of data with connected devices exponentially increasing by the day, from mobile technology to the buildings we occupy. Digital intelligence is the current trend and data is the new currency.

The Oxford Dictionary defines intelligence as: "The ability to acquire and apply knowledge and skills". But is there also a standard definition of what an intelligent building is?

The Intelligent Buildings Dictionary says it is "a building that integrates

technology and process to create a facility that is safer, more comfortable and productive for its occupants, and more operationally efficient for its owners". An "Intelligent Building" has a multitude of definitions across the world with a different meaning to both owners and occupiers.

The Intelligent Buildings Institute in the USA defines it as "a productive, cost-effective environment with an optimised structure, systems services, management and integration".

In Europe, the Intelligent Buildings Group defined an intelligent building as one that; "Creates an environment which maximises the effectiveness of the building's occupants while at the same time enabling efficient management of resources with minimum life-time costs of hardware and facilities".

In contrast, the Asian market focuses on automatic controls for building services, building networks and telecommunications.

The Japanese emphasis is on management efficiency, satisfaction for tenants/people, low costs, as well as fast, flexible and being economical to build.

The International Standards for Automation Organisation (ISA) is developing Standard 111 Unified Automation for Buildings, which proposes the following: "To develop standards, recommended practices, and technical reports to communicate the necessary information to allow sub-systems to be managed, and to interact such that the building or collection of buildings appear to the user to be a single, coordinated and cohesive building automation system".

All the above may apply, however, a building riddled with innovative technology creating a super smart building brings a number of challenges, and not just of a technical nature. These buildings break traditional procurement and construction methods, and this is why some of the smartest conceptual ideas fall short of the vision.

TOWARDS A COMMON LANGUAGE

Searching the internet provides a wealth of information regarding smart buildings, particularly from technology suppliers who have promotional videos selling the latest gadgets. Browsing through the plethora of hypertext, a few common smart building themes can be found:

- Green
- Comfortable
- Connected
- Safe
- Productive and creates "a user experience".

We have been doing "green" for several years and are very proficient at making buildings both efficient, and comfortable.

"Connected" is not just about remote access, or providing wi-fi, it's all about data, and lots of it. Data is powerful if you know what to do with it. The banking and advertising industries have been using data for years, and this has now entered daily life, with building analytics systems becoming standard tools for building operations.

Safety is critical, and typically defined by local codes; however, being safe has gone way beyond fire and evacuation systems. In a world with threats ranging from terrorism to cyber hacking, "safety" covers a wide spectrum. Smart buildings need to have the ability to protect themselves and connect with the occupants, providing safety advice and mass notification through several mediums such as social media, apps and visual noticeboards. A smart building also needs to protect its data, particularly occupant credentials.

"Productive" might be the hardest term to define, with possibly differing outcomes between occupants and the building owners.

A productive building using analytics could reduce operational costs through capturing occupant complaints, initiating workflows, reducing maintenance and maximising energy efficiency.

An occupant's journey through a smart building will engage with many technology touch points. With the exception of car parking, vertical transport is typically the first touch point. Once they have mastered the "destination control" system, been approved by the "access control" system using either access card or mobile phone, a lift will be allocated.

The next touch point is the room environment, which includes lighting, temperature and fresh air – all combining to make occupants healthier, happier, and therefore hopefully more productive.

All of the above is quite typical in a modern building, but I believe a smart building should be capable of understanding its environmental conditions, the needs of the occupants, be able to learn, adapt, optimise and self heal.

TECHNOLOGY LANDSCAPE

The biggest challenge with technology is keeping up with it. Due to the long duration of the planning and construction procedures, especially for complex projects, it is not surprising that buildings can be out of date at practical completion.

To understand the technology trends, we refer to Gartner, an American research and advisory firm providing information technology related insight for IT. Gartner has developed a technology hype cycle, Figure 1, based upon expectations over time, which identifies a number of technologies and their life cycle. (www.gartner.com).

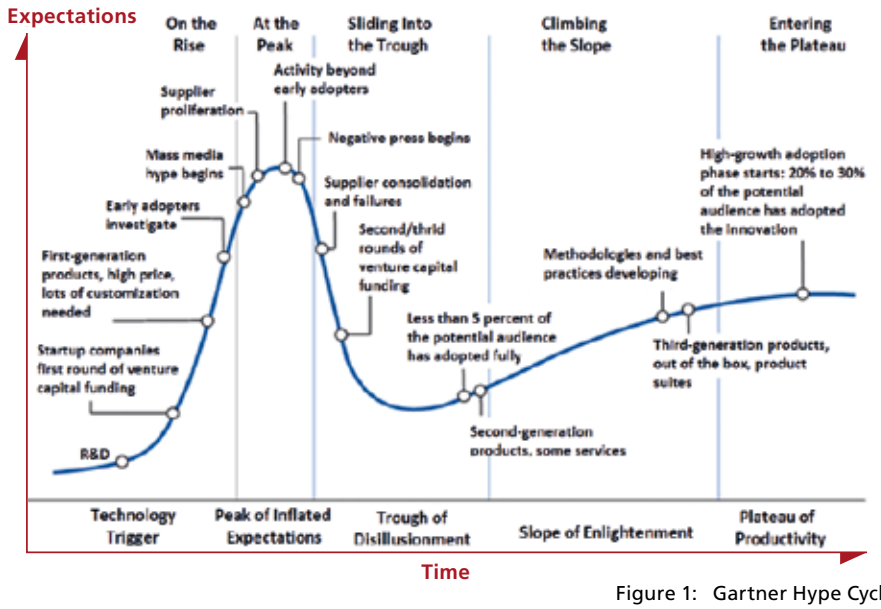

Figure 1: Gartner Hype Cycle.

INTEGRATED CONNECTIVITY

Traditionally, buildings have had multiple systems delivered in silos using their own communication networks, creating disparate and proprietary data. Over the past decade there has been a trend to converge these systems with a common network backbone as an integrated communications network (ICN). There are many challenges to consider when delivering an ICN.

- **Timing** – The network needs to be ready during construction in time for systems commissioning.
- **Compatibility** – The network must be verified for all proposed systems.

This hype cycle method can be applied to smart buildings as shown in Figure 2.

As an indicator, BACnet and open systems have become a standard offering, whilst the other technologies such as big data, analytics and smart lighting are getting some traction.

IoT sensors and Artificial Intelligence are in incubation so watch this space as these become standard in the future.

If we specify current technology making its way up the curve, it will typically be out of date by building occupancy, which could be two or three years later. Developers need to lock in supplier costs at tender, whilst the owners want the most current and up-to-date tech available. This conflict of interest needs to be resolved.

Figure 2: Smart Buildings Hype Cycle.

- **Reliability** – Paramount, as all systems can be affected by a network failure.
- **Operations** – The operational budget must also include network maintenance and support.
- **Security** – Security needs to be addressed for cyber-attacks, virus control and connection policies.
- **Ownership** – Ownership of the network must be clearly defined with service level agreements.

FEELING THE DIFFERENCE

Smart buildings are all about sensors, and lots of them. The more they have, the cleverer they are, that's the assumption. Some buildings claiming to host even 40,000. But what are they monitoring?

Buildings have always had sensors, from simple thermostats measuring temperature to air quality sensors monitoring CO_2 levels.

However, smart buildings extend their sensors to monitor external data, as well as operational and in some cases occupant data.

This includes data which may impact on the operation of the building, such as utilities, transport, weather and local public events. Additionally, structural monitoring, thermal mass and solar shading data can collectively be harnessed to provide a deeper understanding of building behaviour.

LOCATION BASED SERVICES

Understanding where people are in a building is extremely valuable for both building operation and tenancy space utilisation. Occupant data can be as simple as people counting to understand how many people are in the building, through to the complexity of where occupants are located. Agile working with hot desks has its benefits, but requires the need to understand desk utilisation, and where people are located, particularly in a large building or on a campus.

Room-booking systems have now become desk-booking systems, with visual dashboards indicating desk availability. Working in a project team may require a collaborative workspace, integrating location services, desk-booking and space utilisation to ensure a positive user experience.

There are many new standards to protect personal data. Also, people don't like the thought of being followed by big brother, so care must be taken and transparency applied, if this is a requirement. Access cards will tell when an individual has entered a tenant space, but not the location within that space. Laptop or hardware port connections can tell where someone is connected but they can leave the hardware in situ and go to a meeting eroding the accuracy.

Lighting control systems are now able to provide a level of occupancy data with passive infrared (PIR) sensors and Bluetooth in the light fitting, creating a digital grid or ceiling with various other sensors including temperature, although measuring space temperature at ceiling height is not the best reference point.

INTERNET OF THINGS

The latest buzz acronym is "IoT" the Internet of Things, which basically allows devices to connect directly to the cloud. This technology will share an abundance of data with any other IoT device. Currently, start-ups across the globe create new IoT devices for the consumer market. Smart thermostats, IP cameras, you name it, it's being developed; however, interestingly enough, without any security standards – and this is already making the news headlines.

"Home thermostat hacked"
– Heating system disabled

"Home webcam hacked"
– Occupants spied upon

Connecting anything to the internet is fraught with danger without precautions, and smart buildings are venerable targets turning IoT into the "Internet of Threats".

Shutting down a building management system (BMS) might seem trivial, but think of the disruption it may cause. Buildings have been connected to the internet for years, many without any security interventions, such as fire walls or antivirus programs. This issue must be addressed as more buildings and systems are integrated. Also, a substantial impact to a building being hacked is not so much the results of systems being over-ridden, but the brand damage it can cause to the building owners and tenants, particularly if the business in question is a tech firm.

IoT protocols are being developed to create a standard such as MQTT, which

is an extremely lightweight publish/subscribe messaging transport for IoT sensors providing messaging to the cloud.

To keep up with the trends, BACnet is being updated to include for the enhanced security requirements of IoT and cloud-based solutions. Wearable technology is a great example of IoT connected to cloud based monitoring systems. In 2016 the consultancy PricewaterhouseCoopers (PwC) reported of the 500 Australians surveyed, 55 per cent owned a wearable device, a symbolic majority compared to the 49 per cent in the USA. With health and wellbeing at the forefront of the corporate agenda, this will increase which could see buildings responding to a new set of data requirements.

ARTIFICIAL INTELLIGENCE

Looking into the future, we can just imagine how smart buildings will be able to take over control with the help of artificial intelligence.

Imagine an HVAC system with sensors, valves and relays that learns, configures, optimises and adapts without a central control system.

There is still a long way to go, but today smart-edge devices are being developed that are contextually aware, and understand their location and purpose – which is making them incredibly powerful.

Any AI system relies upon data that needs to be accurate and understood. Over the last few years analytics systems have been purported to be the solution to poor-perfoming buildings by mining the data in the BMS, and running rules.

The data being mined needs to be named correctly and the process to map the BMS points correctly is time-consuming and costly.

Project Haystack, an open-source initiative to streamline working with data from buildings, has developed a naming convention to make this easier. However, according to data scientists, naming is only part of the equation, and a building schema needs to be used to associate equipment such as “Brick”.

A building designed using 3D modelling and federated into a BIM has the potential to provide valuable data but in many cases seems to not quite make it to operations. Connecting thousands of devices and embedding them into a 3D environment is possible, but has its limitations, with large databases and enormous processing power required to render images.

Keeping BIM data up-to-date is the biggest challenge. Future technologies such as the Tango platform from Google may radically change the way we view and manipulate large models.

WRAPPING UP

We are just starting out on a digital journey to make buildings smarter, with new technologies entering the world market every month. With numerous sensors and connected devices transmitting their data, our industry is going to be significantly disrupted, and those that embrace the change will flourish whilst others that are sceptical will be left behind.

Quantifying the benefits of increased user experience with operational efficiencies and the technology budgets within the construction industry will be an interesting challenge; let’s hope someone is brave enough to break the mould. One thing is certain: construction disruption is happening which will impact the way we design and procure. The industry needs to get on board.

Technology expectations and budgets need to be set and not allowed to fall foul of the “value engineering” process or poorly executed design and construction (D&C) contracts.

Have you raised an eyebrow? Asking yourself the following questions may help you to strengthen your belief in the future of smart buildings:

Did you ever think you would send money to people you don’t know for something you have not seen? ***Online shopping such as eBay has disrupted retail.***

We were told not to meet people on the internet and get in strangers’ cars! ***Uber has disrupted Taxis.***

Building are developed on a financial model with tenants locked into occupancy challenging timelines. This probably will not be disrupted!

By practical completion buildings suffer from compressed commissioning, poor performance and ongoing issues.

Artificial Intelligence might just be around the corner to disrupt this! ▮