Enriching the "I" in Bim: A BIM-Specifications (Bimspecs) Approach

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ABSTRACT

This paper conceptualizes a framework for bridging the BIM-Specifications divide by embedding project-specific information in BIM objects by means of a product library. We demonstrate how model information, enriched with data at various levels of development (LODs), can evolve simultaneously with design and construction using a window object embedded in a wall as lifecycle phase exemplars at different levels of granularity.

The conceptual approach is informed by the need for exploring an approach that takes cognisance of the limitations of current modelling tools in enhancing the information content of BIM models. Therefore, this work attempts to answer the question, “How can the modelling of building information be enhanced throughout the lifecycle phases of buildings utilising building specification information?”

LITERATURE REVIEW

Problem Overview. Building Information Modelling (BIM), a process of digitally representing buildings in 3D, is redefining the world of construction (Azhar, 2011; Succar, 2009). Building specifications on the other hand, are a class of building information crucial to the lifecycle of buildings which capture information related to material quality and the associated workmanship necessary for project completion (Potter, 2002).

Ongoing efforts in the construction industry are targeted at exploiting Building Information Modelling for increased efficiency and productivity gains. Indeed there is evidence that such efforts have given rise to industry-transforming outcomes as improved team communication through visualisation (Succar, 2009), as well as increased accuracy in building design and construction through clash-detection, cost savings and time savings (Azhar, 2011). However, in the context of the whole building lifecycle, such gains are, arguably, *automational* rather than *informational* (Fox and Hietanen, 2007). Table 1 is a contextual summary of the extent and impact of the automational and informational benefits of BIM on the building lifecycle phases.

Table 1. BIM Lifecycle-Impact Matrix

BENEFIT VERSUS IMPACT SCALE		EXTENT OF IMPACT		
Impact Criteria	**Impact Phase(s)**	**Short Term**	**Mid Term**	**Long Term**
Cost Savings (Bryde, Broquetas and Volm, 2013	Conceptual - EOL / refurbishment	✓	✓	✓
Time Savings (Bryde, et al., 2013)	Conceptual - EOL / refurbishment	✓	✓	✓
Improved Communication (Bryde, et al., 2013)	Conceptual - EOL / refurbishment	✓	✓	✓
Improved Coordination (Bryde, et al., 2013)	Conceptual - EOL / refurbishment	✓	✓	✓
Speedy Evaluations (Manning and Messner, 2008)	Design - FM	✓	✓	✓
Controlled whole-lifecycle costs and environmental data (Azhar, Hein and Sketo, 2008)	Conceptual - EOL / refurbishment	✓	✓	✓
Improved customer service (Azhar, et al., 2008)	Design - FM	✓	✓	✓
Automated Assembly (Azhar, et al., 2008)	Design and Construction	✓	✓	
Improved Design (Azhar, et al., 2008)	Design	✓		

* ***EOL*** *= End of life,* ***FM*** *= Facility Management*

Based on the matrix (table 1), *automational benefits* are realised from exploiting the functionalities of BIM tools during design and construction, while *informational benefits* accrue from leveraging modelled information for addressing stakeholders' requirements throughout a building's useful life - conceptualisation, design and construction through to occupancy - and eventual deconstruction as the case may be.

Information from building specifications are crucial to ensuring that the final model is a true representation of the *as-built* outcome as required, designed and specified. Therefore, rather than the mere use of the features of BIM software during design and construction, a long term benefit of BIM relates to the iterative, sustained application of the information content of building models for decision making throughout the useful life of buildings until their refurbishment or eventual deconstruction.

However realising the long-term benefits of BIM will prove challenging if model and specification information are not systematically integrated in a manner that reflects the different phases unique to the building lifecycle. This work proposes, therefore, that further benefits of BIM may be realised through a systematic and sustained integration of specification information that is useful in all phases of a building's lifecycle; from conceptualisation, through its operation and eventual deconstruction as shown in Figure 1.

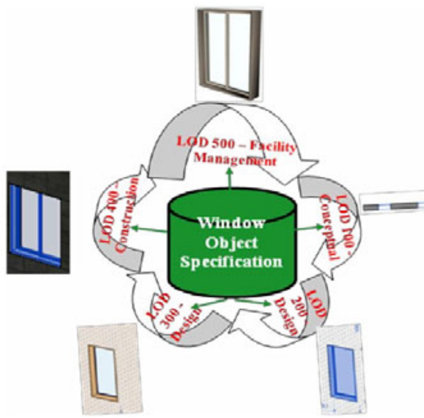

Figure 1. A BSL (BIM-Specifications-LOD) Framework (window object example).

Current and Contextual Approaches. There is increased awareness of the short term implications of model information for building design and construction as well as longer term implications for Facilities Management (Chew and Riley, 2013). Such early focus on BIM-centric information underscores the need for specification information from the point when the client's brief is produced to the eventual refurbishing or demolition of buildings (Chew and Riley, 2013). Yet, these sets of specification information have not been explicitly considered as much as other rapidly improved aspects of BIM applications (Kreider, Messner, and Dubler, 2013). Current studies indicate that there are no standardised approaches to integrating specification information within BIM environments and such specifications information are, at best, mere references and adapted in ways that are non-replicable and non-integrated (NBS, 2011; Weygant, 2011).

A Level of Development (LOD) refers to the extent to which the geometric and non-geometric components of model objects have been defined (Ciribini, 2013). Although authors differ as to the definition and content of LODs (AIA, 2013; BIMForum, 2013; International Facility Management Association, 2013), this paper concerns itself with developing a systematic approach to embedding specification information in models at different LODs based on LOD definitions by NATSPEC (2013) as indicated in the *BSL framework* (figure 1).

A summary of the LOD requirements for a window object, as proposed by BIMForum (2011) and NATSPEC (2013) is exemplified in table 2.

Table 2. LOD-Lifecycle Matrix (derived from NATSPEC, 2013).

LOD	Definition	Contextual Lifecycle Phases
LOD 100	Overall Building massing indicative of height, volume, location and orientation	**Conceptual**
LOD 200	Generalised systems or assemblies with approximate quantities, size, shape, location and orientation	**Design**
LOD 300	Specific assemblies that are accurate in terms of size, shape, location, quantity and orientation	**Design**
LOD 400	Specific assemblies that are accurate in terms of size, shape, location, quantity and orientation with complete fabrication, assembly and detailing information	**Construction**
LOD 500	Constructed assemblies, actual and accurate in terms of size, shape, location, quantity and orientation	**Facility Management**

The shaded region in figure 2 further shows (graphically), the flow-on effect of information specified at the early phases of the building lifecycle on the information needs throughout the rest of the building lifecycle phases (information granularity is gradual between LOD phases).

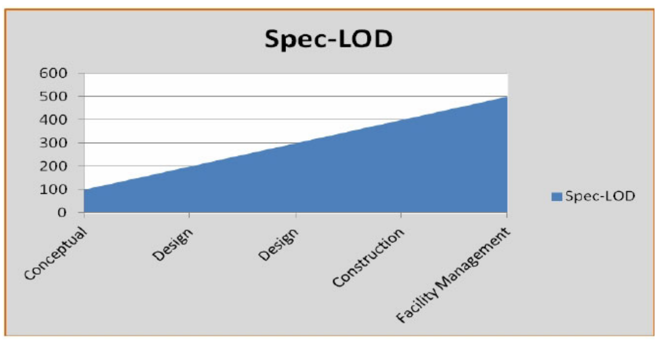

Figure 2. Flow on effect of phase-wise specifications on different LODs.

On this premise, the following sections of this paper present a method for embedding specification information in BIM models from a product library. Thus, each model object (in this paper, a *Window Object*) is a self-contained repository of information that may be accessed and updated at various stages of a building's lifecycle to support the technical and non-technical decisions in building design, construction and maintenance.

METHOD

In this section, we show that information within BIM models (using Revit Architecture as a tool) may be systematically enhanced by utilising Specification information from a product library to, firstly, enrich a generic *Revit* (900 x 1800mm) *Fixed Window* object and then transform it to a proprietary *Aluminium* (1200 x 900mm) *sliding window object* at increasing levels of definition.

Tools and Aim. To explore the outcomes of embedding specification information within Building Information Models, taking cognisance of building lifecycle phases, we utilise the following tools:

- A BIM authoring software - Revit
- A Product Library - (Proprietary Product Library, (Duddy et al., 2013))

First, desirable specification information is mapped onto an excel spreadsheet based on COBie (but with necessary extensions) which is then transformed together with IFC-based geometry to the product library database (Utiome and Drogemuller, 2013). Together, the COBie-derived specification information and the ifc window geometry make up the product line template within the product library. The underlying processes for generating the content of the product library are discussed in Utiome and Drogemuller (2013). The information that is added to the spreadsheet includes the information normally included in a written specification, such as relevant standards, workmanship, materials and manufacturer requirements.

RESULTS

Figures 3-7 are screen captures of the processes described in section 3.1. In all instances, the underlying assumption is that each window object was originally at LOD 100 as defined in the LOD-Lifecycle Matrix (table 2).

Step 1: Select window and click on the Consult National Object Library icon on the Add-Ins tab within Revit.

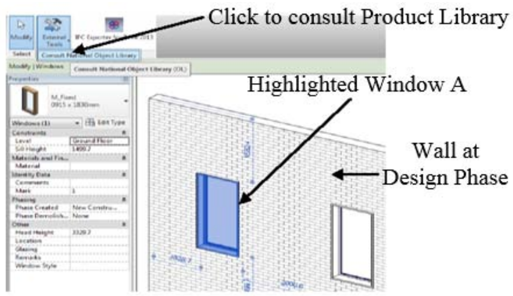

Figure 3. Window A

Step 2: Select the Desired Window at the appropriate LOD (in this instance, 200) from the product listing in the product library then click on the 'Import to Revit' icon.

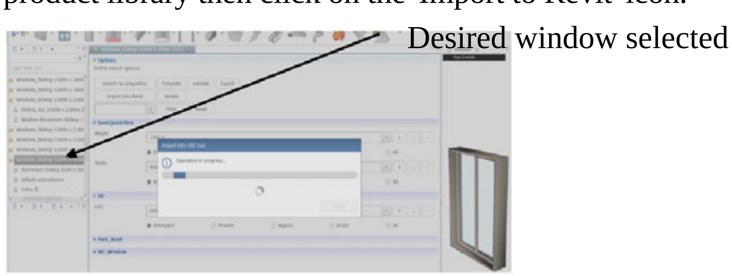

Figure 4. Importing *1200* x *900mm sliding window* specs to Window A.

The new specification information / property sets for Window A are thus viewable in the Revit properties panel and through the property inspector as shown in figure 5.

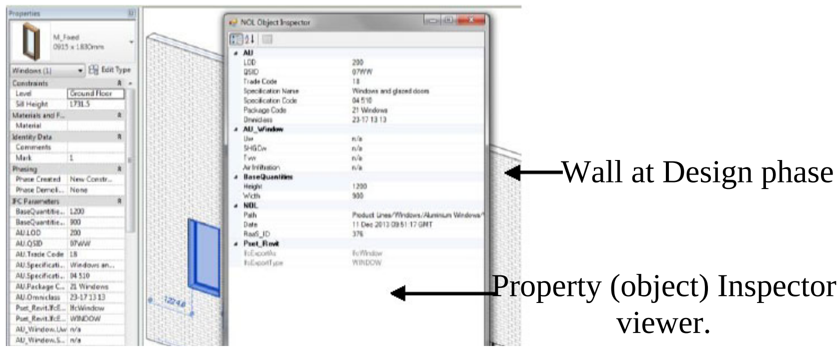

Figure 5. Imported specs for Window A at LOD 200.

Step 3: Repeat Steps 1 and 2 above, selecting **LOD 300** in this instance (figure 6).

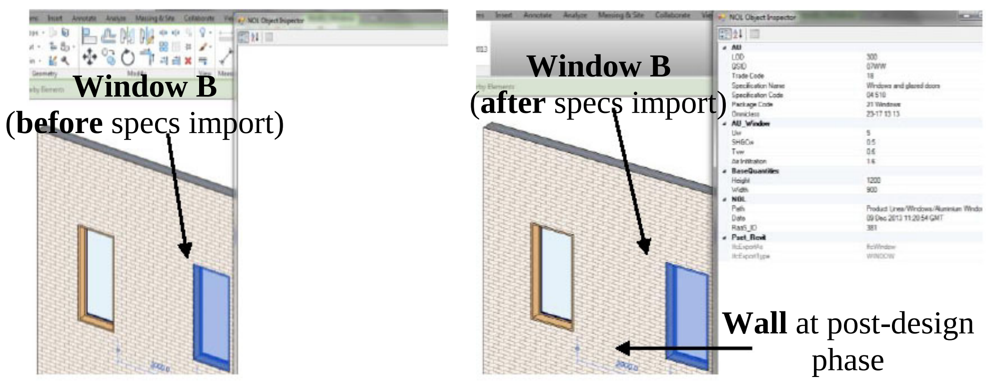

Figure 6. Window B (at LOD 300) - viewed with the property inspector panels *before* and *after* embedding of new specs from the product library.

Step 4: Repeat Steps 1 and 2, selecting **LOD 400 and 500** for Windows C and D respectively (see figure 7).

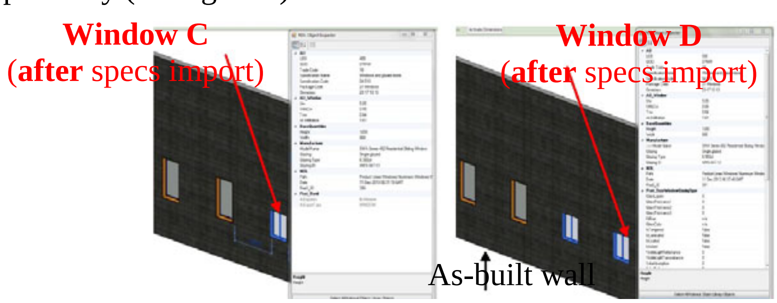

Figure 7. Windows C (LOD 400) and D (LOD 500), viewed with the property inspector *after* embedding of new specification information from the product library.

DISCUSSION

Specification properties in Windows A and B are enriched without alterations to their geometry. In Windows C and D, on the other hand, the embedding of specification properties results in geometrical changes; both processes leveraging library-based specifications. While the key focus was on the ability to import proprietary information into a BIM tool by leveraging information from a product library, we have shown (section 3.2) that increasing levels of development for the Wall object (capturing different lifecycle phases) can be achieved simultaneously with increases in the LODs of the Window objects. Overall, embedding specification data through this approach potentially enriches users' storage, retrieval and reuse of building information external to the model environment. Furthermore, a library with a range of interoperable objects encourages lifecycle information use and coordination, thus enabling a paradigm shift in favour of a semantic understanding of the function of specifications as inherent components of BIM models.

CONCLUSION

This paper illustrates how different levels of development (LODs) of a window object (hosted in a wall) can be integrated with the various phases of the building lifecycle. The results show that specification information can be embedded in BIM models at those levels of development while accurately meeting the information needs of the building lifecycle phase at which the specifications occur.

Therefore, further benefits may be realised through model development which systematically captures the process of the whole building lifecycle from the conceptual phase until the end of its useful life by enriching model information with embedded specification information at different levels of development in BIM models.

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