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EDITORIAL

BIM for the management of building services information during building design and use

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Many interpretations of what Building Information Modeling (BIM) is, and what implications it may have on the wider construction industry have been published; yet still there is ambiguity about what it means for the broad areas of building services engineering. Successful implementation of BIM to support effective space conditioning and efficient operation is underrepresented in literature, with much focus on industry perceptions of BIM (McGraw Hill Construction, 2014a, 2014b) and less on quantifiable proof of improvements (Barlish and Sullivan, 2012; Giel and Issa, 2013). It is therefore crucial that demonstration of BIM applications to these aspects demonstrate the potential benefits a holistic approach to novel use and applications across engineering design and operation be made.

According to the UK BIM Task Group (2016), BIM is “value creating collaboration through the entire life-cycle of an asset, underpinned by the creation, collation and exchange of shared 3D models and intelligent, structured data attached to them”. The UK’s strategy for construction (Cabinet Office, 2011) aimed for 15-20% cost savings by the end of 2015, with many aiming to achieve this through implementation of BIM. Apart from the cost savings that more efficient design procedures can achieve, the possibility for continuous analysis and utilization of descriptive information regarding a building’s performance both during design and operation (Dowsett and Harty, 2013) means opportunity for novel utilization of this information is growing (Krygiel and Nies, 2008). For engineers of building services, those responsible for the operation of those systems and the occupants of a building, BIM is the means by which relevant information describing a building can be accessed and be given context.

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BIM provides an integrated platform by which information can be shared and used across a building's lifetime to assist in its operations and management. This potential was recognized by Braun et al (2010). Twenty years ago, Scarponcini (1996) discussed the use of an integrated approach to information management which was also recognized as an asset to the management of a building's design and operation. Specifically within this area, efforts to utilize what is now common practice of creating a model or set of models containing what is effectively an as-built representation of a building are extensive. Use of BIM to assist with sustainable building design (Azhar and Brown, 2009), asset management (Zhang et al., 2009) and sustainability accreditation (Azhar et al., 2011; Wu and Issa, 2012) are just a few examples of where the industry is focusing efforts. But throughout all published works the lack of integration between defined yet un-interoperable standards is a common theme limiting widespread adoption of these solutions. The same issue may be shown by Scarponcini (1996), where optimization focuses "only on the design phase of the facility's lifecycle". Working between disciplines, each with their own information requirements, and across major stages in a building's lifecycle, standardization across the entire process is unlikely to happen (Hooper, 2015); however, within the realms of ventilation and air-conditioning engineering design, optimization and operation there is still opportunity for consolidation.

The goals of integrating the design of building services, performance simulation, and coordination of these with all other industry sectors are yet to be realized; however, exchange between disciplines is becoming more possible due to improvements in software interoperability. Following this, fault detection and diagnosis (FDD), asset management, facilities management and performance evaluation of buildings and their mechanical equipment are now moving out of research and into public application through systems such as the Buildings Controls Virtual Test Bed (Wetter et al., 2015). Once again, this is yet to be applied across the industry, requiring significant skills in setting up such systems. Replicability of such capabilities is not yet achievable given the lack of standardized systems or access to relevant information during building operation.

Tuohy and Murphy (2015) support the case for application of BIM to assist in the reduction of the widely researched "Performance Gap". Improvements in exchange of information between simulation tools and BIM authoring tools could provide a more concrete source of design information and point of reference during building operations. The same effect could then enable the creation of an accurate up-to-date source of descriptive information useful for FDD and the ongoing performance assessment of a building during its lifetime such as that demonstrated by Dong et al (2014).

The papers presented here aim to address some of these issues, in particular the integration of information across currently separate platforms, and the use of this information to increase understanding of a building's operational performance both for evaluation and improvement. Integration of BIM with automated condition-based maintenance uses information generated from a BIM environment (using the COBie standard) to provide a basis upon which systems may be monitored, indicating problems to reduce inefficient operations and energy consumption or cost.

The possibility of using BIM for storage of information collected in 'walk-round' energy surveys is evaluated, indicating where deficiencies in current BIM authoring tools and energy modeling software mean the input of survey data into such environments is limited due to their current capabilities. Disparity between these further exemplifies the problems inherent in movement towards a common data environment.

From these papers, and the large body of knowledge already existing around BIM and its application to building design, operation and optimization, the primary challenges facing effective implementation of BIM as a supporting tool could be understood as follows.

- Interoperability of information between design and operation systems is essential to enable that information to be used across platforms and systems.
- Reproducibility is only possible where there is information necessary for that reproduction. As BIM implementation matures, more opportunities for use of extensive datasets and information will become available, and only then could the full potential of BIM be realized in terms of its impact on building performance optimization.
- The role of the building services engineer is changing with the availability of the considerable amount of information being generated using BIM and output from monitoring systems. The ability to handle and interpret large datasets created both within models and from in-use building monitoring is becoming more relevant.
- Although considerable research is published continuously on the subject of BIM, we should not overlook its holistic application to the construction and engineering industry. BIM is not just a new technology, but a change in procedures used to develop and manage information. Compliance with local regulations concerning its

implementation is widespread, but novel utilisation as part of this compliance is still rare outside schools of research establishments.

Without focused efforts to make developments in BIM more widely known, the comments made 20 years ago, and repeated often will continue to be made. Developing and applying new tools to assist in these functions in some small test cases where many factors are controlled is what the industry excels at, but falls short of widespread exploitation of these improvements. Making this work known, and applying it to less controlled case studies is where new problems are identified and solutions to those problems can inform the creation of more useful tools, that have much greater impact on the performance of buildings.

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