BIM-ENABLED COLLABORATIVE PLATFORM FOR INNOVATIVE LOW IMPACT SCHOOL PROCUREMENT – THE OAKFIELD PRIMARY SCHOOL PROJECT

Partners: Willmott Dixon – Contractor (lead)
Oxford Brookes University – Academic partner
Scape Group – Procurement specialist

Project location: Oakfield
Sector: Education
Completion: October 2012 (34 weeks)
Contract value: £2.7m
Type of work: Primary school new-build and refurbishment

Introduction

BIM-enabled collaborative platform (BIM-ECP) for low impact schools is an InnovateUK funded project aiming to utilise Building Information Modelling (BIM) to enable continuous process and product development through collaboration between key members of the supply-chain. One aspect of BIM-ECP has been applied at the new Oakfield Primary School, a combination of new build and refurbishment project, completed and opened for use in October 2012. Using Building Management System (BMS) project data, the partners are looking at ways to use BIM in order to close the upstream knowledge-feedback loop between construction and design.

Background

The advent of BIM promises to reduce challenges inherent in the tasks embedded in the various stages of the project life cycle. The Literature suggests that, of all the stages, the operation and management aspect is the least explored in BIM applications (Becerik-Gerber et al., 2011; Codinhoto et al., 2013). The reasons from a technology perspective include operational and interoperability diversities between BIM applications and existing FM software tools, unclear responsibilities of who updates the models with information, the disconnection/lack of collaboration between the operation stage and earlier stages of the building life cycle amongst others. Besides proprietary issues of who owns the model/information contained therein and associated legal implications, organisational
challenges of the fear of pitfalls from adopting a new technology, the financial implications and the undefined fee structure for additional scope all contribute to the seeming lag in FM BIM uptake. As such an aspect of the BIM-ECP for low impact school project focuses on exploring the practicalities of making building operation data useful in BIM applications.

The BIM-ECP uses BIM as a learning mechanism to support integrated collaborative procurement, design and delivery of low impact standardised designs for turnkey school projects. The role of BIM is to intelligently digitise the various aspects of the building project in order to provide consistent information that can be reused by stakeholders throughout the building life cycle. It is expected that BIM will immensely improve the efficiency of project planning, design and construction as well as facilitate building operation and maintenance. This is possible through improvements in project collaboration, reduction of errors, fast-tracking of project delivery and support for Asset Management. This case study presents how a proposed feedback loop incorporating BMS data into a BIM model can inform the future design of similar buildings as well as Facilities Management operations and processes. The BIM-ECP framework for feedback utilisation is illustrated in Figure 1. It captures the proposed BIM implementation process to improve building design where existing drawings, textual information and specifications are reproduced as BIM generic systems. These systems can be further developed to site-specific BIM models by incorporating as-constructed information. The process develops the model progressively from as-designed models, to as-constructed models and live BIM models which facilitate construction and operation purposes. It also serves as a channel to supply feedback information, such as BMS data, to be used in the Model Preparation stage for the development of next iteration of the generic building design model.

**BMS data utilisation in BIM**

The new Oakfield Primary School was used as a real life case to illustrate learning from BMS data in a BIM environment. The Oakfield Primary School, which was originally constructed in the 1950s with numerous extensions over the years, was replaced with a new building using one of Sunesis’ pre-designed solutions. The new building is a single storey steel portal frame structure with a floor area of 1187 m². It has an EPC rating of A under Part L 2010 and included (i) all-electrical services (ii) Solar-thermal hot water system and (iii) naturally ventilation via windows/roof lights. Performance targets for the new building were set in terms of energy use, running costs and carbon emission levels for both regulated
usage (building services such as heating, hot water and lighting) and un-regulated usage (IT server, kitchen equipment, plug in appliances etc).

The Oakfield Primary School was completed in October 2012 and incorporated a fully operational data acquisition system. The system monitored energy consumption levels which were collected and processed in spreadsheets as part of the soft landing after care activities. During an 18 months operational period the partners monitored how the building was performing both in terms of energy usage and costs as well as design efficiency. This in-depth Post Occupancy Evaluation (POE) was a key part of demonstrating how the Sunesis design can meet the needs for high quality and rapid delivery education buildings at an affordable cost. This approach was short-listed at the CIBSE Building Performance Awards 2015.
BIM Model Development for Sunesis (Keynes)

<table>
<thead>
<tr>
<th>Model Preparation</th>
<th>Consultation, Appraisal and Planning</th>
<th>Contract and Build</th>
<th>Handover</th>
<th>Operation</th>
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</thead>
<tbody>
<tr>
<td>Sunesis keynes drawings &amp; specifications (CAD, PDF, TEXT)</td>
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<td>Generic BIM Design Model</td>
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<td>Site-Specific BIM Model</td>
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<td>Actual Construction</td>
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- **Site-Specific BIM Model**: Site Model (Revit/Google Earth and others) + Generic Model (Revit and others) + Site specific BIM (Revit and others) + Progressive As-designed BIM (Revit and others) + As-constructed

- **Actual Construction**: Construction (BIM-based) + Operational Data (ArtrA/360 Field) + Completed building (operation via soft landing)

- **Feedback Utilisation Framework**:
  - Site Model (Revit/Google Earth and others)
  - Generic Model (Revit and others)
  - Site-Specific BIM (Revit and others)
  - Progressive As-designed BIM (Revit and others)
  - As-constructed

- **Operational Data** (ArtrA/360 Field)

**Figure 1**: Feedback utilisation framework
The industrial partners and the research team were driven by further utilisation of the collected energy performance data as part of the BIM-ECP project. At first, information
mapping was utilised in order to link BMS data to BIM-enabled environments such as the Revit Building Design Suite application. The outputs from the developed prototype for this purpose are given in figures 4 to 6. The prototype operates as an external add-in tool in Revit where energy performance history can be called up for chart based visualisation. The advantage of these charts to designers is that they offer an opportunity for fast design and performance benchmark review or, where required, they can facilitate a more detailed analysis. For example, designers may focus on categories such as Heating, Hot water and ICT sub-consumption for further investigation if the respective charts reveal any unexpected outputs.

Figures 4 and 5 show alternative chart views of the design and actual energy consumption figures at the Oakfield Primary School from November 2012 to February 2014. Similar charts can be obtained for other projects if relevant energy consumption data are loaded into the prototype. It is also possible to view a combination of the sub-consumption categories as given in Figure 6. Individual values of energy sub-consumption categories such as heating, hot water, lighting etc. can be further investigated for each of the listed projects or used as benchmarks. In the latter case projects with abnormal consumption trends can be identified and an investigation into possible causes and effects can be conducted. Importantly, the prototype compares information on energy costs for design and actual consumption of projects.
Figure 4: Comparison of the Oakfield Primary School design and actual performance
Figure 5: Oakfield Primary School design and actual stacked column comparison
Conclusion

The incorporation of Facilities Management aspects into the development of BIM models has enjoyed little popularity despite of being the outputs of the concerted efforts of planning, design and construction. The BIM-enabled collaborative platform for low impact schools project explores using historical BMS energy consumption data to inform contemporary design processes and Facilities Management aspects. The case of the Oakfield Primary School illustrates how sensing and automated data acquisition technologies (BMS data) can be combined with building information modelling (BIM). The prototype was implemented in .NET framework and interfaced with Revit Building Design Suite 2014. The approach presented in this case study is useful in bridging existing gaps of harnessing historical data from the building operations phase to assist in building information modelling and design.

References

