BMS AND THE DAILY CHALLENGES

The challenges facing the BMS specialist are many fold and although the Building Management System and its basic role as the control of the mechanical services plant and equipment has not really changed over the years the emphasis for the BMS Contractor is moving from one of simple HVAC control systems to more complex integration, energy management and smart building technology.

The original idea of the automatic control system was as its name suggested an automatic control system that within our industry was used to control the heating ventilating and air conditioning systems.

This role continued for many years with the automatic control specialists becoming more and more involved in the actual selection of plant control as some building services consultants moved this responsibility from their remit to the controls specialist. The argument made was that the controls specialist had to control the air handling plant despite the fact that the building services consultant was designing the systems long before the controls specialist became involved.

Added to this you have the dreaded words value engineering mentioned in every project not only for the BMS but it is the BMS that we are concerned with and it is the BMS that in my view seems to be criticised mostly.

Thinking about the challenge of the BMS in the future it is becoming evident that the traditional BMS specialist whose role will include controls and invariably power wiring, motor control centres and the like is being asked more and more to become involved in energy management, tenant billing, integration of third-party services, smart buildings and added to this is the challenge of controlling plant and equipment that is becoming more complex to understand that is becoming supplied with integral controls that are supposedly better than that provided by the BMS specialist along with the general cost-cutting and increased scope required by the end user.

The BMS specialist should really be involved as early as possible with the project and I see the role of the BMS consultant as taking this activity on in the early stages. However, even as a

BMS consultant we are not often involved in the stage 2 and stage 3 parts of the project and influences that we can have are reduced as design decisions have already been made.

It is understandable that the BMS specialist nor the BMS consultant can be involved at every stage and perhaps therefore we need to educate the mechanical engineers to at least appreciate that we can only control a system that is controllable and there is little point in trying to design the mechanical services system that are too complex and perhaps goes against traditional practice and then expecting the BMS to be able to solve problems where perhaps the use of low loss header or more pumping circuits would make life easier for everybody.

Value engineering

The word value engineering means lots of things to lots of people personally I believe it means 'what can we take out of a job to save money'. From the BMS perspective we are unlikely to have provided unnecessary control instruments and actuators as unless they serve a purpose they are not usually included. Every project could have instruments and actuators removed and these will make substantial cost savings however, there has to be a payback for this reduction of materials.

A particular project springs to mind where the monitoring of plant and equipment was deemed by the main contractor to be an unnecessary expense as these did not actually provide control functions. The client however when made aware of these reductions and the consequences of them was not enamoured with the idea. It was pointed out that without these monitoring functions it will be necessary for him to employ site staff to physically inspect systems such as water treatment plant on a weekly basis as without them doing that faults may never be discovered. For a small project this is a high cost and it is unlikely that a permanent on-site maintenance team will be employed although it is agreed that on a larger project where facilities management is more high-profile that this reduction in monitoring should not really bring about additional costs. Conversely these larger projects are more likely to involve energy management and proactive maintenance and the removal of these monitoring systems will greatly reduce the ability of the BMS to provide useful information on which the facilities management team can base engineering judgements for proactive maintenance, energy management and general good housekeeping of the plant and equipment.

Very often the professional team will question why a project is over costed and these can be many fold. Perhaps the end users requirements have been changed during the design period, perhaps the plant and equipment envisage has been revised, perhaps the building use has changed there are many minor changes all of which will bring about cost changes.

As the BMS specialist we have to recognise that we must reduce our costs however, this does not mean reducing standards or simply moving scope such as motor control centres and power wiring from one contractor to another we need to bring ideas to the value engineering workshops that are useful and not be blockers.

One of the challenges that we face in value engineering is that unless mechanical plant and equipment is removed then the BMS costs cannot come down. There are alternatives suggested such as using package specialist plant and equipment with inbuilt control strategy, the use of alternate BMS systems, the use of a less sophisticated control strategy along with the usual suspects of just reduce the cost as we must be overcharging the client.

Packaged plant

The suggestion for using package plant and equipment often comes from the packaged plant supplier as the cost for the control system is generally hidden within the larger cost of the equipment they are providing. For the BMS specialist this is taking away plant and equipment costs and profit and yet leaving the BMS specialist often with the challenge of integrating this third party equipment with other control systems on the project. An argument is often used that says the systems are open protocol and therefore it is simply a question of plug and play however, open protocol and plug and play are not simple, never have been simple and the costs are borne generally by the BMS specialist rather than the third-party specialist.

Furthermore when third party control equipment is used the third-party specialist has numerous engineers who can understand the plant such as the chillers, boilers or the air handling plants but there engineering expertise with respect to the control system is usually vested in one or two people and asking these people to attend site on a regular basis can be very difficult. The mechanical contractor therefore reverts to the BMS specialist to solve these issues when in fact they are not in the remit of the BMS specialist responsibility, nor within the BMS costs and

sometimes not within the BMS specialist understanding. Unfortunately this practice of using the BMS specialist to resolve control issues across the site has always been around and whilst the BMS specialist was providing control panels, valves, instruments and actuators then these cost could be absorbed however, with more package plant and equipment and more third party suppliers of instruments and actuators the ability of the BMS specialist to absorb these costs is falling and to be honest the automatic control systems on the sites are becoming more disjointed rather than integrated as nobody is taking overall responsibility.

System integration

Thinking about system integration there is a general belief that system integration and plug and play are standard fare and easily resolved. Although undoubtedly integration is possible and does take place and is useful, there are many instances where the integration is difficult to interface and should not really be considered.

Things that spring to mind include such items as pressurisation units although the pressurisation unit is an important part of the project I fail to understand what information is needed from a pressurisation unit other than a high and low pressure alarm and perhaps a common fault. Every mechanical engineer wants this information to be hardwired as it forms part of the safety circuit and yet pressurisation units are now provided with Modbus cards. All of the extra effort of Modbus integration just adds extra work, effort and commissioning time for little or no gain.

It is often a requirement that the chillers are connected to the BMS via a high-level interface and this is carried out on numerous projects. Again though I wonder what useful information is being provided to the BMS to make this interface necessary. I agree that with a smart building and perhaps if the BMS can understand if the chillers are lightly loaded or heavily loaded, their electrical use, compressor hour run, head pressure, oil pressure and the like that it may be possible for the BMS to operate the chiller more efficiently. However, do we have the skills to understand the efficiency of the chiller to allow the BMS to operate this more effectively?

Whenever system integration is suggested it is usually the BMS specialist who has to provide the glue that joins all these systems together. The specialist suppliers offer multiple

information from their Modbus tables but when asked to suggest perhaps four or five useful items nobody ever seems be a to come up with a sensible suggestion other than let's have all 50. The problem is that with all this information being provided nobody either looks at it, nobody understands it, and unless a lot of time has been spent during commissioning there is no guarantee that the information being provided on the BMS screen is the information being obtained from the third party equipment.

So as far as integration goes it is important that the end user understands what information he needs and with that in mind the building services engineers can provide it. However the end user really does not know what information he needs and is guided by either the building services consultant or perhaps the facilities management team each of which will have a different view. This is just an example of why cooperation is required across the project where everybody has a role to play and each is important at a particular time.

Smart buildings

A lot has been spoken about smart buildings in the last three or four years. As of yet we really don't have a clear definition of what a smart building is.

Generally there are two schools of thought : the first is that the Smart relates to the intelligent management of the services system the other is that the Smart relates to the intelligent management by the occupants of the building services systems and other in-house services.

As far as building management services are concerned the smart operation is one that should already be implemented with information being moved into such platforms as maintenance records and asset management. Unfortunately these are the type of activities that are quickly value engineered out of developer led projects, which unfortunately means that the facilities management team are fighting an uphill battle before they even start.

On the other hand if an end-user is the developer they are keener to implement this type of service but it quickly becomes apparent that if the building is a multitenant let then the smart aspects other than that for the central plant are quickly diluted.

The implementation of the smart central plant system is at the moment laid at the door of the building management services contract. Although the systems are manageable and programmable by the building management system contractor the problem is one of the contract rather than a technical issue. At the project completion it is impossible for the BMS specialist to demonstrate the smart facility as this can only take place over the next 3 to 5 years as a minimum. This will involve the BMS specialist in long-term activities at the site and these are against the principles of the main contractor for the project who is unable to demonstrate his works are complete and therefore perhaps is unable to obtain full costs for the project from the developer. The only way that this sort of impasse can be solved is that the smart section of the project needs to be implemented with basic hardware during the contract and a separate smart intelligent contract is let after contract completion. This will allow all parties to move past the stage of completion and onto the stage of operation in which the smart management can be implemented.

Whether or not the BMS specialist is best place for this smart environment is yet to be seen as to be honest there are perhaps only three or four buildings in the UK that are attempting to embrace the full implementation of smart.

It is fairly evident that the smart building will quickly become the norm although the definition of smart may be manoeuvred towards high level integration of mechanical services plant and equipment with each other which in turn will eventually lead to new methods of plant control strategy based upon the needs of the occupant rather than the hard desired value set out by the building services engineers during the design phase. It is important to recognise that Smart will not in the first instance be saving money but be more able provide a platform upon which the facilities team can build proactive maintenance based on real data, they could service the end users more efficiently for instance by measuring water flow rates in toilets and reducing the cleaning staff of these areas if they are lightly used.

Building management system control strategy

The control strategy in any building management system is based upon basic principles that have been in existence for as long as building services have been designed. Although the hardware has changed from analogue controllers through to cloud-based computerised systems

principle of control over their handling plant is still the same. Good building environmental conditions relies upon good control strategy, good instruments and actuators and an understanding by the BMS specialist of the requirements of the original HVAC designer. Very often the design ideas of the HVAC engineer become lost in translation and often the engineer is unable to put down into words his requirements. The sort of issues can be resolved if engineers communicate with each other on a professional basis unfortunately there is often a tendency for one or the other side to put up barriers of defence. This stand-off is often blown out of all proportions and all that suffers is the project. As engineers we all need to work together to solve these issues. Once this collaboration takes place there can be give-and-take on both sides perhaps pipework can be slightly modified to provide space for instrumentation and perhaps control strategy from a similar project can be described to the HVAC designer so that he can make use of other people's ideas which have proven to work.

Even once this corporation is active there is still the challenges at site level of practical constraints and unfortunately the value engineering applications. If the value engineering applications decide to reduce the instruments and actuators provided by the BMS then everybody needs to be aware of the consequences. During the life of the project, engineering teams need to work together to resolve continuing challenges that only become apparent as the project develops. There is little point in believing that giving status A to a tech sub or perhaps a description of operations means that no other work is required, experience shows that once plant is operating dynamically the set points, control strategy and expectations have to be modified to bring it in line with the performance of the actual plant in the building which it serves.

Again we are faced with the problem that at the day of practical completion there is still an expectation that nothing else is required to be carried out and that the building automatic control system is going to be working perfectly forever and a day. This is evidently not the case as otherwise we would not have maintenance contracts in place although I agree that this is perhaps for repairs but the better projects view maintenance as an ongoing continuous commissioning activity which will improve the conditions within the building and will provide proactive maintenance tasks.

Energy management

Energy management and energy monitoring is used on nearly every project whether these be small two story developments or perhaps 50 story tower blocks.

The BMS specialist is possibly best placed to provide the energy monitoring systems insomuch that these are generally electrical, water, heat meters that are provided with Modbus, M-bus, BACnet connectivity that require to be networked together and displayed at the BMS head end supervisor. There is a belief however that the energy monitoring should be carried out by some other third-party specialist who has convinced the end user that they can provide them with energy management to a far high level and far cheaper than that that can be delivered by the BMS specialist. It is not deniable that perhaps this is the case for some suppliers but is not for others. However, the suppliers almost invariably are not interested in providing any installation services to the construction phase of the project but often set down rules and regulations such that only meters provided by them can be used and that only wiring to their specification is suitable. This may be the case but it is the BMS specialist who is being asked to install this works and is being asked to verify and confirm that the works are operating satisfactorily only for the third party to then take this information and return it to the user very often as a simple graphic dashboard with some ideas about how energy could be saved and perhaps provide a baseline of other buildings of a similar nature showing that the operator of this building is working more efficiently than others. I find it hard to believe that the BMS specialist cannot offer this type of activity, often the BMS specialist is not given the opportunity to provide energy monitoring and management and yet they are asked to provide smart building controls that are far more complicated than energy monitoring and management.

With regards to energy monitoring this is often mixed up with tenant billing all of which leads us to apparent need for MID approved meters. Very often energy monitoring can be carried out simply by the use of flowmeters and temperature sensors and even simple hand-held instrumentation is acceptable. The MID meter is only needed if billing is to be carried out and even then if there is an agreement between the occupier and the tenant as to the method of measuring the energy perhaps the MID meter is not needed at all. However this is one of the myths of the industry that grown up around itself along with an apparent idea that a MID

approved billing system has to be implemented. I have never actually seen a standard for a MID approved billing system and am sure that one does not exist.

I am of the opinion though that extensive use of flowmeters and temperature sensors as part of an energy metering system provides a lot of information to the BMS that if managed correctly will provide a basis for better control strategy and more efficient use of plant and equipment. The plant manufacturers of boilers and chillers can provide coefficients of performance which can be used as part of the staging and loading of the central plant. If the BMS measures the heat/coolth provided by the chillers and boilers and compares this to the electrical energy being used by those particular plant items it can develop its own coefficient of performance of the plant based upon real activities taking place in the building. I agree that the mathematics will not be simple but with some thought by perhaps facilities management team in conjunction with the BMS specialist they should be able to develop a very sophisticated program that is able to control plant and equipment in the most efficient manner.

APARTMENTS

There are numerous projects today that involve residential apartments all of which require some form of control system.

There is a belief by the building services engineers that we don't need a BMS in apartment on the other hand they are insistent that heating cooling systems do not fight each other and that the tenant is provided with a method of time clocks and calendars along with energy displays and temperature adjustment. This appears to me to be an automatic control system which we will call a BMS, unfortunately the developer assumes that the BMS is expensive and all he wants is a simple control system.

Developers and some services engineers believe that a cheaper control system can be achieved by use of packaged plant each with his own control instruments and actuators. Yet again however they leave the task of joining these disparate control systems together to the contractor who in turn is to provide a BMS specialist who provides expertise in this field. The cost therefore are still the cost of the BMS no matter which way anybody tries to look at. Generally an apartment costs somewhere between £5000 to £7000 for a system that includes:

underfloor heating, fan coil units, whole house ventilation plant, gas cooking. This level of cost is bulked at by the developer who decides to save money and end up with a system that is not compatible with each other, usually they are two or three control panels to be operated by the tenant and in the worst case two temperature sensors in the room. The dumbing down of control systems will continue until the tenant complains about how difficult it is to operate in his view the simple heating and cooling thermostat. On the other hand tenants these days have access to smart phones and apps and wonder why they cannot just sit in the lounge talk to their smart phone and the temperature is adjusted the room. These are of course possible but only if infrastructure has been provided in the construction phase and unfortunately this infrastructure is not cheap but tenants will demand it.

Commissioning

The BMS is usually the last item to be commissioned on the project with usually the least amount of time available. In nearly every instance whenever the BMS is offered for inspection it will fail. It will not fail because the BMS does not work it will fail because insufficient time is provided to the BMS specialist to properly set to work test and commission the installation. To compound the matter third party control systems are very often not commissioned to the same level as expected of a BMS and these third party suppliers are very rarely available for long-term commissioning and testing at site level.

Everybody knows that the BMS takes a long time to commission and everybody says it can be done in no time at all just by using more personnel. This is not possible and if more emphasis was placed upon the BMS commissioning and less upon the hydraulic balancing of water and air systems it should be possible for the BMS to be used as part of the air and water balancing commissioning. Perhaps control valves with inbuilt flow monitoring can be used that can be remotely set by the BMS to provide the correct flow rates rather than sending commissioning engineers into ceilings and inaccessible risers to set control valves. Perhaps more emphasis should be placed upon the environmental condition rather than concerning ourselves about finite flow rates of air and water to a fan coil unit.

When the BMS is up and running it can be quickly be seen from the graphics whether or not an air handling plant or heating system is acting as one would expect. There will of course be BMS

control issues but these are unlikely to be poor software design rather they are more poorly installed sensor locations, poorly selected mechanical plant, poorly balanced water and air flow rates and with the use of suitable instrumentation it is quick and easy to spot if isolating valves are closed or if perhaps reverse flow is taking place or even if the sensors are actually installing the pipework.

Over and above this has to be recognised that the BMS can only establish good control strategies once the plant and equipment has been running continuously for three or four weeks and ideally if the building is occupied. Expecting a BMS to be looped tuned in a couple of days is not practical, unfortunately that all is normally allowed by the main contractor. As a witnessing engineer I will not sign off the project until I see it running not necessarily fault free but at least running under his own control for three or four days. During this time I would expect the contractors to provide some step inputs to it to simulate a rising or falling heating cooling load and then we can review the actions of the BMS takes. So long as these actions are generally in the right direction and it can be seen that the system is operated satisfactorily then this would be an acceptable milestone. However long term adjustment and loop tuning needs to take place in the following 6 to 9 months. This has recently been recognised in the soft landings programs but these are only given scant review by most contractors as I said earlier the main contractor needs to demonstrate on the date of practical completion that the works are complete.

If the BMS requires loop tuning afterwards then there is a view that perhaps the works are not complete or that practical completion is given with the caveat of the soft landing and ongoing BMS commissioning. Unfortunately this is not really helpful to the BMS specialist as perhaps he is unable to obtain full cost for his work. This is a conundrum to be resolved and perhaps is best viewed as a separate contract of BMS commissioning that is outside of the main contract and takes place after practical completion. I realise that this is not normal situation but we have to find a way forward to break this barrier called practical completion that on one side of it says all the work has to be complete and on the other side of it says everything is a defect that has to be resolved by the contractor.

Commissioning and finding instability in the control strategy is not really a defect. It is reasonable in my view to have commissioned the BMS to a static state before practical completion with a separate contract for dynamic commissioning after practical completion.

Contractors should make the best use of a BMS to test and review the MEP plant and equipment operation, seek out issues and resolve these. The MEP plant should be set to run at its earliest practical time and continuous monitoring of the plant inputs and outputs should be made either by experienced MEP engineers or through an automatic test script. The issues should be resolved, perhaps rebalancing water flow rates or adjusting system set points until stability is achieved. It is not an overnight process, soft-landings help but more can be achieved if clients recognise that plant operation is dynamic and needs to be 'run in' for a few months. Contractually I know this is difficult but surely it's better to provide the right solution over an agreed time period rather than the wrong solution at a fixed time.