LINKING CRM AND CAD WITH IFC-CRM GATE

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ABSTRACT

Over the years, IT industry has tried many approaches to come to grips with the heterogeneity of software. Interoperability is a proven strategy to overcome this problem and facilitate converting of implicit knowledge to explicit knowledge. This interoperability may be established by a tightly or loosely coupled integration mechanism though for construction sector tightly coupled integration is not enough. There is an increasing demand for loosely coupled integration with the support of standardized models. Customer Relationship Management Information and Communication Technologies promise some opportunities to overcome these problems and facilitate knowledge capture throughout the lifetime of buildings. In this paper we are focusing on a link between Facility Management processes as the point of customer interaction and the design processes as where the quality is defined for an AEC product. This link (under development) is basically consisted of an IFC compliant Virtual Building Information Model (VBIM) and its connection to Issue Tracking Systems and relevant Knowledge Base in CRM software systems through a VBIM History Server.

KEY WORDS

Industry Foundation Classes, Customer Relationship Management, Facility Management, Interoperability, Design, Construction

INTRODUCTION

Due to the standardization efforts and the advancement in syntactic and semantic technologies, the interoperability of ICT (information and communication technology) solutions in the design phase is improving and information is being passed on to the construction phase with less and less friction. Particularly within domains we are seeing some good examples of smooth information flow throughout the process. A good example of this are the ICT solutions developed for design-build phase of AEC (Architecture, Engineering, Construction) and those for the FM (Facility Management) domain. For the AEC design-build phase, Computer Aided Design and Drafting (CADD) and Computer Aided Architectural Design (CAAD) software, project management software, spreadsheets, database applications, ERP Systems in general all communicate with each other in a convenient manner and there is an increasing support of standards such as IFC and (on

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another level) XML. Many of the tools and ICT solutions used in FM phase are similar or the same. But on the information level there is a very significant gap between the two phases. This gap is preventing the processes during these two phases to benefit from each other. An opportunity exists to capture important knowledge, if this gap could be bridged. In this paper we analyze this gap and propose a technical solution to bridge it.

METHODOLOGY

This study is based on using some of the Customer Relationship Management tools and techniques as a facilitator for interoperability between AEC and FM. We begin listing out the current state of interoperability in construction information technology (IT), and then make a brief analysis of AEC/FM to list the interoperability requirements between AEC and FM domains. IT solutions invented for CRM functionality are so powerful that we believe would provide solutions for the interoperability problems and barriers faced in construction IT today. Prerequisite to examine those opportunities is the determination of a mechanism (a gate) which would establish linkage between the current interoperability solutions in construction IT and available CRM solutions. The second part of the paper represents a model (under development) for how to use CRM as a facilitator towards the solution of listed problems.

INTEROPERABILITY ISSUES IN CONSTRUCTION IT

Interoperability issues in construction IT may be investigated at different levels. Three major problems which we would like to emphasize here is the difficulty with integration of product models with document based information (Froese 2004), supporting standard data model mappings (Amor 2004) and IFC related issues (Kiviniemi 2005).

Software packages available today for CAAD are capable of saving design intent as product data within a “Building Information Model (BIM)”. The requirement for CAAD software which is capable of capturing design data within a BIM is an old issue in terms of IT. One of the first examples of such kind software had been analyzed by Bjyl as early as 1979 (Bijl, 1979). Yaski also analyses the need for a consistent database for an integrated CAAD system and better interaction and management of CAAD content by architects (Yaski 1981). The General A/E/C Reference Model (GARM, Gielingh, 1988) is one of the first examples for use of Product Modelling techniques to capture the semantics within the construction objects. Wix’s Building Construction Core Model (BCCM) is the initiative of IFC (Wix, 1995). Within the European ESPRIT projects ATLAS, COMBI and VEGA (Liebich and Wix, 2006) explored the applicability of Product Modelling within demonstration scenarios coming from the construction industry. Although research on the field is quite old implementations came into practice after advances in object oriented modeling and programming and specifically after the emergence of IFC specification which in whole has about ten years of history.

This capability provides excellent coordination and management of project data while enabling 4D (CAD + Project Plan and Program with the addition of time data) and 5D models (CAD + Project Plan and Program with the addition of time and cost data) while promising effective FM for lifetime of the buildings. Yet there is still need for some document based information which should be integrated to the project data. That need is

always existent because it is not possible for all the project participants and FM companies to own the same sort of sophisticated software package. Froese elaborates on the problem and indicates that the most basic approach to integrating model based and document based technologies is the cross references from one on the other (Froese 2004). This cross referencing addresses the need for a classification system which would facilitate the process.

One other issue which must be solved is the mapping issues between any two standard data models used in the AEC industries. This task is enormous and very complicated and needs highly specialized experts in the area as well as reliable tools to automate transition (Amor 2004). The need especially arises when importing and exporting data between different standards (such as IAI-IFC and ISO-STEP) as well as between BIM used in software packages and these standards, hence CAAD software usually keep data within different structures.

A standard classification scheme would assist the conversion process. In our model we propose a "Virtual Building Information Model (VBIM)" based on a faceted classification system which we believe to facilitate the solution of these issues as well as assisting the actors of the AEC/FM domain at dealing with interoperability.

INTEROPERABILITY IN AEC/FM DOMAIN

Interoperability is the prerequisite for Knowledge Management. It is usually considered as an Information Technology (IT) problem which must be solved as a prerequisite to integration and KM. Integration has been a central topic of construction informatics and basically can be achieved in three levels (Cerovsek et al., 2002):

- Personal level (Between actors of the system)
- Data level (outputs of one application package can be read from an other)
- Services and tools level (between application processes as synchronous or asynchronous data exchange)

In the AEC/FM industry, the knowledge acquisition is limited. A lot of the knowledge throughout product design-build phase remains tacit and is not explicated. A large proportion of this knowledge emerges from the relationships between a customer (client) and a performer (designer, engineer, and builder). It has been proven in other industries that elaborating on the relationship with the client and focusing on the client satisfaction while establishing an organization alignment such that this becomes a proper focus of the processes dramatically increases the acquisition of knowledge and facilitates converting of implicit knowledge to explicit knowledge.

A very significant behavior in the AEC/FM domain is that, although many researches emphasize the need and necessity of the integration of "Design Build" and "Facility Management" phases of buildings to facilitate tracking the lifetime of built facilities and buildings in order to better understand the results of architectural and engineering design solutions, test the performance of as built elements (manufacturing output) and use extracted knowledge for future construction excellence (Fischer & Kam, 2002); AEC and FM still act and function as separate domains. While in general, both AEC and FM processes use the

similar software packages and these tools are generally interoperable with each other, actual information exchange between those domains is very limited.

Different actors contribute to "Design Built" and "Use and Maintenance" phases of buildings. For some sophisticated facilities the relationship in between is much closer such as "as-built" projects. In this case some use and maintenance manuals are available from project management for the use of facility management. But for many types of projects as-built information about built environment is almost completely hidden and cannot be used by the "Use & maintenance" processes.

One of our proposals with in this paper is to extend the scope of interoperability and promote it in three different levels which as an outcome of our previous analysis in the field of CRM (TR). Every process in manufacturing (design and build), Services (FM) and marketing (real estate) has a common structure. Elements of this structure are "Actors & Organization", "Processes", "Information Technology (IT)". According to our opinion while providing interoperability solutions such as IFC, it is also essential to define some standards or "starter kits" which would guide the companies and actors of the sector with aligning their personal or organizational behavior (business culture) to the proposed system and help enterprises to reengineer their current processes of doing work. CRM case studies show that success with new strategic IT initiatives is dependent on "Human factors (70%)", "Processes (25%)", "IT (05%)".

These data may designate one reason why IFCs' had not been as successful as expected. We assume that the Industry Foundation Classes will continue to gain the support of software developers and integrators in the design-build phase and provide the core structure of the BIM (building information model). They are very convenient in terms of interoperability and provide a reliable and extensible view for every domain in AEC/FM industry. Setting up ICT solutions over an IFC foundation is believed to ease interoperability. New ideas and concepts can be integrated to extend the current IFC specification. Though there is still need for models for IFC which would facilitate the acceptance while increasing the awareness and use among industry professionals of the AEC/FM domain.

BACKGROUND AND RELATED WORK

In AEC industry the buildings and built facilities (the integrated solution) are unique while entities which these solutions are composed of are typical; providing opportunities for the industrialization of the sector. This actual framework also has its support as the conceptual building information model at the background. While buildings are different from each other, the language (and the data structures) required to describe them are believed to be stable (Turk et al. 2004). This makes it easier to define and analyze the ontology of those systems and a generally agreed ontology is a prerequisite for effective information exchange. The development of the semantic web with agent based information is a current example, where interoperability is enabled trough ontology development and standardization (Ekholm, 2004).

Advancing technologies such as grid computing, the semantic web and web services promise new interoperability opportunities for integration and facilitate the formation of Virtual Organizations (VO) while increasing the collaboration and information sharing among the actors of those VO. Especially small to medium enterprise (SME) companies have

limited resources in order to benefit from sophisticated IT solutions and higher levels of interoperability promises increase in knowledge assets which is strategically essential while providing higher levels of business competence strength.

FM & AEC INTERACTION AS THE SUBJECT OF INTEROPERABILITY

Facility Management (FM) is a profession that encompasses multiple disciplines to ensure functionality of the built environment by integrating people, place, process and technology. Facility Management companies are characterized with their widespread differentiating functions. A FM firm may be a consultant company, real estate company, building operation and management company, as well as a subcontractor of the actual design-build phase. FM services may be provided by companies as well as by individuals. Thus FM includes almost all the required tasks to trace the lifetime of buildings.

The scope of our model focuses on Building Maintenance processes (The preventive and remedial upkeep of building components and systems – including but not limited to HVAC, electrical, plumbing, elevators, carpentry and painting; excluding janitorial and grounds maintenance), as a basis for linking with CAD. Issue tracking is possible and CRM interaction may occur at any state of FM related activities meaning that every actor of FM domain is the main user of the system in terms of our model.

These maintenance activities may be the subject of Corrective Maintenance (maintenance activities performed because of equipment or system failure; activities are directed toward the restoration of an item to a specified level of performance, sometimes called "breakdown maintenance"), Cyclical Maintenance (maintenance that can be predicted and performed on a regular basis), Deferred Maintenance (a formal or informal listing of unaccomplished maintenance tasks; such situations arise because of shortages of funds, personnel, or specific management practices), or Preventive Maintenance (planned actions undertaken to retain an item at a specified level of performance by providing repetitive scheduled tasks which prolong system operation and useful life; i.e., inspection, cleaning, lubrication and part replacement)(Cotts and David, 1992).

SCOPE OF WORK

The main scope of our work is the optimization of the quality of life by optimizing the quality of entities surrounding us. What we try to do is to collect some “historical” data related with the performance pitfalls of built entities - from design to demolishment - in order to count the incidences, compare with similar issues in different types of buildings (or projects), compute the frequency of occurrences thus provide a basis for future construction excellence. Identifying the priorities of design problems and facilitating the industrialization of construction sector by providing more and more robust solutions to the identified issues through architectural and engineering design. Interoperability between FM and AEC then become the first issue to solve in such a scenario.

THE IFC-CRM GATE

Customer relationship management (CRM) is about creating systems that allow for a more intelligent and specific relationship between a company and any individual customer (end-

user). Two cornerstones of CRM are the knowledge or customer information platform (which includes hidden requirements about new product specifications) and the customer interaction platform. Our definition for AEC/FM cluster defines it as the gateway to the Total Quality for construction sector.

CRM is a knowledge management activity. CRM is intended to be a repeatable process to ensure ongoing, continually improving, and consistent results. CRM comprises the acquisition and deployment of knowledge about customers and their "needs and wants" to enable a company has the right leadership, strategy, and culture in terms of higher total quality.

As a basis for improved knowledge capture in AEC industry we propose a gateway between the issue management in CRM systems (collected during FM processes) and the BIM (mostly defined during CAD processes). Its prototype implementation (under development) will use the IFC grounded interoperability between those two domains to establish a virtual collaboration platform between designers and customers to provide knowledge acquisition and sharing in order to establish continuous quality improvement for the construction sector. The proposed CRM – IFC gateway framework is consisting of three major elements:

- A business model defining some new actors for the AEC/FM domain as well as correlated business processes
- An extension in the IFC specification to "measure" quality defined in IFC compliant BIMs' as well as to contribute CRM data to the BIM
- The underlying data model

IT solution (under development) uses IFC 2X Addendum1 specification as a basis for information capture and benefits from the built-in occurrence capturing mechanism in IFC specification to deal with the issues collected in CRM processes (Figure 1). The interoperability layer is mainly consisted of web services supported with ATLAS (.NET framework version 2.0 implementation of AJAX technology) and Script Callbacks.

ISSUES AND IFC COMPLIANT VBIM HISTORY SERVER

Tracking a building's lifetime is a hot topic but the real benefit from such process can be obtained if only there is chance to match, validate, map and compare data with other – most probably similar – projects. The first requirement is a top authority which would provide an eye "over" the projects. This top authority may be an organization or an IT platform (Such as InteliGrid). In this paper we build our model over an organization scenario (instead of an IT platform). In our business model we do not only emphasize the need of the reengineering of the organization of the AEC/FM domain but also as a hypothesis state that a central authority above all current and future organizations is necessary.

In terms of interoperability, conceptualization of data flow within a project is easier than the conceptualization of data flow between projects. Current efforts focus on interoperability "within" projects. The idea which makes our approach different is the interoperability "between" projects. The occurrence capturing mechanism in IFC compliant databases can be matched with Issue Tracking Systems of CRM. To capture information related with those

occurrences and record that knowledge in such a way to facilitate shifting focus on the problem and the building (or from an other point of view "the project") which the issue occurs; we address the need for a general standardized "bridge" which we call as the Virtual Building Information Model (VBIM) in conjunction with a VBIM History Server and Knowledge Base (KB). The use-cases we address for CRM issue tracking solutions for the use of FM are:

- We point the necessity of a top authority (an agent) that coordinates and facilitates communication and collaboration between customers and various FM firms. This agent keeps and maintains the KB and the VBIM History Server.
- We assume that the customers interact with FM services through this agent; and this agent functions as a consultant for both customers and AEC/FM actors.
- We assume that this agent contributes to new projects, beginning from the "decision" phase and has access all the project data (and BIM as well) it has been a part of, from design to demolishment.
- We assume that whenever data from BIM is available, it is filtered through an IFC Model Server that the GUIDs attached to entities are from the IFC Model Server.
- To capture the BIM related with projects, project participants are registered with this agent with a unique identifier (to successfully attach responsibilities to the actors – even if they take part in different projects - and facilitate history tracking related with both issues and those actors).

What we call The Virtual Building Information System is a "*faceted classification of building entities with added data*". This approach yields an abstract view of building entities with the exclusion of detailed relationship and behavior information. The VBIM addresses four different interoperability problems, which define different business scenarios:

- It is in our scope that the general framework should function for all building stock available. That means the information to be captured can be the actual BIM as well as a bulk of paper blueprints. In case BIM is not available (especially for "older" buildings) and if there is a chance to access some data that may be captured related with that project, VBIM can be used as a proxy for knowledge capture. The logic behind let us to define "partial", abstract BIMs.
- When data sharing may be subject to happen between two project participants of different projects and at neither side be a model server implementation (eq. Between engineer in one project and facility manager in an other)
- If the information required is too simple for a model server implementation but vital in terms of productivity and quality
- If the information need is asynchronous, that the information requested should be extracted from previous projects (or know how)

The classification of building entities in the VBIM is based on Omniclass Classification System (OCCS). The VBIM information is saved as a script in the VBIM database. Hence

our aim is to capture knowledge related with all available building stock, it is very likely that in time the data size maintained may become huge and hard to maintain. Saving data in a script instead of in separate fields approach is specifically chosen for database size management. "VBIM History Server" maintains modification information related with VBIM entities and populates the required dataset upon demand; processing the data in the VBIM script and the "History Index Database". A typical VBIM script is consisting of five main parts as shown in figure 1 and the general architecture of the system is shown in figure 2.

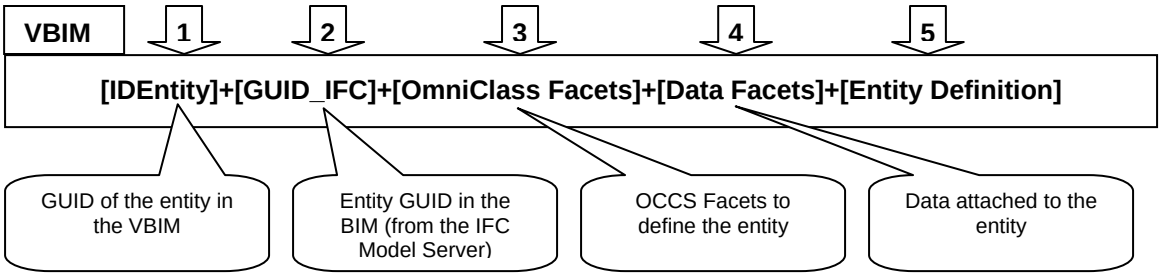

Figure 1 The Virtual Building Information Model

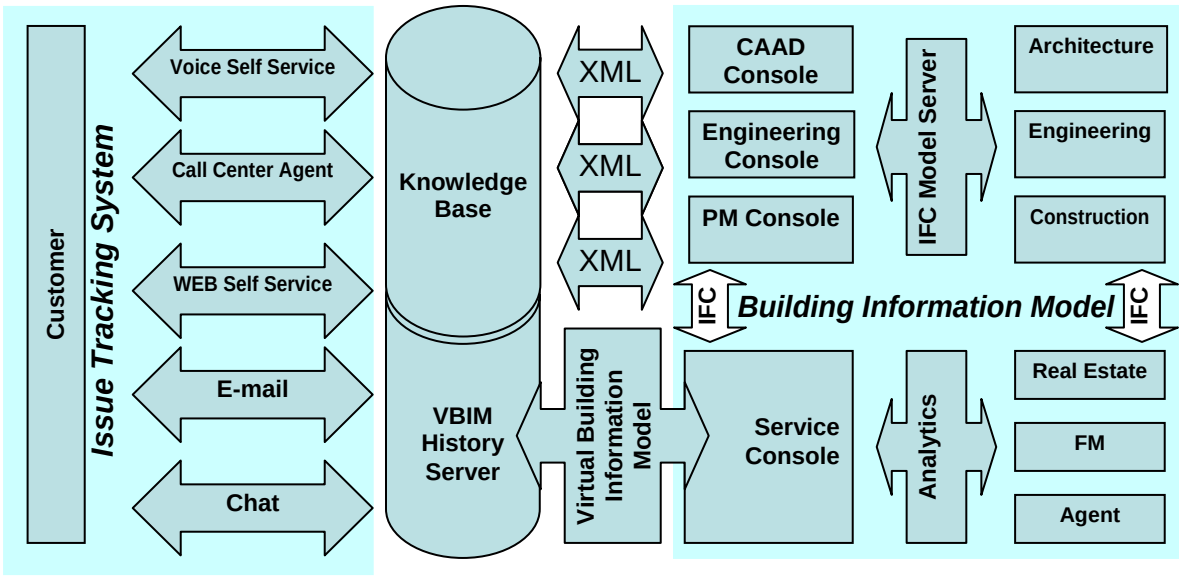

Figure 2 The General Model Architecture

The VBIM captures the initial state (AS IS) of any building entity. VBIM History Server maintains data about the updates (TO BE) state of these entities. The data in the History Server is an index of updates in relation to the "IDEntitiy" GUIDs and captures owner, date-

time, facet and updated value information. These data to the Historical Server Database can be entered manually as well as automatically with the help of an application plug-in. Upon queries the history server collects IDEntity GUIDs based on the query from the VBIM and populates the requested state of those entity(ies) from the History Index Database. Updates to the entities are captured through CRM issue tracking systems and any acquired knowledge (either digital or paperwork) is indexed and saved in the KB with the consecutive Issue ID and IDEntity.

THE IFC CONNECTION & EXTENSION

The VBIM is connected to the IFC compliant databases and the BIM with three tiers. Through the IFC based globally unique identifier of entities, through the "IfcClassification" entity (which enables to be VBIM existent in the actual BIM) and through an IFC measurement resource extension which we propose for some initial CRM metrics. These metrics depend on four new "IfcMeasurementResource" entities to measure the "rank" (attached by the users and customers), "performance" (deviation from requirements, tested during FM maintenance), "consistency" (a special measure designed to measure data quality included in VBIM), and "frequency" (to count incidences and capture how often they occur for a specific kind of problem) related with VBIM entities. However this IFC extension is out of the scope of this paper.

CONCLUSIONS

In this paper we discussed the technical background of a bridge between Issue Tracking Systems in CRM and Architectural & Engineering Design using CAD tools to enable knowledge capture through the life-time of built facilities. We believe that the model has the potential to facilitate interoperability between FM (as the interaction point with customers) and AEC (as the phase where knowledge is created) as well as help with awareness and use of IFC based interoperability. We find it necessary to place a new actor to coordinate the both ends with the following functions:

- Providing the yellow pages needed for coordination and interoperability between projects
- Provide guidance towards interoperability and Construction Excellence as being the one who has direct access to all projects registered
- Organize education programs to increase the awareness and knowledge about interoperability among business actors
- Promote interoperability; act as an agent to provide certification for IFC compliant IT solutions.
- Guide the industry with preparing reports or just enable central access to "prepared" reports by other agents on best practices as well as Key Performance Indicators related with AEC/FM and IT solutions in the field.

These services may exist on a “grid” with the vision of the coordination of a group of resources that can be used for combined efforts with a sophisticated IT support at the background. In order to do business on the grid, security, communication, well defined semantics with the added value to relationships are prerequisites which are kept out of the scope of this paper.

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