PREPARING A BUINDLING INFORMATION MODEL FOR FACILITY MAINTENANCE AND MANAGEMENT

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ABSTRACT: Over the past five years Building Information Modeling Software (BIM) has made tremendous inroads in the US-AEC industry. The use of BIM software such as Autodesk Revit is now common place among large US contractors. The model is currently being used for issues such as design, engineering, visualization, conflict resolution, construction simulation, subcontractor co-ordination and cost projection. In theory a BIM model has the capability of being transferred to the owner for use in the maintenance and management of the facility. However these models are not being used by facility managers for maintenance purposes. A significant part of the problem lies in the fact that the model was not created with the information needed by facility managers. This study focuses on the information needed by facility managers in a BIM model. Autodesk Revit is the most popular BIM tool used in the US AEC sector and was hence used in this study. Facility managers were interviewed to obtain the information they would like to see in a BIM model. An existing facility was used and a new BIM model was created with all the information needed by the facility managers. Several innovative techniques were used to input the information in the Revit model. The model was then reviewed by the facility managers and further improved. Some shortcomings were found that the researchers could not resolve using the Revit model. This paper elaborates the creation of a BIM model for facility maintenance and management and the results of the field test.

Keywords: *Facility Management, Building Information Modeling, University Facilities Division*

1. INTRODUCTION

The construction industry in the US accounts for 8% of the GDP and is the largest employment sector in the private domain [1]. Yet, as vast as the economic impact of this industry is, it is still fragmented in many ways. Within every construction project delivery system, enormous communication gaps exist between the designer, the builder, the owner and the operator. It has been shown that information technology can solve some of the problems caused by inefficiencies that exist due to these communication gaps [2].

Arguably, the largest gap that exists is between the builder and the owner/operator [3]. Upon completion of a building, the builder hands off to the owner and operator an enormous amount of project information, including as-built plans, equipment information and warranties, among many other documents. Then, as is usually the case, the owner/operator spends vast amounts of time and money sifting through the countless documents in order to implement the information into an operations and maintenance system. Due to the inherent communication gaps in this process, the information being handed off by the builder is often incomplete from a maintenance perspective, and therefore the means by which the owner/operator organizes this information is often inefficient. Using Building Information Modeling (BIM), the communication gaps can be filled and the operations and management systems for facilities may be streamlined [3].

Based on a study funded in 2004 by the US National Institute of Standards and Technology, the capital facilities construction industry wastes $15.8 billion annually due to interoperability inefficiencies. Within these \$15.8 billion worth of losses, \$5.2 billion is attributed to the participants within AEC industry, such as the architects, general contractors and suppliers. These inefficiencies include the re-entry and re-creation of information and data, and a duplication of business functions [4]. The other \$10.6 billion in losses is attributed to the owner/operator during the operations and maintenance phase of a building. The inefficiencies in this phase consist of obsolete information technology systems, time-consuming information verification and validation, inefficient business process management, and information delays.

Universities are by nature owners of large number of facilities and spend significant amount of time and resources towards managing and maintaining these facilities. Auburn University is ranked in the top fifty public institutions in the United States. The university has approximately twenty five thousand students and three thousand employees. The university has nearly eight million square feet of managed space across various building on and off campus. The university is currently going through a construction boom and is currently in the process of adding several more thousands of square feet on and off campus. Various departments within the facilities organizational structure of the university are considering the use of BIM technology in the construction of these new projects. At this time, one project has been completed using BIM in the design and construction phases. Another construction project is in progress using this technology and it is anticipated that future projects would also use this technology. This paper addresses the use of the BIM models by the facility maintenance and operations department on campus. For the purpose of this study the researchers demonstrated the use of BIM in facility management (FM) to university personnel. The information presented in this paper is based on detailed interviews of the staff of various facilities departments conducted by the authors.

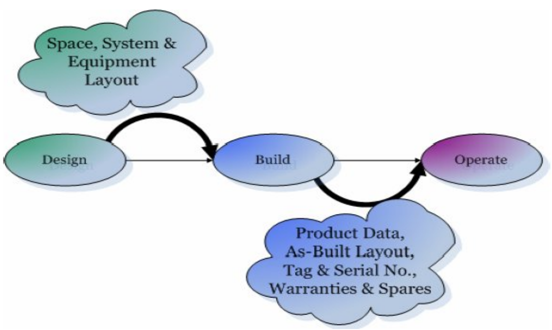
2. FACILTY MANAGEMENT AND MAINTENANCE

Upon completion of construction of a facility the contractor transfers several key information items to the owner. In the case of this study the owner is a large University in the United States and has over eight hundred personnel involved in managing and using this information. The information passed along includes items such as warranties, as-built drawings, equipment lists and preventive maintenance schedules. FM managers use this information to effectively operate and service the facilities throughout its lifetime. This information is also very crucial if there is a need for expanding or conducting major repairs to the facility.

The Construction Operations Building Information Exchange (COBIE) is a spreadsheet created by several national and international organizations in the US to facilitate the passing of information from the contractor to the owner [5]. The information in the spreadsheet is specifically meant for FM and includes information such as warranties, preventive maintenance schedules, part and model numbers of equipment. The information in the COBIE spreadsheet can also be entered in to a BIM since it is already being created during the design phase of several projects. Once the BIM for a facility with COBIE information is passed on to the owner, the owner may retrieve this information, make modifications to the model and the COBIE spreadsheet over time, thereby minimizing the amount of information that has to be manually entered into FM specific software such 'Facility MAX'. The timeline of adding information into the COBIE spreadsheet is shown in Figure 1.

Fig. 1 COBIEtimeline [5]

Currently, several organizations within the US



Government, such as the General Service Administration, the Army Corps of Engineers, and the Department of State, use Construction Operations Building Information Exchange (COBIE) as a standard format. For the purpose of this study the researchers did not create a COBIE spreadsheet for the BIM model, as several personnel in the facilities division were not even familiar with BIM technology.

3. RESEARCH DESIGN

The objective of the study was to demonstrate to the various facility departments at Auburn University the use of BIM in FM. The facility that was used as the subject of this case study was Auburn University's construction management building. This building was chosen for two reasons. The first is because of the familiarity that the researchers have with the facility. The second is because a large amount of documentation is readily accessible as the building is relatively new. Construction was finished five years ago, in 2006, thus pertinent information about the building has been more readily available than in an older building.

The size, approximately 35000 square feet, of the facility chosen was also significant. It was small enough that a new BIM for the facility could be created relatively easily, yet large enough that many Facilities Departments were involved in its maintenance and operation. The facility was big enough that the full spectrum of the Facilities departments that we intended to examine (i.e. Operations and Maintenance, Campus Planning, Space Allocation, Design and Construction Services) was involved in the operations of the building. The researchers conducted two phases of interviews with key personnel in the FM division of the University. The first phase of interviews was conducted to gain a complete understanding of the processes and workflow of the facilities division. The information gathered in Phase I was used in the development of the BIM model for demonstration at the second phase. The second phase involved demonstrating the model in a group setting for all participants. The demonstration was followed by a discussion of obstacles and opportunities for implementing BIM based FM processes at Auburn university.

3.1 Phase 1: Interviews

Data Collection for the case study was performed through the interview of key personnel in the Facilities departments, similar to the study done by Mendez [3]. The purpose of the personnel interviews was to:

- Identify and understand the current practices of information management in the facilities division.
- Identify the familiarity of the facilities personnel with the capabilities of BIM
- Identify information such as equipment and warranties that must be included in the development of the BIM
- Understand the information used by each FM department to conduct facilities management
- Identify important issues, problems and concerns in implementing information in the current FM system
- Understand the workflow and information flow through the FM organizational structure

The Facilities offices and departments that were interviewed included the Office of the University Architect, Office of Campus Planning, Office of Space Allocation, Operations and Maintenance and Office of Energy and Utility Management. Only the department heads for each of these offices were interviewed for the study. In some instances the department heads included the supported personnel during the interviews. All the above-mentioned personnel were interviewed individually in their offices.

3.2 Preparation of BIM Model for Demonstration

Upon completion of the interviews in Phase I of the project, the researchers used Autodesk Revit to create a BIM model for the said facility. Several suggestions obtained in the Phase I of the study were included in the creation of the model. The researchers created a model that included the Architectural, Structural and Mechanical elements of the facility. Electrical and plumbing objects were not included in the creation of the model.

3.3 Phase II: Demonstration and Discussion

In this phase of the study, the researchers invited all personnel interviewed in phase I of the project to one meeting where the model for the facility was demonstrated. The researchers presented the information gathered in phase I and proceeded to demonstrate how that information was incorporated into the model. Upon completion of the demonstration, the researchers opened the floor for open discussion. The researchers moderated the discussion, answered questions about the technological aspects of the software and made general remarks for the most part. Researchers documented the discussion among the various attendees using audio recording devices, which were later transcribed.

4. RESULTS

The results of phase I interviews, their implementation into the BIM model creation and the final demonstration of the BIM model and the associated discussion are presented in the section.

4.1 Phase I: Interviews

A complex structure is in place at Auburn University for the management of facilities. The ultimate authority within this complex structure lies with the University Board of Trustees. The Governor of the state appoints the Board of Trustees and the members of the board approve the construction of new capital facilities at the University. The University President and his staff assist the Board in administrative matters and have a major influence on the Board's decisions. The Executive Vice President of Finance is in charge of the Facilities Division, the Campus Planning Office and the Space Management Office.

In this phase the researchers interviewed the heads of the Office of the University Architect, Office of Campus Planning, Office of Space Allocation, Operations and Maintenance and Office of Energy and Utility Management. The information needs of each of these departments were recorded. The exact content of the interviews is omitted in this manuscript due to space limitations. The interviews however yielded key information that the researchers felt could be easily incorporated into the BIM model. This information included equipment part numbers, warranties, space and area plans. Some information needed by the facility managers such as maintenance logs and work-order history logs could not be easily incorporated into the BIM model. During the course of the interviews the researchers discovered the FM personnel were familiar with using Autodesk products and some of them had taken a keen interest in BIM software from Autodesk, such as Revit Architecture. It was therefore decided to develop the BIM model in Autodesk Revit.

During the interview process it was found that FM personnel used two software programs that were critical to their day-to-day operations. The campus architect, the space management office and the campus planning office used the first software named 'ArchiBUS'. This program was primarily used for monitoring the use of space within the campus and access future needs. During the interview process it was noted that currently the office of space management actually recreates these two dimensional drawings in AutoCAD and imports the drawings into ArchiBUS. Additional information about the properties of the space, room numbers and any equipment information in the facility are added to the drawings in ArchiBUS. The actual as-built drawings provided by the contractor and all the commissioning documents such as warranties, equipment details, service schedules are stored in a vault on campus at Auburn University.

The other software named 'FacilityMAX' is a web-based work-order processing application for managing facilities and is used by the operations management office and the energy monitoring office. It was noted that the processes in place to attend to a work-order generated was remarkably sophisticated. Due the large number of users in a University environment the web-based system was effective. A typical work-order is generated by a member of the staff or a student at the university in this web-portal. The work-order is routed to the appropriate department based on the selections by the user such as the name of the building and type of problem. Each department has a dispatcher who then electronically directs the problem to the appropriate worker to tend to the work-order. The workers receive an electronic message on their phones within a few minutes of the work-order being generated. The facilities division however is manually populating the data about each building within the FacilityMAX software. Data within the FacilityMAX program contains information such as building names, room numbers, equipment names and descriptions. This information is stored in a relational database and managed by the information technology support personnel within the facilities division.

4.2 Phase II: BIM Model Demonstration and Discussion

The demonstration of the BIM model shown in Figure 2 also served as an introduction to BIM software. The participants were shown the architectural, structural and HVAC models. 3D views, sections, floor plan views and elevations were demonstrated. Some basic functionality of the program such as hiding objects, cropping views was also demonstrated. The research team also created some renderings and walk-through that were demonstrated. The demonstration occurred in one of the conference rooms in the same building as the model, this way the participants could get a better grasp of the model.

Fig. 2 Architectural model of the facility used for the purpose of this study

Once the participants were familiar with the model, the researchers demonstrated the parametric functionality of Autodesk Revit. The research proceed to show the HVAC equipment in the model and demonstrated how custom fields may be created to store information regarding warranties, maintenance schedules, part numbers, manufacturer's website and contact information could be stored in the model. The team proceeded to demonstrate how this information could be retrieved using material schedules in Revit. Researchers demonstrated how each space within the building was assigned a room and how the attributes of each room could be manipulated. The team demonstrated how the model plan views, sections and elevations could be exported into other software programs such as ArchiBUS. The creation of material schedules such as counting the number of light fixtures, air terminals was demonstrated. The schedules were then modified using the filtering and sorting tools in Revit. The schedules were later exported to Excel and a database to demonstrate the portability of the data in the model.

Upon completion of the demonstration of the model, the team opened the floor for comments and opinions from the participants. It was immediately obvious that the participants were impressed with the capabilities of the technology. Several participants commented about the amount of time that could be saved by having readily accessible information and not having to re-enter the information into various other platforms.

The utopia about the software capabilities however quickly faded away. Several key players indicated that if this requirement were to be forced upon the design team it would drive up costs for the projects. Furthermore it was unsure that the University could actually require contractors to provide this information, as this was a state funded institution and the guidelines for contracts were dictated by state agencies outside the University. It was suggested that a study to verify Return-On-Investment within the University would provide some compelling arguments to take forward to the state agency to change the laws of the state. The problem of maintaining the models post construction was also brought up. It was recommended that the University consider hiring a full time person to manage the existing BIM models and in the transition to create BIM models for existing buildings. All parties in the Final interview agreed that the University could benefit from integrating BIM into the design, construction, and maintenance of University facilities. However, there was disagreement as to when and if this BIM integration should take place. There were some that believed the adoption of BIM into the Facilities Division should take place as soon as possible, and there were others that believed Facilities should wait for BIM to become a standard part of the state's contract documents.

One of participants suggested that the researchers must make the presentation to the Board of Trustees in order to educate them about the latest practices in the industry. The interviewees cited two ways of going about convincing the board. The use of the return on investment study could be one, along with bringing the board's attention to the work done by existing contractors on campus that are using this technology. At the end of the discussion there was agreement that this technology could be beneficial to the functioning of the facilities division at Auburn University. There was disagreement in the implementation timeline of this technology within Auburn University.

5. CONCLUDING REMAKRS

The use of BIM models in the facilities division at Auburn University was sufficiently demonstrated by the researchers to all departments within the facilities division. There was general agreement within the facilities division about the usefulness of the technology. There was a gap in the knowledge of current practices in the construction industry and the facilities personnel at AUBURN University. In order to incorporate this technology into the facilities division, it is imperative that the University to train or hire a person to manage the technology. University FM managers must also be trained in the creation and use of COBIE spreadsheets.

Several contractors that are building new facilities on Auburn campus are already using BIM models. These contractors should be required to develop these models to integrate COBIE attributes within the model so that it may be used during the facility management phase of the facility. The current practice of re-entering information into FM software is both tedious and expensive and could be avoided by the use of BIM. A Return on Investment (ROI) study would be an ideal method to convince the Board of Trustees and the state agencies of the profitability of BIM adoption for FM. The study should examine the savings through the use of BIM in FM processes at Auburn University. The study should also consider the amount of time and man-hours required for FM personnel to manually re-enter all pertinent information in FM software. This study at Auburn University may be combined with other studies that have documented the return on investment in the design and construction phases of a project to make it a compelling argument for the board and state agencies. The contract language for construction of new facilities may then be modified to incorporate BIM technology in the construction of new facilities.

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