Like most technology products, Building Management Systems are undergoing a seemingly endless cycle of change. The demand for fast, reliable and dependable information is rising with a multitude of new systems feeding on the data gathered from the field and an abundant number of providers are beginning to fill our buildings with new and diverse sensors. End users are also becoming more educated in interacting with their buildings and are expecting more from systems which were traditionally back of house.

HOW HAS BMCS TECHNOLOGY EVOLVED AND WHERE ARE WE TODAY?

Recent BMS History

Unlike most computer systems, the memory and processor requirements haven’t changed too significantly in the field BMS controllers, but the data being gathered and the scrutiny applied to it is ramping up. In many ways the evolution of the BMS in the past has followed closely behind IT trends. The rate of current development demonstrates that this does not appear to be changing.

From his book The Road Ahead (Penguin Books, 1996), Bill Gates saw a trend in tech development - “We always overestimate the change that will occur in the next two years and underestimate the change that will occur in the next 10. Don’t let yourself be lulled into inaction.” This is particularly true for the development of BMS.

Looking back some 25 years ago to the year 1995 and the dominant marketing material for BMS vendors was generally around converting text based “green screen” DOS BMS user interfaces to Colour Graphics in Microsoft Windows environments. This was the moment BMS suddenly came to life.

Fast forward 5 years and there was significant investment in the upgrade of BMS as the Y2k bug spawned a flurry of activity to protect our assets from the perceived new millennial threat.

The promise of “Open systems” was established about 15 years ago. This gave the opportunity for standard devices to sit on the same networks, however this unfortunately was not the beginning of the era of “vendor independence” that many had hoped for. IP based controllers and systems began to emerge as RS485 networks struggled to pass the volume of new data.

Around 10 years ago, a web compatible and mobile compatible BMS had become expected. Most vendors provided a solution to appease expectations, but the uptake was mixed. In Australia there was a skills shortage as mining exports more than tripled over the 10 years to 2012. Many consultants, engineers and technicians moved to better paying mining jobs, vastly reducing the amount of manpower available to spur development in the BMS industry.

Following the downturn of the mining industry 5 years ago came the firm establishment of automated analytics and intelligent buildings in the Australian market with mixed results. The marketing promise of reduced operating costs from Data Driven Maintenance was not as conclusively realised by building owners and managers as first thought, with some platforms being rushed into deployment and others under serviced.

Today

Today, the BMS market is met with an explosion of new market influences. Buzzwords are abundant: IoT, AI, hyper-connectivity, cloud solutions, information driven maintenance, data lakes, Fog computing, big data, framework, multi-platform systems. Information is being demanded on an unprecedented level, and there is
a clear expectation for fast reliable information. There are a massive number of devices and companies with interests in measuring and controlling all aspects of a facility. For example, Augmented Reality (AR) and Virtual Reality (VR) technologies are becoming more widely used in healthcare from the operating theatre to the boiler room. The construction industry – historically slow implementers of technology – are now commonly using VR combined with 3D drawings and precision laser pointers to lay out equipment and install hangers inside concrete slabs before they are poured.

Service organisations are also beginning to use AR to see through walls to the services network of pipes and ducts to diagnose systems. Some mechanical service providers are streaming live (and historical) BMS information to their technicians to aid them in the servicing plant and diagnosing building system issues.

BMS information is even being used to assist in equipment lifecycle planning. The runtimes of equipment obviously contribute to the wear of the machines, likewise the number of starts per hour and the additional stress on under-sized machines contribute to the shortening of equipment life and reliability. Third-party devices are also being applied to measure the vibration or sounds from major plant to predict equipment failure. Energy, water and other performance measurements are seeing greater demand with increased scrutiny.

The current generation has grown up in a world where “all” information is at the tip of their fingertips through connected mobile devices. Because of this, it is anticipated that the expectation for meaningful, secure, interactivity with systems will only increase with time.

WHAT DOES THIS MEAN FOR THE HOSPITAL ENGINEER TRYING TO MANAGE THE BMS?

The reality for many hospitals means considering the existing installation and potentially significant investment in their BMS. In many cases the BMS vendor is the only source of technical advice for the client. Unfortunately, this provides an obvious biased opinion and is not likely to result in a more innovative approach to the solutions required in today’s market. On the other hand, the BMS vendor usually has a good knowledge of the idiosyncrasies of the facility and the ability to provide excellent supporting information to an upgrade which they are involved in.

Sadly, being locked into a single manufacturer’s platform usually means:

- High maintenance costs
- High repair or upgrade costs
- Dependant on vendor for advice

As such, one of the most frequently asked questions is “which BMS should I choose?”. This however doesn’t have a simple answer, as most platforms provide similar hardware and software features.

Sometimes the larger companies offer improved support – but at what cost, and have they been able to retain the skilled staff you want to turn up on the next service call?

Smaller companies often have a greater level of customer service but can lack the diverse skill sets required for modern projects.

Some offer “open programmability” inferring that other vendors can extend, repair, service or upgrade the system, but there are still ways to lock down even these systems.

New players to the market are offering “controllerless BMS” where they use Internet of Things sensors which are combined in logic on either an edge device or in the cloud.

Some of the BMS Skills required in today’s market:

- Programming language (specific to the vendor and sometimes multiple vendors)
- Graphics and human interfaces
- Trends and historical reporting – managing controller capacities and databases
- Mechanical design
  - Hydraulic / liquid flow
  - Airside
  - Chillers and staging
  - Energy management
  - Control loops
  - Sensor selections and proper locations
  - Control device selections
- Electrical systems and power analysis
- Cabling design – sensor and signal electromagnetic interference, RS 232 / 422 / 485 and IP network cabling designs and limitations
- Protocols
- Databases
- Other vendor integration
- Data presentation
The answer to the question “which BMS should I choose?” is therefore about who is programming the system and the level of support offered post-installation.

The most important consideration is where technical advice is sought from and how the BMS is policed. A detailed specification is required for small changes to the system or even a service contract. The BMS work needs to be periodically verified to ensure compliance with the specification. BMS vendors often see the BMS specification as a “guide” rather than a contractual document. This has usually come about because of poorly written specifications in the past.

In some facilities “analytics” engines have been added, overlaying the BMS with a promise of cheaper maintenance, improved energy efficiency, reduced reactive works or even to police the BMS. While some platforms are achieving some of their goals, often the reality involves more alarms (now coming from the original BMS and the analytics engine), duplication of systems to license and service at additional cost to the building manager, conflict between multiple vendors with competing interests and even downstream BMS networks being overloaded and crashing.

It is clear that analytics have a place in the modern system, but just like the BMS, they need to be carefully specified and verified to ensure they achieve the targeted goals. In the past, when it came to issue resolution there used to be a BMS contractor and a services provider (usually mechanical services) standing in a plantroom pointing the blame at each other, now there is a new player in the room offering more confusion.

Often analytics providers are not integrating to the desired levels and do not implement nor sometimes understand, the hierarchal relationships between the plant and equipment which service the facility. When implemented correctly, this can provide very powerful insights into the interconnected systems, but too often these are underdeveloped and “simple” rules are applied which are not much better than a well configured BMS alarm regime.

Another legacy issue many hospital engineers face is poor documentation. As-built data is often unavailable, out of date or incomplete. Many construction projects deliver separate systems which are expected to provide a seamless user experience, but often fail to achieve the desired level of integration. A recent count of programmed control systems in the central plant of a modern hospital saw over 70 disparate systems. From generator and HV control systems, right down to stand alone pump controllers, there were over 6 different Windows operating system versions required and countless vendor software packages and proprietary connector cables to manage. In fact, most of the systems were not networked to each other and only a handful had some level of basic integration. Before the audit, the plant operator only knew of 6 of the 70 installed systems, exposing the hospital to significant risk should any of these systems fail. During the review, it was identified that most of the control systems did not have backups for their program or had ever been serviced.

In another review of a recently constructed site, it was revealed that there was incomplete commissioning data. While this initially may not sound significant, further investigations identified that the BMS programmers had mislabelled sensors and actuators, failed to connect some devices, fed redundant systems from the same power source or were controlled by the same hardware (causing a single point of failure) and had created graphics that were not matching the physical installation or schematics. In totality, these issues can be compared to a ticking time bomb which is waiting to flare up, usually at the worst possible time. Compounding the seriousness of the situation, the service provider was unaware of these issues and had no plans to test the functionality of the critical systems.

Post-installation, poor documentation also led to the inability of the end user to monitor, control, understand or change the BMS. The BMS training for the operators was inadequate and often referred to non-specific generic literature. The user interface was not properly accessible for graphics, reports, alarms and was not intuitive or an accurate representation of the reality in the field.

While the previous example was of a greenfield site, often the biggest issue with older facilities is change management. Recent projects have required a significant and expensive re-commissioning process due to well-intentioned technicians who have reprogrammed the BMS to address physical issues, made changes based on poor information leading to an incorrect diagnosis, remotely conducted maintenance without verifying the result onsite or have used the BMS to “fix” other physical issues without addressing the root cause. Many of these changes were undocumented.

Older facilities over time undertake projects to expand or reconfigure spaces into alternative uses. It is often overlooked that the BMS requires modification to
match the requirements of the new space and best serve its needs. Whilst an older facility will plan for the lifecycle replacement or upgrade to the mechanical services, the upgrade or replacement of the BMS is commonly underestimated or poorly planned. Easy energy efficiency gains can be realised by replacing mechanical services, however these gains can be compounded by ensuring that the controlling equipment is current and capable of providing the full extent of control required. Whether maintaining or upgrading an older facility, it is important to consider the fire, power and other life safety functions controlled by the BMS. Neglecting the BMS and leaving these functions untested and unresolved can lead to compliance issues during mandatory full function (power and fire) testing.

Within the health facility world, uncontrolled or poorly understood changes to the BMS programming have recently been associated with mould issues, creation of single point of failure and the inability to diagnose problems because the BMS graphical information was no longer valid. All of these situations lead to a significant increase to patient care.

THE FUTURE FOR BMS IN HEALTH CARE FACILITIES

Having demonstrated the potential pitfalls in a poorly implemented and maintained BMS, the goal for the modern BMS user is to create a managed, well documented, intuitive system serviced by a competitive environment where the most suited vendor is selected, and price is reasonable. Where practical, convergence with IT should be sought to leverage systems and architecture already provided in a reliable and controlled manner. Analytics can be used to support a well configured BMS and provide valuable insight into issues which would take a trained operator a significant amount of time to manually diagnose. Finally, the system should have a lifecycle plan for progressive upgrades and be future proof.

The facility should also consider other input sources to their data model including BIM and any other construction modelling. New facilities or expansion project data can provide valuable information about the relationships between equipment and the spaces they serve, while existing facilities can benefit from point mapping and retrospective drawing uploads to build-up the information when required.

To achieve a reliable and high performing BMS, the follow suggestions are provided:

- Prior to undertaking a BMS project, engage a vendor independent BMS specialist consultant to assist throughout the course of the project. Having a third-party specialist assist with identifying the primary requirements of the BMS and provide guidance in writing specifications will greatly improve the odds of a successful outcome. This will also help prevent being drawn into a single manufacturer’s platform and the accompanying pitfalls.
- Consider a separate technology package to sit parallel with the mechanical, electrical, communications and security contractors. The BMS shouldn’t be an afterthought, but rather an extensive, planned technology installation.
- Create a clear specification for mechanical, BMS and analytics services post construction. This should be targeted on proactive, performance-based maintenance outcomes to ensure that the product has been installed correctly and is operating to its best ability. Savings will be realised in reduced temperature complaints and energy usage.
- From the outset of a project, specify the targeted analytics of the new system:
  - Immediate alerts - separate to BMS alarms, these alerts are used for multi-faceted events where the equipment is detected to be operating incorrectly. Conversely, ensure there are appropriate inhibits are built to prevent false alarms as over-alerting can lead to lax response times.
  - Short term trends - equipment is failing to perform the required outcomes over a period of a few hours or days.
  - Long term trends - equipment is repeatedly out of service or desired conditions over a long term. This can also be used to support a lifecycle analysis of the underlying plant and equipment.
  - Develop comparative sensors to cross-check readings.
  - Develop exercise routines for plant, actuators and end devices.
  - Configure data to feed into a larger dataset which can provide source information to other services in a secure structured method.
- Establish clear change management expectations by conducting regular change management meetings with defined responsibilities and deadlines.
- Establish a programme to conduct risk management reviews, including physical installation, contractor performance, end user requirements and compliance testing.