CONTENDING WITH THE CHALLENGES OF DEPLOYING BUILDING PRODUCT MODELS IN THE CONSTRUCTION PROCESS

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Most of the propositions to improving the management of information in the construction process are either management or technological centric. The goal however is common in that they all aim at integrating the data generated by a generally multi-disciplined work force, and optimise its usage. This has resulted in a paradigm shift towards information, communication and technology related concepts such 'virtual building teams'. The virtual building team paradigm encourages project development participants to create and share comprehensive project data throughout the construction lifecycle. Myriads of techniques and technologies have been proposed for this task; building product modeling is one of them. Building product models play a pivotal role in this regard because they use non-proprietary format approach to exchanging data. However, if data exchange is to run smoothly, it is vital to identify and contend with the challenges that come with product models. This paper discusses some of the challenges of using product models in construction, and how best to optimise the neutral data they possess.

Keywords: building product models, construction process, deployment challenges

INTRODUCTION

Current dynamic construction environments demand the ability to exchange and integrate information from different sources and in different data formats (Caldas and Soibelman 2003). Construction has made significant strides in the uptake of information and communication technologies (ICT) because the cost/performance ratio of ICT continues to shrink (Johnson and Clayton, 1998). Despite minimal realisation of the investment in ICT, most professionals have redefined their roles so as to embrace the knowledge and technology-driven strategies to construction business (Ibid). This is partly because information is cardinal to business and that ICT is one of the key enablers to business change management (Stewart and Mohamed, 2004). However, business data from multi-disciplinary information sources at every stage in the construction process is yet to be fully integrated, and optimised (Hew, Fisher and Awbi, 2001). This could partly be attributed to use of conservative systems to product development (Lehtonen, 2001). While these systems are critical to construction, improvements to them can be made.

The concept of a 'virtual building' is but one of the many techniques anticipated to making a significant contribution to the improvement of the construction process. A 'virtual building' or a 'Building Product Model' is a computer interpretable description of a building, structured according to some building product data model

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(Koivu 2002). It is a digital information structure of the objects making up a building, capturing the form, behaviour and relations of the parts and assemblies within a building (Eastman 1999).

This research aims to elicit contributions from construction management audience on the development and management of the building product model – *the data repository* – within the construction process, based on the Industry Foundation Classes (IFC) data model.

OBJECTIVES OF THE RESEARCH

This research is part of the overall objective of developing a tool that can implement a holistic approach to sustainable construction; by facilitating the contribution of every building team member to the project lifecycle – *as they do traditionally* – so that they can leave a reliable as-built database at project completion.

The aim for paper is to seek contributions on:

- Identification of challenges inherent in the development of building product models;
- How to devise a system of tackling the identified challenges;

EFFORTS TO INTEGRATING CONSTRUCTION DATA

Attempts to integrate construction data have been either management or technological centric or both. For instance, knowledge management is one concept that is being explored to integrate information in the construction process. Although a good deal of knowledge within organisations may of course be amenable to the application of IT-based tools and techniques, approaches to knowledge management have increasingly explored ways in which social structures and communities influence the capture and diffusion of knowledge and learning (Bresnen, Edelman, Newell, Scarbrough and Swan, 2003); because the existing limitations of an IT-based view of knowledge capture and codification have long been emphasised (Ibid).

On the other hand, technical integration approaches can be generalized into two categories:

- Firstly as represented by the knowledge-based interface approach that allows different systems to share information at a low system level;
- Secondly as represented by communication between applications. It does not require different systems sharing anything at the low system level. Instead, different systems communicate with each other through a neutral data format, such as IFC, which is usually based on preset standards (Zhu and Issa, 2003).

Because of the nature of the BPM which is data centric i.e. it supports the concept of a central information repository, it is the authors' opinion that adopting a BPM approach will sufficiently influence traditional practices to become more efficient and innovative by providing:

- Once off data input;
- Can be manipulated by each of the current actors through context sensitive interfaces;
- The client with a single building data repository at the completion of the project;

- Support the concept of building life cycle assessment;
- A possibility to offer more effective collaborative design and construction practices.

Building product modeling was chosen for the research because it can closely mimic the existing organisational structure in construction and build upon the established benefits of the conservative approach to product development.

Sharing Construction Data Using Building Product Modeling

A product model is a richer representation of a building than any set of drawings (Eastman 1999). Traditionally, construction projects are defined by numerous documents, among which there may be overlap and inconsistency (Mak, 2001). Different project participants maintain these documents separately, and inconsistencies are typically discovered only in the field – *when trades personnel working with different documents interact* (Cyon 2003). As a result data is re-entered in new and different formats, data is lost or corrupted, vital information is omitted or not fully exploited (IAI 2003; Froese 2003). This manual data re-interpretation and entry is a non-value adding activity, can often introduce errors into the project, and inhibits the use of better computational tools (Tarandi 2003; Zhiliang, Heng, Shen and Jun, 2004). Bad coordination also results to using insufficient, inappropriate, inaccurate, incorrect, and late data (Tam, 1999). Therefore a key driver to information sharing using a building product model in the construction industry could succinctly be said to be 'information chaos.'

Additionally, geographically and temporally distributed design teams are contributing heavily to constructed facilities; with a high level of outsourcing and heterogeneous software tools and expertise (Szykman, Fenves, Keirouz and Shooter 2001). As a result of this new product development paradigm, there is a greater need for software tools to effectively support the formal representation, capture and exchange of product development information (Ibid; Chinowsky and Rojas 2003).

If the building product model is implemented using a persistent data repository, it becomes a 'virtual container' within which related data items exist (EPM 2002). The data in the model is created, manipulated, evaluated, reviewed and presented using computer applications (Eastman 1999). The idea of a single repository becomes more accessible to everyone, as shown in Figure 1. Every item is described only once, using any modeling tool. The potential benefits of product models are visible, but the actual impact on the processes and the businesses is not yet known (Koivu 2002).

Approach to Deployment of Building product model

In construction projects, activities are typically divided into functional areas, which are performed by different disciplines (e.g. architects, engineers, and contractors) that operate independently (Love and Irani 2003). Moreover, these functional disciplines often develop their own objectives, goals, and value system. This phenomenon is similar to the deployment of building product models. It has largely been in line with the functional areas of the building team. A key factor causing such a scenario has been the difficulties inherent in the development customised interfaces to the data repository so that each project team member can read and write data to the repository; *as shown by colored arrows in Figure 1.*

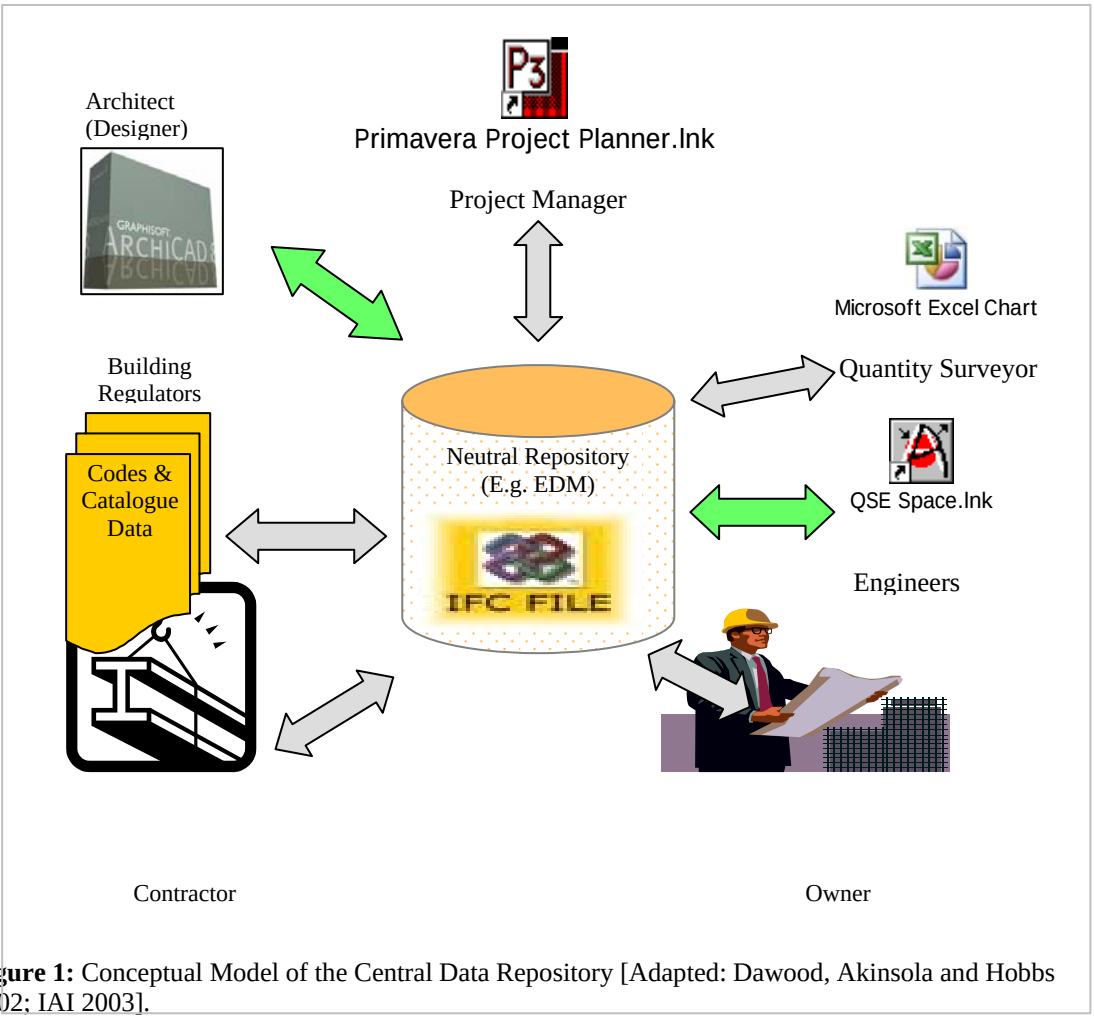

Figure 1: Conceptual Model of the Central Data Repository [Adapted: Dawood, Akinsola and Hobbs 2002; IAI 2003].

CHALLENGES IDENTIFIED THUS FAR

The deployment of IT within businesses has often resulted in the replacement of old problems with new; and the expected business benefits of IT not realised (Love and Irani, 2004). The inherent difficulties in identifying and assessing the benefits and costs are often a cause for uncertainty about the expected impact that the investment might have on the business (Ibid). Some of the envisaged challenges of deploying BPMs are:

- Custody of the single repository of data within the construction process;
- Creation of new ICT Skills for Users of the Models or;
- Creating a new professional altogether;
- The complexity of software applications in construction is increasing. This makes it difficult for project personnel to maintain familiarity (Cheng, Kumar and Law, 2002);

Attributes of the Just Right Custody Actor

For the industry to benefit from the building life cycle (BLC) approach to product delivery systems, a building product model (BPM) is crucial. Some of the fundamental factors on which just – right custody of the model is based are:

- Uncertainty with the objectivity of individual consultants, hence a process with no 'conflicts of interest' cannot be guaranteed;
- There is a need to deliver two items to the client: (a) a virtual model of the building, which is an accurate representation of (b) the actual built facility;
- That the issue concerns the management of the technology, because system support is not enough;
- That there is a need for responsibility to managing the data repository and that it is a data based management problem;

Product model custody has to be placed with a certain actors; one who is consulted by all project parties not only on matters of construction but also general construction commercial management. Some of the desired attributes would be:

- A team player;
- With vast construction business expertise;
- Not party to construction contract because of inherent conflict of interest;
- Serving the client's interest;
- Ability to update the repository, with high ICT skills;
- Unbiased to any profession;

However, below are the questions that beg answers:

1. Who amongst current industry professionals would befit the just-right custodian of the product model?
2. What are the knowledge and skills needed for this actor?
3. How do current knowledge and skills equate when assessed against needs of the actor?
4. What are the implications of BPM on current skills base?
5. Or do we really need custodian at all?

Consider the following professions.

The Project manager has a responsibility, among other things, to manage the project communication.

Project communications management includes the processes required to ensure timely and appropriate generation, collection, dissemination, storage, and ultimate disposition of project information (PMI 2000). Information distribution methods would include inter alia shared electronic databases (Ibid). However modern project management practices have weaknesses in managing new requirements, as earlier observed.

The Architect can manage a project from site selection to completion. In many building projects the role of the architect includes co-ordinating a team of specialist

consultants such as landscape architects, engineers, quantity surveyors, interior designers, builders and subcontractors (RIBA 2004). Therefore s/he:

Understands the process very well;

Produce designs and details;

Does it make the architect an automatic choice to manage the BPM?

The quantity surveyor estimates and monitors construction costs, from the feasibility stage of a project through to the completion of the construction period. After construction they may be involved with tax depreciation schedules, replacement cost estimation for insurance purposes and, if necessary, mediation and arbitration (AIQS 2004). Therefore s/he:

Implements management cost control systems, from inception to completion;

The scope goes beyond the current lifecycle;

Could the quantity surveyor be the correct choice to manage the repository, with a view to resolving potential conflicts even before they arise?

An Independent As Built Data Manager:

Facilitator from inception to fitting and operation;

With a new skills base or an extension of current ones;

To ensure accurate storage and validating;

To ensure that professionals provide the system with needed data;

CONCLUSION

The concept of building product modeling is one of the many technological centric initiatives, aimed at adding value to the building life cycle approach to product delivery systems. However, the management of process and people related factors associated with the paradigm of building product models require realignment to the current roles of construction actors. It may also require a new actor who would be entrusted the responsibility of managing the repository, with a view to delivering a virtual model of the building and the actual constructed facility to the client.

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