INTELLIGENT BUILDINGS AND THE BID SPECIFICATION PROCESS

Rawlson O`Neil King
Continental Automated Buildings Association

ABSTRACT
This paper describes the main findings of a landmark research study undertaken by the Continental Automated Buildings Association to improve the understanding of the market imperfections and the inconsistencies that exist in designing and implementing intelligent building projects through the bid specification process.

PROJECT BACKGROUND

In 2013, the Continental Automated Buildings Association conducted a collaborative research study that examined the impact of the bid specification process on the deployment of intelligent building technologies in North America.

The Continental Automated Buildings Association (CABA) is an international not-for-profit industry association dedicated to the advancement of intelligent home and intelligent building technologies. The organization is supported by an international membership of nearly 400 companies involved in the design, manufacture, installation and retailing of products relating to home automation and building automation. Public organizations, including utilities and government are also members.

CABA's mandate includes providing its members with networking and market research opportunities. CABA also encourages the development of industry standards and protocols, and leads cross-industry initiatives.

The organization, originally founded in 1988, operates a research program that conducts market research focused on both large building technologies and home systems. The collaborative landmark research study, commissioned by CABA and conducted by research vendor Frost & Sullivan, found that the bid specification process has thrived due to demand for service solutions prompted by unique end-user needs and the perception of the cost-efficiency it provides building owners and operators.

BUILDING SPECIFICATION PROCESS

Building owners and operators utilize the bid specification process to procure the products and services required to run their properties. Building owners and managers use specifications, or written requirements, to outline the materials, products and services necessary for a proposed building construction project. Specifications describe the type and quality of every product and service required for a building project. They describe the requirements for building fabrication, erection, systems installation and finishing.

Specifications also include any necessary codes and standards applicable to a building project. Specification guidelines are endorsed by the construction industry in order to establish proper construction and installation practices for various service providers to follow and to ensure that building requirements are met in a cost-efficient and competitive manner for building owners and operators.

These specifications are used when building construction projects go to tender. CABA's research has found that specification guidelines are endorsed by the building technology industry in an effort to establish proper construction and installation practices for various service providers to follow and to ensure that technology requirements are met in a cost-efficient and competitive manner for the building developer, owner or operator.

CABA's research, however, indicates that the end result obtained by pursuing the bid specification process does not often mirror the original project vision, particularly when it comes to procuring the most optimal technology or service solution.

The distinct influence of various trades in the contracting and subcontracting processes involved in the end stages of a bid specification project results in cost becoming the sole determinant for procurement, no matter what the original schematic design recommended.

Additionally, the methods followed for vendor procurement have been significantly affected by the evolution in buildings, brought about by the influence of information technology on physical systems. As a result, owners of intelligent building consider technology integration to be important, however, the investment and perceived value derived from integrating IT dedicated to building intelligence are not well aligned.

Lack of product knowledge is a common issue among most owner and operators. The study also found that the demand potential for intelligent building solutions is further impacted by the perceived price-performance ratio of these products. Buildings owners do not have a clear idea of the actual benefits of buying these products and solutions, especially the life-cycle benefits of the new technologies.

Further current bid and specification processes followed in the industry lack transparency, are price driven, and do not offer adequate impetus to the incorporation of intelligent technologies. The issue lies in the fact that technology suppliers do not have a good understanding of spec practices, and likewise, spec providers lack a thorough understanding of technology advancements.

CABA's research also found that there is a greater need for vendors and service providers to collaborate and create join bid specification business models to service the intelligent building market. The immediate need for industry participants is to organize initiatives to work together and create structural frameworks for joint collaboration in developing building technology and spec development practices. Research however indicates that the end result obtained by pursuing a bid-specification process does not often mirror the original project vision, particularly when it comes to procuring the most optimal building technologies or service solutions. The distinct influence of various trades in the contracting and subcontracting processes involved in the latter stages of a bid-specification process project typically result in cost becoming the sole determinant for procurement, no matter what the original specifications called for. The consequent result is that buildings constructed using a traditional bid specification model often do not effectively contribute to an "smart building strategy".

SMART BUILDING STRATEGY & INTELLIGENT BUILDINGS

A smart building strategy is a clearly delineated plan that leads to a building that is intelligent. Ideally, such a strategy leads to an "intelligent building" that uses both technology and process to create a facility that is safe, healthy and comfortable and enables productivity and well-being for its occupants (Frost & Sullivan, 2009). Such a strategy works to ensure that a building can provide timely, integrated systems information to building owners, managers and tenants so that they can make intelligent decisions regarding operations and maintenance, and has an implicit logic that effectively evolves with changing user requirements and technology, ensuring continued and improved optimization. A building is therefore typically deemed "intelligent" when its subsystems provide the occupants with productive and comfortable conditions by responding to their requirements to enhance their workplace or living environment.

While many researchers note that no standardized definition of an "intelligent building" exists (Clements-Croome, 2004; Kell, 2005; Wong *et al.*, 2005), Himanen (2003;2004) identifies six common attributes that apply to the majority and plurality of intelligent building definitions. According to Himanen (2004), most intelligent building definitions highlight: (a) the requirements of building owners and end-users; (b) the integration of building systems; (c) the integration of a sophisticated operational environment within building architecture, structures and systems; (d) the importance of advanced technologies and economics; (e) concerns over the building life cycle and the necessity of flexibility in a changing economy as a result of globalization; and (f) the importance of ecological sustainability. Clements-Croome *et al.* (2007) advances that the key attributes of intelligent buildings are that they be sustainable, healthy, technologically-aware, meet the needs of occupants and business and be flexible and adaptable to deal with change.

Intelligent buildings therefore can be described as the application of an "information technology paradigm" to the built environment in order to extend mechanical mechanisms of control. Castells (1996) notes that an IT paradigm is distinguished by its use of cheap inputs of information derived from advances in microelectronics and telecommunications technology. The paradigm is characterized by (i) technologies that are specifically devised to act on information; (ii) the pervasiveness of new technologies; (iii) a networking logic that interconnects technological systems; and (iv) flexibility.

The intelligent building concept, which emerged in the early 1980s in the United States, advocated use of sophisticated networks and systems to enhance user interface and interaction with building management systems. According to Hetherington (1999), the original concept for an intelligent building advocated extensive use of elaborate centralized systems to facilitate control of both building support and voice- and data-based communication systems. The concept however would evolve in the 1990s to include the application of interconnected technology to provide enhanced control over a building by way of sharing information and data between a number of traditional segregated systems.

According to Tapscott & Caston (1993), the maturation of computing and telecommunications, along with miniaturization and wide disbursement of information technology in both enterprise and personal environments throughout the 1980s, resulted in a critical "shift" in the information technology paradigm. This evolution in network computing was characterized by the shift from traditional semiconductors to microprocessor-based systems, along with shifts from host-based to network-based systems. In terms of software environments, technology shifted from vendor proprietary software to open software standards, allowing for multi-vendor partnerships. Software shifted from alphanumeric to graphical interfaces; and from stand-alone to integrated applications. These technological changes helped recast relationships, transform organizations and redesign business processes.

Bar and Borrus (1993) argue that this "paradigm shift" accelerated in the 1990s, due to the convergence of three trends: digitization of telecommunication networks, development of broadband transmission and a dramatic increase in the performance of computers connected by networks. The use of interactive, networked computer systems, made operational in wide area networks, would shift the computer paradigm from mere linkages between computers to cooperative computing, in effect, interconnecting disparate systems into singular systems supported by frameworks of "structured extensibility".

King (2010) describes structured extensibility frameworks as technical approaches that extends networks by integrating a broad range of technologies into a highly integrated network of economic relationships. It is a network logic that is predicated upon the utilization of information grids that are based upon distributed and ubiquitous computing.

According to Aradaiz, Freitag and Navarro (2000), ubiquitous computing occurs when networked computing resources are extended beyond traditional conceptions of computing. Users augment their computing and communication capabilities with a multitude of computing devices, conceivably allowing the network to become an infinitely accessible environment.

Under such computing models, technologies would no longer be characterized as strictly separate and independent systems, segmented by limited accessibility or computing power. Throughout the 1990s, information technologies would be defined by smaller, faster, and more pervasive systems and characterized by connectedness, which is the structural ability to facilitate noise-free communication between components; and consistency, which is the extent to which there is a sharing of interests between a network's goals and the goals of its components.

Such connectedness and consistency between multiple technological components would enable series of disparate technologies in buildings to be intelligently deployed and integrated for the management and control of physical assets and facilities.

Conventional buildings suffer from an inability to communicate and intelligent manage the large amount of data that they possess or generate. With the advent of networked computing, rapid efforts were taken to automated buildings to achieve remote monitoring, diagnostics and centralized operation. These resulted in benefits such as cost effectiveness, process improvements in facility automation, monitoring and management and more efficient real estate portfolio management.

Being dependent upon computing technology, the evolution of intelligent building systems relied upon the evolution of underlying technology and the concurrent revolution that technology represented in terms of connectedness and control. Indeed, the universe of technology solutions that create an intelligent building have evolved considerably over the last decade. Innovations in energy saving solutions, smart sensing, remote monitoring, automated diagnostics, as well as a myriad of Internet-based solutions have made their way into the domain of intelligent building solutions.
Many buildings need to exhibit higher operational efficiency at lower cost with respect to factors such as energy consumption and operational costs, life cycle benefits and management of resources. The aim of an intelligent building is therefore to provide operational excellence and ease in maintaining the functionality of individual systems by continuously monitoring, diagnosing and take preventive actions with scheduled maintenance. With intelligent buildings, an owners' operating costs are significantly lower as a result of more efficient operations and better control. Intelligent features of building such as monitoring and control of energy-intensive systems such as HVAC and lighting can be measured for optimum performance and predictive maintenance needs, reducing both energy usage and operating expense.

In technical terms, an intelligent building integrates individual building subsystems, such as security, lighting, energy efficiency, maintenance, heating, air-conditioning, and ventilation utilizing networked information and communication technologies. Such an integrated system is typically characterized as a building automation system (BAS). A BAS is a programmed, computerized network of electronic devices that are employed for control and monitoring of systems. It primarily aims at optimizing the performance, start-up and maintenance of building systems and greatly reduces the interaction of mechanical subsystems in a building.

BAS is primarily used to improve energy efficiency by monitoring the temperature inside and outside buildings and controlling boilers and coolers. Essentially, they aim at optimizing energy consumption by employing a control strategy that helps building operators reduce costs, while maintaining occupant comfort. A typical BAS carries out the following functions: the optimization of start/stop of systems; the scheduling of maintenance; predictive fault detection; alarm generation and preventive actions minimizing damage in the case of emergency; and the constant monitoring of systems to detect abnormal operating conditions, in order to take corrective action and bring the system back to normalcy.

Building automation systems vary in capability and functionality, but typically consist of sensors, controllers, actuators and software. Depending on whether a "human-in-loop" factor is involved, decisions are taken manually or by utilizing embedded intelligence such as decision-making algorithms. The ultimate goal behind a BAS installation is to enable a computerized, intelligent network of IP-based electronic devices that will monitor and control the mechanical and lighting systems in specific buildings and their associated energy requirements.

Systems integration, through BAS, is central to a smart building strategy because by combining individual building systems into a common user interface, operational activities in various subsystems can be monitored to detect inefficient operating conditions, allowing corrective action in order to achieve high levels of systems optimization. Higher optimization in building systems leads to built structures that are safer, more cost-effective, and easier to maintain. Optimized controls can also allow owners and managers to operate more energy efficient buildings (King, 2011).

In a period of volatile energy prices and increasing concern over climate change, the need for more innovative application of building technologies has become acute. As a consequence, intelligent buildings have received increased attention in North America due to their potential to reduce building energy costs, mitigate greenhouse gas emissions, reduce water consumption, and add value to the buildings given the savings and the positive effects on occupant safety, comfort and satisfaction. Actions taken to reduce building energy consumption and minimize fossil fuel pollution will have lasting environmental effects given that most power plant generated energy in North America is supplied by fossil fuels. Processes, building and system design, and high-performance technologies are therefore sought to reduce energy consumption and mitigate the production of greenhouse gas emissions (King, 2011).

Energy costs represent about 30 per cent of an office building's total operating costs, providing enormous opportunity for building owners not only to reduce operating costs but also to make significant improvements in the overall environmental performance of their properties. By changing energy management practices and instituting intelligent building technologies that enhance energy efficiency, building owners and managers can reduce energy consumption by up to 35 per cent (King, 2011).

Energy efficiency and operational costs savings have been instrumental in driving integration of intelligent building technology. With energy costs fluctuating and the building sector consuming more energy, operating costs are expected to continue to rise unless energy consumption is more effectively managed. Industry surveys have determined that building owners and managers are realizing the many financial benefits of intelligent technologies, such as lower energy costs, lower maintenance costs and lower repair and replacement costs. Building owners and operators are leveraging the energy-saving aspects to fund intelligent technology projects. Additionally, there is pressure on some building owners to provide a detailed accounting of their greenhouse gas emissions through taxation schemes and regulatory reporting. As a consequence, strong interest exists for the implementation of intelligent building technology. The implementation of such systems would take place, especially for new construction projects, through the bid specification process.

Research indicates that the contractor that takes on the responsibility of fulfilling the project execution and installation of a new building typically assumes all procurement responsibility, although decisions on what to procure are often incumbent upon what the project fulfillment partners decide in conjunction with the building owner. These fulfilment partners usual comprise energy services companies (ESCOs), a design build firm, civil engineer (CE) or the project management firm involved in the design, specification and conceptual planning process of the project. There is a further fragmentation of the value chain at the general contractor level where the specific tradespeople get involved, including electrical, mechanical and other sub categories. These sub categories interface with the general contractor to provision specific products, technology and services, as dictated by the project vision outlined in the specification. Together, they take the responsibility of organizing and managing the various suppliers and integrators of the myriad of items required to complete project. It may also be the case that only one type of contractor, whether general, electrical or mechanical, is used in a project.

Methodical and straightforward as it may appear, the reality of conducting business within this value chain presents some critical challenges for all parties involved. Managing costs, expectations, project objectives and ensuring that all parties understand and deliver to those objectives poses a major hurdle in each step of the process. However, a significant constraint arises in that the structure of the bid specification process has remained fairly static, despite the fact that technology and operational requirements of buildings have undergone considerable changes, due to the application of an "information technology paradigm" to buildings. The sophistication and innovation in technology and building systems creates the need for tradespeople and project fulfillment partners to understand technology in order to incorporate them into a new construction project. However, provisioning those changing technological requirements calls for the inclusion of other non-traditional or "new entrants" into the traditional value chain and delivery process. The dilemma of operating within a static structure is that there is little or consensus as to how and where these new entrants should be included.

To add to this challenge, controlling price has become virtually impossible, given the fact that added functionality and intelligence is now often integrated into OEM products and solutions at the system integrator level. This leads to either inflation in the bid price, risking rejection, or an artificial cut down in price quote to ensure selection. Moreover, such products are increasingly left to be procured by the non-traditional partners and tradespeople whose interaction with the fulfillment partners is either indirect or undefined at best. Either way it ultimately depends on the fulfillment partners to see value in such products or know where they fit into the project requirements. Consequently, the value and benefits that a building owner can obtain from new technology is not always being realized.

Broadly, the following issues prevent the present delivery process from functioning in optimal manner for the implementation of intelligent building technologies in new construction, including:

• **Notion of Single Supplier -** While this notion was rendered redundant long ago, surprisingly it still persists in the present contracting model that is followed in the intelligent buildings procurement and project delivery process.

• **Technology Silos -** The existence of technology silos happens because several OEMs and technology vendors continue to offer proprietary technologies despite the takeoff witnessed in system integration and interoperability, aided by the use of open communication protocols.

• **Differentiating the "Buyer" from the "Installer" -** The fragmentation, mentioned earlier, at the contractor level not only adds the influence of subcategories of tradespersons, but imprints a flaw on the delivery process itself.

• **Incorporating the Technology Contractor -** Perhaps one of the principal factors creating the lag in the delivery and value chain process and technologies advancement for intelligent buildings is incorporating the technology contractor into the process.

Owing to these inherent issues with the present delivery process, and the structure of the value chain, the bid specification methods adopted by the intelligent buildings industry function with varying amounts of restraining factors. Ranging from process flow, spec design, procurement and partner collaborations, these factors limit the building owners and investors from achieving high performance buildings. The report therefore identified a disconnect among various value chain partners leads to the process being used sub-optimally, with little scope for successful incorporation of intelligent building solutions. Subsequently, they are responsible for creating profitability issues for value chain participants, as well as creating barriers to technology adoption.

Findings from the report show that building owners consider technology integration to be important; however, they do not have a clear idea of the actual benefits of buying these products and solutions.

Instead, end users (building owners and managers) surveyed were said to mainly rely on consulting specification engineers and design build organizations, those responsible for completing a final project design and providing detailed construction drawings, technology specifications and support, to make the “right” technology selection. The report also found that while engineers and design build organizations had significant influence on the building owner’s decision making process, not all engineers appear to understand the technology or value associated with intelligent buildings. This is because the emerging technologies are heterogeneous, fragmented, and increasingly complex.

Consequently, the end result obtained from the bid specification process does not often mirror the original project vision, particularly when it comes to procuring the most optimal technology or service solution.

Instead, in most cases, cost was the sole determinant for procurement, no matter what the original schematic design recommended. In fact, CABA’s study found that low-cost technology, with quick payback, was often favored over smart controls and automated solutions, the latter of which may have a higher upfront cost, but could potentially lead to measurable returns in the long-term.

IMPROVING THE BID SPECIFICATION PROCESS

Currently, the distinctively disjointed and transactional model leads to low intelligent building technology adoption. Yet engineers and design build organizations, already cited as key players in the value chain, can undertake a number of tactics to increase widespread usage:

• **Take a unified view**: It makes sense for ultimate owners/operators of a building to have better and smarter technologies in the building, and for buildings to be looked at as an ecosystem rather than a series of systems or contracts.

• **Collaborate more**: Getting to know more about intelligent building technologies can also be done by working with more vendors and associations like CABA, to determine where to situate new partners into the value chain. One important—and fairly new—partner in the bid spec process is that of the technology integrator: an expert who understands how different technologies can be integrated into a building to make it smarter, and who is involved in the procurement process.

• **Educate the end user:** An engineer’s role is not just to deploy and specify what goes into a building; they must educate the building owner or operator about considerations apart from budget. For example, many advanced components that go into a building will enhance its performance and value as an asset. Engineers must be able to demonstrate to building owners the value of implementing smart technologies from the very beginning of the project.

While present practices followed in pursuing bid and specification projects are well ingrained among value chain partners and have provided a structured and systematized way to undertake procurement of technology and services for projects, fundamental issues need to be addressed in order to mitigate project failure or completing projects below their set expectations.

In order to optimize the bid specification process by way of all critical supply points within a service delivery ecosystem, a number of new aspects need to be incorporated into the process to obtain better outcomes. These aspects include: opting for more objective point criteria, autonomous supervision by a quality surveyor or advisors, cost threshold avoidance, developing scopes for new vendors and embracing an integrated design and delivery approach.

REFERENCES

Ardaix, O., F. Freitag and L. Navarro., 2002. *On Service Deployment in Ubiquitous Computing. Parallel Architectures and Compilation Techniques*, PACT'01, Workshop on Ubiquitous Computing and Communications. November 2002; Barcelona, Spain.

Bar, F. and Michael Borrus, 1993, *The Future of Networking*, Berkeley: Berkeley Roundtable on the International Economy (BRIE).

Castells, M., 1996, *The Rise of the Network Society, The Information Age: Economy, Society and Culture Vol. I.*, Cambridge, MA Cambridge, MA; Oxford, UK: Blackwell.

Clements-Croome, D.J., 2004, *Intelligent Buildings: Design, Management and Operation*, London: Thomas Telford.

Clements-Croome D.J., Wu S., John G.A., and Quick J., *High Quality Building Services Systems Based on Whole Life Value*, Reading: University of Reading.

Hetherington, W., 1999, *Intelligent Building Concept*. Ottawa: Public Works & Government Services Canada.

Himanen, M., 2003, *The Intelligence of Buildings. The Feasibility of the Intelligent Building Concept in Office Buildings*. Espoo: VTT, 8 (VTT Publication 492).

Frost and Sullivan, 2009. *Bright Green Buildings: Convergence of Green and Intelligent Buildings*, Continental Automated Buildings Association (CABA) [online]. Available at: http://www.caba.org/brightgreen [Accessed August, 2013].

Kell, A.R., 2005, *The Global Development of Intelligent & Green Buildings*. Beijing: ibexcellence.

King, R.O., 2010, *The Dialectical Nature of Control Upon Electronic Networks*. Saarbrücken, Germany: Lambert Academic Publishing.

King, R.O., 2011, Intelligent, Green Building Technologies Lower Overall Building Costs. *CABA iHomes & Buildings* 8(2) Summer 2011, 8-9.

Tapscott, D. & Art Caston, 1992, *Paradigm Shift: The New Promise of Information Technology*, New York: McGraw-Hill Companies.

Wong, J. K. W., Li, H., & Wang, S. W. (2005). Intelligent building research: a review. *Automation in Construction*, 14(1), 143-159.

BIOGRAPHY

Rawlson O'Neil King is Communications Director at the Continental Automated Buildings Association. His research interests include smart home and building technologies, smart communities, communication and socioeconomic control, Internet service provision and national security issues. King holds a Bachelor of Journalism and M.A. in Mass Communication from Carleton University in Ottawa, Ontario. He has authored a book about control and electronic networks and has published numerous articles in trade publications and academic journals.