University of Washington's BIM COBie Pilot Project

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Abstract

Researchers and practitioners have partnered up to implement a BIM/COBie Pilot Case Study project at the University of Washington. This is part of a joint initiative by the Construction Owners Association of America (COAA), buildingSMART alliance, and the Engineer Research and Development Center (ERDC). The University of Washington Capital Projects Office has been accepted to host one of 6 case study pilots in this year's COAA case studies and has brought UW researchers in to support the change design and analysis. For the University of Washington, this COBie pilot project is seen as a part of a larger initiative by Capital Projects and Facilities Services to create better hand off processes for facilities and O&M information from design and construction to operations and maintenance and the creation of meaningful BIMs for the owner. In this paper we present the initial findings from the pilot project, which includes an analysis of existing practices and the ways in which the complex institutional owner, with over 700 buildings, consumes and uses data throughout operations and maintenance. While direct digital exchange sound simple in principle, we have discovered that when bringing a construction data set into a large distributed organization and IT infrastructure such as a large college campus, there are a number of complicating factors to consider in terms of pathways, format, content, timing, personal relationships, and user interfaces.

Keywords

Facility Management, Capital Projects, BIM, COBie, Operations Maintenance

1. INTRODUCTION

This year marks the 150th anniversary of the University of Washington (UW), and the construction of buildings that house faculty students and staff go back over 100 years. Both the documents we have of our buildings and the work practices surrounding construction, operations and maintenance are influenced by the organization's history, culture and size (Seattle Campus ~ 335 buildings). In an attempt to improve the exchange of information at the conclusion of a construction project, the Capital Projects Office (CPO) and Facility Services (FS) at the UW joined a case study project initiated by the Construction Owners Association of America (COAA). This research relies on the basic framework established by buildingSMART alliance for COBie case studies, (East & Kenig, 2011), however the UW team has adapted the case study protocals to meet our internal constraints and goals.

The protocol specified by COBie suggests that in an ideal project the information exchange process begins during the design phase and continues throughout the subsequent

phases of the project. Additionally, it was suggested that contract language and specifications should be changed to require the general contractor and subcontractors to submit information in the COBie format. (East, 2011). At the point in time that the pilot project was identified as the Foster School of Business Phase II, it was deemed grossly burdensome and costly to retroactively change contractual language. Instead, the general contractor was amenable to compiling information about the major Mechanical, Electrical, and Plumbing (MEP) equipment and putting it into the COBie format. Consequently, this project focused on the handoff process between construction and operations. We focus our attention on the owner organization and how they consume and use the data. This will better inform future development of contract deliverables in future projects, where designers and builders will be required to develop COBie dataset deliverables.

To assist in documentation and analysis, the Capital Projects Office (CPO) and Facility Services (FS) contracted with research faculty in the UW department of Construction Management. Professors Rojas, Dossick and Schaufelberger had conducted previous COBie-related research with two graduate students in 2008 and 2009 on a military project at Fort Lewis. It was felt that having Dr. Dossick's experience would help speed up the learning curve for the team. At the initial interest meeting held at the Capital Projects Office, CPO felt that 1) having someone familiar with the COBie process and 2) having people independent of the team already assigned to the project would allow collaboration, but would not draw resources away from the already intensive construction process.

2. METHODOLOGY

The UW CPO started this project by funding the research as an additional deliverable within the building project itself. Several high level meetings established general directions for what the project would try to achieve—an understanding of what it means for the UW to receive COBie datasets from the construction phase. These initial meetings began with the COAA group and then broke into smaller internal groups within the UW as research got underway.

The first phase of the research was exploratory. We set out to determine what existing practices are in place, what types of data do field crew members and campus engineers need to do their jobs, and in what forms are these data currently. Research began by conducting multiple informal interviews with people deemed important players in the generation, compilation, and delivery of information during the construction phase. Furthermore, the UW publishes organization charts online, which provided a general idea of the framework of the university and suggested which individuals might exchange information based on their roles (University of Washington Facility Services, 2010). From these organization charts, we selected a number of people that we felt would be representative of the work at the UW. Looking specifically at the CPO, FS and consultants for the project, we identified a list of targeted interviewees.

Next, we generated an interview tool that would help us maintain consistency across a formal set of interviews. We created a list of questions that we felt would help paint a picture of how the University staff exchanges information. This tool attempts to create a dialogue and draw out an understanding of how the interviewee fits into the UW network of staff who manage construction projects as well as operations and maintenance activities. Throughout the interview process, we derived work flow diagrams, collected department-produced organization charts, and facilitated group discussion sessions for key technologists at UW. The concept of these diagrams came from the COAA's Case Study Template for COBie projects and specified the use of Swim Lane Diagrams and the BPMN (Business Process Management Notation) (East & Kenig, 2011).

We coded the interview data set and analyzed emergent themes in order to identify potential obstacles to improving information exchange and leveraging COBie technology and processes.

3. BACKGROUND

UW Facility Services tracks certain equipment, also known as assets, using a Computerized Maintenance Management System (CMMS) in order to improve the speed and effectiveness of maintenance. The CMMS allows tracking of an assets' important features, in COBie these are called attributes. The CMMS at the UW at its most basic tracks the manufacturer, model, serial number, and installation date of an asset; though for some pieces of equipment they may record other pertinent information to assist in preventative maintenance and work orders (such as refrigerant type or power requirements). The CMMS system also tracks the maintenance history for each asset.

The asset management tools adopted by the UW have developed over the years. Starting in 1992, UW developed their own in-house systems. In 2001, the UW adopted a program called FM Enterprise (FME), which was later upgraded to the same provider's web-based version, FaciltyMax (FMax). In 2009, this software provider was purchased by another company and acquired a new name, AiM by AssetWorks. According to AiM's website, the program *Enterprise Asset Management* is compatible with COBie2 format (AssetWorks 2011). For this pilot project, the general contractor and MEP subcontractors are collecting COBie data throughout construction and compiling a COBie BIM file in Autodesk Revit. The direct digital exchange between Revit and AiM will be tested in the next few months as construction finishes.

In addition, there has been a transition to digital storage in the Campus Engineering Records division in recent years. Archival documents including: Operations and Maintenance Manuals (O&Ms), as-built drawings, warranties, and specifications. Hardcopies are still submitted, but they are scanned in and then stored until state mandated archiving requirements allow them to be destroyed. Other hardcopies are also usually sent to the client, the trade shops, engineering, and sometimes into a maintenance room in the building itself. However, consistency among storage of these documents was found to be inconsistent as practices change over the years. While some improvements have been made, "Records used to be a black hole. But now [digital software] in Records is more efficient so things are better.", there are still challenges in finding the O&M data needed for routine and emergency maintenance or engineering activities as one interview explains: "90% of data I'd say we get from either ourselves or our technicians out in the field because AIM is hollow for us right now"

4. ANALYSIS

Part of the inherent difficulty of this project and one of the goals that the research sought to discover was that as a large organization, the UW is separated into distinct divisions that operate more or less independently. In our interviews we consistently found that employees had a general concept of where information came from or where it went, but the detailed knowledge of how it was used or the work practices of other divisions was missing. There is a largely informal network that has developed allowing people from different groups to develop relationships and rely on each other for informal information exchange in an ad hoc manner.

Implementing the COBie project became a catalyst for analyzing standard business practices that had much broader implications then the use of COBie itself. While on the one hand we conducted a fairly technical analysis that included mapping data input and output requirements, on the other hand we uncovered organizational and business process issues that likely plague many large institutions and corporations of this size. We found that adopting

COBie was not just about *what* information was being exchanged, but more importantly the how, when, and where it was being exchanged. There are several dimensions to the challenges of information exchange including pathways, formats, content, timing, personal relationships, and user interfaces.

4.1 Pathways of information exchange: (shared database, email, ftp site, cd/paper handover)
The pathways that information must follow in order to reach the desired recipient can be an obstacle to overcome to improve information exchange. When there is added complexity to the path that information travels, there is more time and effort required to quickly retrieve or cache that information. In 2010, the UW Finance and Facilities departments underwent an internal audit known as the 'Lean' project. Throughout interviews, people would refer to the findings of that project and the positive impact it had on improving the avenues of information exchange, "After the lean project, my job got easier because there's no paper." When asked how they received information now, they responded "On CDs. Sometimes emails, but I don't like that. It's hard to track." During the lean project, people discovered that documents were no longer required to be delivered in a hardcopy format as had been the practice. The state law, 40.14 RCW, had been changed to allow a more flexible archiving method for the records department. This is enabling systemic changes throughout the organization.

However, for maintenance crews, there is a tension between efficient data creation, collection and management and the "time-on-task" or "wrench time". As one crew member noted, "In the lean study, it was something like 87 minutes per day spent doing electrical work. Max was 5 hours depending on task." Technicians are burdened with tasks *outside of their field of expertise, and yet when systems are created to shield them from paperwork, data duplication is the result.* For instance, in order for a field technician in FS to process and update a work order, "We print out a piece of paper, hand it to the technician who goes out and writes all the details on the work order. [They] then turn it back in to the leads. In our shop the leads <enter> that information and close out the work order." In this scenario, the information had to be transferred from a digital format to a paper format and then back again. This simple sequence creates an added layer of effort, and in exchange provides the field technician an open format that they can work with, handwriting, but then requires interpretation and *duplicate effort* on the part of the lead to recreate this data digitally. Conversely, data retrieval time is also an issue. One technician stated, "We don't have time to go get this info and still take care of the client." The time spent gathering documentation is being done by a technician when the systems and training does not support this effort.

Furthermore, there is a cost to implementing new technologies and the *training* needed to familiarize trade technicians with that technology. One perception regarding using iPads in the field was that, "some people will not take care of it. Or charge it. Or Lose it. It would be good with some, not so good with others." In another interview, "One of the things we've been talking about for PM for backflows has that feature. We're trying to figure out how our trades people will use that out in the field. There's an advantage, but the cost of them having that instrument in the field, I'm not sure the tradeoff is worth it." The transition to rely more on digital technology still has many technological as well as organizational issues. If trades transition to using iPads in the field, for example, will they be able to retrieve that information on the central database. Currently some trades don't make the transition to mobile technology because you "walk into a building and the concrete takes it (reception) away." If there's a reliance on digital technologies there will be vacuums where that information cannot be accessed.

Whether it is being submitted or retrieved the whole process is impacted if there is not an easy two-way flow of information. For example, technicians were unable to retrieve training videos created during the closeout process to help them understand how a piece of equipment should work, "In the last five years they've been videotaping all these but the funny thing is, we don't know where all these things go. Those videos just disappear. And you can't get them online – we have yet to see a video in records. I guess I've never seen those evolve from when a building is turned over."

As technology becomes more pervasive and people want to see more and more information stored online, the records system must be able to grow to accommodate this while seamlessly carrying over *legacy information*. "CAD drawings are not online. There is an index that shows it, but you have to request the CD separately. It's a software thing. Hopefully that will be fixed so we can put CAD drawings on there." Unfortunately, there may be less *incentive* for software providers to create an effective way of transitioning out of their system, which leads to retaining the older system longer than its useful life.

4.2 Format of information exchange (paper vs. .pdf vs. native format)

Another limitation to the exchange of information is the format in which the information comes. In some cases it is necessary to maintain *document control* to preserve integrity and protect information from accidental or intentional manipulation. There is a gradient of alterability – for example, a hardcopy paper document is essentially seen as locked down due to the inconvenience of substantially altering that document. A .pdf attempts to provide that same immutability in a digital format, though that has degraded some with the advent of new programs that annotate over .pdfs. The next level that is commonly used would be the native format, like an excel document. While it is possible to lock this information down in, there is a need for other levels that allow easy and reliable extraction and reuse of the data while preserving the original format for archive.

Transitioning to a digital format appears to create more *flexibility* in some things, such as how information can be sent to multiple people, but it also imposes a *rigidity* to how information is presented which can create bottlenecks. For example when discussing submittal reviews architects and engineers explained that "you need to be able to see two or three things at the same time. That's hard to do on a single computer screen. We still ask the contractor for hard copies because it's easier to flip pages and keep your thumb in one while looking at something else. We'll get to all digital eventually." While digital information was easier to transmit digitally, it was more difficult to use. There is an added step needed to determine whether the comfort of a hardcopy is worth the added expense of sending the hardcopy.

Hardcopy, though a reliably static record, is problematic for digital archival and retrieval. Every time that information is converted between hardcopy and digital, there is an added expense. In the Records department, we asked how hardcopies get filed?, "We are scanning them in house. We used to send out to vendor but it was expensive. We have a machine there in the other room. It's time consuming, we have to scan all of them." Documents are created electronically, then printed, then scanned in again. An additional effort is the need to switch between scanning hardware. "And we have all kinds of scanners… the big one, the small one, color, … we have a lot of expensive equipment." [Is it quick?] "Yeah. It will scan both sides, but the tabs are hard – they take a while. Sometimes they [contractors] fold up drawings and put them in the O&M. We try to reproduce the tabs digitally. … Stop… go… that machine is good for stack, but the stop and go is a problem. Each O&M is a document. An O&M for a chiller is one document. … And we have to read each sheet, rotate properly … If there's color we have to

use a different scanner." Many of the things that contractors do in closeout documents may seem like they are making 'nicer' documents, but improved organization for Hardcopy does not support digital archiving activities.

There is no question that direct digital exchange of these types of documents is an improvement. However, digital exchange challenges practices throughout the distributed IT infrastructure. For example, "On Skire [a new project management system at UW], there's an approval system on there so once everyone has approved documents, records will be able to go into that system and pull all those documents digitally, instead of burning a CD. We have this fancy thing called the Internet. I have that problem with CAD, people want to email them to me but records need a CD. I'm not going to take the liability for burning that CD. We're requiring vendors to provide checked and reviewed CD. We have to make sure there's integrity of the file system from beginning to end."

4.3 Content of information exchange (useful for FS?)

Throughout this project, we have focused on understanding how people are using the data, information and documents. This is a complex question, in that O&M is a diverse set of tasks that requires diverse sets of information. For example, when engineering records personnel were asked what requests they get, they explained that "Electrical wants shop drawings because they have more detail than the [design] drawings – the nitty gritty. The contractor was good about labeling conduits and outlets…the more detailed info, the better. Mechanical shops mostly want instructions for equipment they haven't seen before.... Carpenters call a lot about hardware." However, there data source changes are already being recognized by the field crews. For example, ""The old system we had to go to the manual, but now we can go directly to the manufacturer's website and ask a specific question about equipment we're trying to service. So websites can provide us with better detail." there should be link to the manufacturers website because it is an emerging source of information for maintenance that didn't exist in the past."

The turn over process is quite complicated, particularly during the warrantee period. As one facilities staffer explains "a [mechanical part] failed under the one year warranty at [a recently completed building], but I can't get a warranty replacement because I don't have the original purchase order. So I'm trying to say Mr. Manufacturer your part failed, that was $115 I don't want to spend again…. See, now I have to go through a [construction management] coordinator … he's got to take my info, call the sub … back and forth … wastes so much time, is it worth $115 anymore? Probably not at that point." This poses a challenge to the COBie process both in terms of content as well as timing. As we work through the details of what data needs to be included, we need to think through different types of scenarios the trades face in order to create complete data packages that address various constraints such as warrantee issues.

4.4 Timing of information exchange (days, weeks or months?)

For archival records, the UW uses a centralized database with a web-based retrieval portal to access project documents like O&M manuals and drawings. In 2011, the time between substantial completion and final receipt of these documents ranged between 10 and 13.5 months. This gap is problematic for the maintenance crews who are working with a new building. When dealing with a new building, the crew lead explained the process of trying to find a manual in that he would "better go search the Internet to find it myself. Or call up the manufacturer and have them email it to us. Then we have to print it out."

While it takes considerable time to physically turn documents over at the end of a project, it again takes time to import them into the database. Interviewees stated, “There are only two of us. Last week I was at HS doing an onsite survey. That’s what this all is (indicates several bankers boxes). I’m going to compare everything, index and scan. It’s going to take a while.” While the Records department is being proactive about searching out information that they don't have and trying to create a central location where all documents are stored. With only 2 people, having greater automation should help efficiency and allow them to work on other elements of the campus like marketing what they have available and how others can use it.

While digital exchange will greatly speed the process of uploading the new documents for a building, quality assurance is still an issue as one interviewee explains “One thing that came up in the lean process is making sure the digital document is internally complete and correct. Someone could have had a setting wrong and printed out an empty page or the whole thing is empty, but if no one looks at it you don’t know so you’re storing an empty document. We’ve had issues in the past with drawings that were bad in hard copy. Cut off, scaled down… and those were getting through. If no one is looking, esp. digital, it becomes easier to let those things slide through and we no longer have a hard copy to fall back on.”

4.5 Relationship of the people exchanging information (formal sources vs personal relationships)

Large organizations often rely upon Tacit Knowledge networks to bridge the gaps between databases and information. Like the field crews on construction jobsites, the maintenance crews problem solve and get the information they need through their social networks as often as they do from the formal information channels. As one explained, "Its contractors and technicians and workers that we all build relationships with on jobsites or know from previous jobs or whatever that will feed us information because if we expect management to tell us, it will never happen." Another technician explained that it is “the relationship. They know me. They know I’ll take care of it. I’ll end up calling the subcontractors and they’ll come out to fix it.” Human beings are excellent information retrieval systems. Often times, for the technicians, the easiest source for the information is a fellow technician instead of trying to navigate the digital archive.

4.6 User interface (web-form vs. Google maps)

Information exchange includes the creation of data, the exchange of this data and then the final retrieval and use of the data. The vision for retrieval is all encompassing: “What I would like to see is how Google does their maps. You can get closer and narrow in, so take a building and make a map – different types, electrical, mechanical, carpentry, etc. – zoom in to light fixture or outlet, … touch it and information would be right there in front of you … 2D is fine” This is a good example of how commonplace free user interfaces like Google maps are educating people to a new method of using/find data.

As these data sets become more comprehensive with drawings, models, asset data, manuals, training materials, and maintenance records, the user interface to a software program is very important. Even if the structure and information behind the interface is excellent, it can pose a serious obstacle for allowing retrieval of that information. In one interview in the records department, we asked about the records for a recently completed building. “Yeah, we have 439 documents. O&Ms, specs, some drawings too. One O&M manual is considered one document.” For those trying to retrieve this information, even someone who is computer literate, sifting through these documents for only one building can take some time.

There is currently much criticism at UW of the CMMS interface: "There is a lot of clicking. The defaults aren't there anymore. There used to be dropdown menus. The print seems a little clunky. As we tackle the digital transformation, seeking to improve access to data, the interface will be a paramount. Particularly in the light that the average technician may not be as familiar with computer systems and training takes time and energy away from "wrench time."

5. CONCLUSION: DATA PRACTICES IN DISTRIBUTED ORGANIZATIONS

The process of COBie involves the collection, exchange and use of operations and maintenance data. What we have learned to date is that large institutional owners have complex and distributed organizational needs for this data that challenges the centralized vision that BIM for FM currently has to offer. The various functions of space planning and budgeting, preventative maintenance, renovations and repairs, annual city inspections, emergency response, and the lock shop require a diverse set of data and information from the BIM/COBie data set and likewise create and maintain their own datasets over the course of operations. In today's organizational and technological environment, we see the COBie loaded BIM being consumed by the UW's distributed IT infrastructure. The asset data from the COBie structure will be imported into the CMMS; the BIM model will be simplified for space layout and planning functions; while the complex details of the building record will be archived in engineering records.

The exchange process is not simply one of creating and transfer the data, but much work needs to be done around how operations and maintenance staff use this data. Questions of pathways, formats, content, timing, personal relationships, and user interfaces all need to be reviewed and evaluated for successful COBie and BIM adoption.

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