Evaluation of BIM-COBie Data For Facility Management

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Thesis

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ABSTRACT

“Three dimensional modeling is profoundly becoming a synergistic idiom associated with information communication technologies in the AEC / FM Industry. There are many researches that are going on around the world to discover & improve the efficiency & effectiveness of the integrated information in the construction process. The purpose of this research paper is to study the process of the Evaluation of BIM-COBie Data for Facility Management at University of Washington. The findings of this research show that BIM-CObie concepts can play a very critical role in improving the data management process of facility services of a building throughout its life cycle. Looking into the bigger picture for the future projects, this research work would be helpful in weighing the kind of data management processes to be implemented to create a significant impact on the cost of the building life cycle.”

“

I would like to dedicate my thesis to my late Mother.

To my amazing dad whose sacrificial care for me made it possible to complete this work.

Finally my three elder sisters [Trinity] for endless love and support.

”

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CONTENTS

ACKNOWLEDGMENTS

"It is a great pleasure to express my sense of thanks and gratitude to my mentor, philosopher and guide **Dr. Carrie Dossick,** Associate Professor of Construction Management Department of Construction Management, College of Built Environments. Her dedication and keen interest above all her overwhelming attitude to help her students had been solely and mainly responsible for completing my work.

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I thank profusely all the staffs of Facility Management Department at University of Washington for their kind help and co-operation throughout my study period.

I am extremely thankful to my friend and partner in crime. **Bita Astaneh Asl**."

01 INTRODUCTION

"Introduction, provides background about data integration in the University of Washington. It explains the basic components of a data integration system cited in the university. It also explains what are the challenges are faced by the university."

01 INTRODUCTION

One the most challenging problems that the construction industry is facing today is how to improve the efficiency and effectiveness of the integrated design and construction processes. It is no longer simply a problem of organizing a different solution to the facilities, but now the new and bigger needs of the project owner have to be satisfied. Thus, the way in which the building will fulfil the expectations of all these parties is becoming the measure of its success. The owner doesn't only mean just the one person who owns the building, but it also includes the organizations who have provided it, who will manage it and those who will occupy it.

The owners are becoming more aware with their growing experience and the concerns towards the project has relevantly changed. Owners are now more often enquiring about its maintainability, sustainability, accessibility and energy analysis. With so much information produced by so many sources and experts during the project, it becomes very difficult for the clients to visualize the design, assess any forthcoming changes and analyze the cost and time impact of the construction project.

The current development plans for a construction project that aims to address the occurring problems, such as duplication, irregularity and disorganized information, have been eventually led by two factors namely the technology push and strategic pull. The technological push has led to the development and implementation of hardware and software to improve the number of functions. The strategic pull can be evaluated by the growing number of workshops, seminars and meeting for the project.

BIM – COBie modeling and data management processes are slowly but intensely becoming an important part related with communication technologies in AEC / FM Industry. There are many researches that are going on around the world to discover & improve the efficiency & effectiveness of using a new type of information in the construction process. The purpose of this research thesis is to study the process of data management for the operations and maintenance of the construction project focusing mainly

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INTRODUCTION

on the Facility Services at University of Washington.

1.1 HISTORY OF UNIVERSITY OF WASHINGTON AND FACILITY SERVICES

Over the past 150 years, the University of Washington and the FS staff have worked together to create one of the most livable, innovative and vibrant institution in the country. Facility Services has played a key role in preserving its facilities in all three university campuses which includes over 500 hundred buildings with over 20 million gross square footage of space, including the University of Washington Plaza, consisting of the 325-foot [99 m] UW Tower and conference center. It's operating expenses and research budget is close to $6.4 billion every year (Wikipedia 2012). At an individual project level, it is about 60 to 70 percent of the total life-cycle cost occurs in third phase of operations and maintenance.

Pilot III Project

Research Work

UW spends 60% to 70% of budget on operation & Maintenance

The data integration works in three phases: first design phase where the University of Washington brings the architect and contractors on the board for the particular project. In the second phase CPO and FS work with all the consultants throughout the construction. In the third phase all the data passed to the record department. The record management system creates and manage data in the innovator which is the data integration system for the university. This is where the operation and maintenance [O&M] department can access the information from the university site.

1.2 EFFORTS BY UW FACILITY MANAGEMENT

In 2011, the Capital Project Office at The University of Washington started a collaborative pilot project with the Department of Construction Management for the betterment of Facility Services at the university. One of the major topic of discussion that drew a lot of attention in the recent past is COBie – BIM processes for FM. Ever since then many researchers have incorporated these topics in their part of the studies. Stepping into the most recent effort - Pilot Project III that aims to strictly focus on the feasibility of BIM – COBie process for asset management in operation and maintenance.

1.3 CORRELATION WITH THE COBIE PILOT PROJECT

This thesis was a part of a larger research initiative at the University of Washington. In which the Pilot Project - III [2014 – 2015] had two main goals as the topic of research. First, to document the Animal Research Care Facility, ARCF that is an upcoming building at UW, work order as a case study. The researchers intended to document the ARCF case study as the contractors develop the BIM execution plan and COBie deliverables for the project. The team closely worked with the facility managers and other staff members to understand how and in what ways COBie – BIM data can be used for the maintenance of the building, though out the building's life cycle and how the information will be is transferred to the UW Facility Services Systems.

The second, the main part of this thesis was to do the Re-Baseline modeling for the existing building of UW. For this project, William H Foege – Genome Science Center at the UW was selected as the case study. In this part of the research, the BIM – COBie model was built according to new COBie standards generated by evaluating the interviews with the facility services staff during this process. Coordinating with facility staff in developing database and interface systems (AIM, GIS, BIM) for the new dataset that FS can follow for other buildings of the campus in the future. This thesis is an extraction from the Pilot Project that focuses on Level of Details required for the Data Management and also focuses on the kind of data required in respect of its geometry i.e. 2D or 3D types.

1.4 PURPOSE OF THE THESIS

In this research work the aim was to identify the Level of Details required by the facility managers for the operations and maintenance of the construction project. The other focus of this thesis is to discuss the kind of data the facility managers prefer in geometry i.e. 2D or 3D kind of data. By doing the Re-Baseline effects - the BIM data modeling, one can develop a very sophisticated and precise data set. It was important to select the right interface to build the data. Therefore, Autodesk Revit was selected as the software tool to create all the BIM – COBie information. The dataset created in Revit could be very sophisticated formatted according to the requirements of the FM. As the FMs are the people who use the building the most compared to the any other AEC specialist, it is very important to know the requirements from the FM during the initial stages of the project so that researcher could work towards one goal. Hence, this thesis focuses on the Level of Details and the kind of detail required by the FM with the help of COBie Pilot Project.

1.5 RESEARCH QUESTION

This research evaluates the impacts of BIM – COBie data on construction projects by providing interview results and performing an experiment which provides the time difference between the traditional and time taken during an experiment for processing the work orders and seek the differing opinions on what kind of data is preferred for O&M in respect to its geometry.

This research emphases are on two key problems areas:

1. **What kind of geometry is important for improving the efficiency of data management of the operations and maintenance through**

the complete life cycle of the building?

2. **How much impact can be brought in the current format if the data is presented and prepared in a different way?**

1.6 IMPLEMENTATION OF COBIE – BIM TECHNOLOGY FOR FACILITY MANAGEMENT

Alike BIM that is a process of information management, COBie is a standardize format to keep a data is a particular manner which is used for operations and maintenance of the building. COBie will be discussed is the following chapter in detail.

Currently, FM uses paper or scan files of the building data which gets quickly outdated and hence, it's hard to be believe its accuracy. One of the factors that we can also present is the cost and time required to refer to the paper files when FM operation occurs. This eventually ends up to the poor performance of the building and its equipment. According to a report from US Dept of Commerce Technology Administration (NIST), the cost of inadequate interoperability in the U.S. alone is approximately $15.8 billion dollars annually.

With the reference from on the other study done by Penn State University, DOD & DOD Sandusky Laboratories, University of California. For every work order it takes between .75 and 2 hours to gather information necessary to complete that work order. If we can give Facility Owners the information they need in a minimum of 15 minutes. We can save up to 6356 work orders per year and $583,316.00 in a year alone. (Greg Alevras n.d.)

1.7 Motivation

Construction projects broadly undergo four phases – design, construction, maintenance and demolition. Certainly the most interaction between the AEC specialists happens during the design phase. But maintenance is always in the longest part of the building's life cycle in which there is a high potential for improvements and corrections. Therefore, it can be considered the most important part of the building's life cycle.

Although the design process itself constitutes of just only 5 percent of the build cost, there is much more costly information that is produced during this phase. This information is directly supporting the maintenance phase where the data management role comes in to play and can be accessed as remaining 95 percent of the cost of the building. Therefore, considering this the COBie should be initiated in the early stage of the project.

Before incorporating the COBie standards in the project, it becomes very important to know the relevant information required by the owner for the further use. Therefore, with this thesis, we could bring out the set of attributes of the assets in the building for the operation and maintenance. Further looking into the advantages and hindrance of this process as discussed in the following part, will help us to decide the scope of the work and topics to be focused on in this research.

1.8 ADVANTAGE AND HINDRANCE OF THE TECHNOLOGY

Some the hindrances and misconceptions about these new concepts are that most of the people in power are stuck with the old ongoing process and they think BIM ends after construction of a facility is finished. This makes them not to invest in this technology. Another misconception that people have is that they think, all the information they need to run my facility was turned over in the BIM model. As the BIM-COBie processes are new to industry and require certain people who have the knowledge about it. With no presence of these people also makes it difficult to agree to this process.

Most of the organization thinks that they are required to invest their time in thinking about the FM solutions when commissioning begins. Which is not true as most of the information is all set according the BIM-COBie standards if it starts from the beginning. The truth about these concepts are that indulgence of these concepts in the early stages of the project will surely earn by saving them time and money in the future. And these facts and data are not incorporated to big organizations, but instead it is valuable to almost any organization that deals with FM. Hence, there is a huge scope of implicating their concepts in the projects of any sizes.

1.9 STRUCTURE OF THESIS

In Chapter 01, Introduction, provides a history of the Facility Management Department at UW. It also describes about the efforts made by UW FM for improving the management system and how they started the correlative pilot project with the Department of Construction Management. Further, it discusses about propose of the thesis and questions asked in the whole research work. The researcher also discusses about the reasons that motivated to this thesis by briefly explaining the reasons and potential benefits & hindrances.

In Chapter 02, Literature Review provides detailed information about BIM and COBie concepts. It also describes the essentials\ requirements for these concepts while also discussing about the potential benefits & hindrances. Later part of this chapter focuses on the level of data and the kind of information required by the FM for the O&M throughout the life cycle of the building.

In Chapter 03, Case Study provided the study on the BIM – COBie processes done in the different university projects such as Texas A&M Health Science Center and the University of Chicago administration building renovation project.

In Chapter 04, Methodology is the most important chapter of this thesis. In this chapter, the researcher explains about the interviews and experiment performing during the whole process. He also explains about the phasing conducted during the thesis and finally concluding the chapter with the type of data collected.

In Chapter 05, Analysis chapter is the output of the chapter 04. It brings out the results about the experiment conducted. In this chapter, the comparative analysis is also done, with respect to the time & cost. There is a detailed explanation about the result of the interview for the kind of information required for FM. In the final part of the thesis, there is a comparative analysis of time taken for the whole process in real scenario to the time recorded during the experiment.

In Chapter 06, Conclusion states the final results of the research. It also presents the researcher's opinions over the questions asked by him and the conclusion of the interviews and experiments.

Apart from going through the whole text in the thesis there is a great need to understand the importance of graphs, diagrams, flowcharts, tables etc. included in the thesis. COBie being a new topic to this industry, the diagrams presented in the thesis will make the reader's understanding better. Therefore, it is important not to neglect them and take references.

1.10 SCOPE AND LIMITATIONS

1. The outputs from this study are limited to institutional projects only and do not have any study for commercial, residential, or industrial construction.
2. This thesis is limited to only duration of 9 months only. Hence, few topics are explained very briefly.
3. Being a hot topic, it is difficult to stand up to every expectation and wishes. This research represents the opinions of current employees who had helped in providing information and reviewing the proposed ideas.
4. Being a Construction Management student, there a lack of technical knowledge about certain software for which an external source was used and bond to its timings.

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LITERATURE REVIEW

“Literature Review provides detailed information about BIM and COBie concepts. It also describes the essentials requirements for these concepts while also discussing about the potential benefits & hindrances. Later part of this chapter focuses on the level of data and the kind of information required by the FM for the O&M throughout the life cycle of the building.”

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LITERATURE REVIEW

The Industry Foundation Classes (IFC) data model is intended to describe building and construction industry data.

It is a platform neutral, open file format specification that is not controlled by a single vendor or group of vendors. It is an object-based file format with a data model developed by buildingSMART (formerly the International Alliance for Interoperability, IAI) to facilitate interoperability in the architecture, engineering and construction (AEC) industry, and is a commonly used collaboration format in Building information modeling (BIM) based projects. (t. f. Wikipedia n.d.) [2]

In the previous chapter, we discussed in brief about the changing scenario of the world in respect of valuing the data and looked very briefly on the advantages of new technologies which have brought drastic changes in the behavior of the people working for an organization as well as in the system itself.

As the new technologies are coming up every day and therefore it is becoming difficult to cope up with the pace for an organization. Recently there are some new system and concepts that have really become a hot topic of discussion in the industry over the facility management side of the building. Some of the few upcoming technological concepts are BIM – COBie processes. These are all IFC base concept for an efficient working and data delivery of a project. In the following part we will discuss about these technologies and how they are emerging in the current scenario.

2.1 BUILDING INFORMATION MODELING [BIM]

Building Information Modeling [BIM] is an intelligent model-based process that provides understanding to help you plan, design, construct, and manage buildings & infrastructure (autodesk, benefits n.d.)[1]. BIM is slowly changing how buildings, infrastructure, and utilities are planned, designed, built, and managed. Looking at the concept of BIM, it is a platform which helps in turning information into comprehensive and deliverables to the business value at every step in the process. Pursuing the potential of BIM's dynamism - an organization of any size can maximize the business benefits and go beyond once limitation.

The terminology BIM can be divided into different parts or we can say it is a perfect combination of these three different aspects which are mentioned below.

• Building – the entire life-cycle of a building during the process of design, building and operations.

• Information – includes all data about the building and including its life-cycle.

[1] autodesk. n.d. http://images.autodesk.com/adsk/files/2011_realizing_bim_final.pdf.

[2] Wikipedia, the free encyclopedia. n.d. "Industry Foundation Classes." Wikipedia.com . Accessed 05 03, 2015. https://en.wikipedia.org/wiki/Industry_Foundation_Classes.

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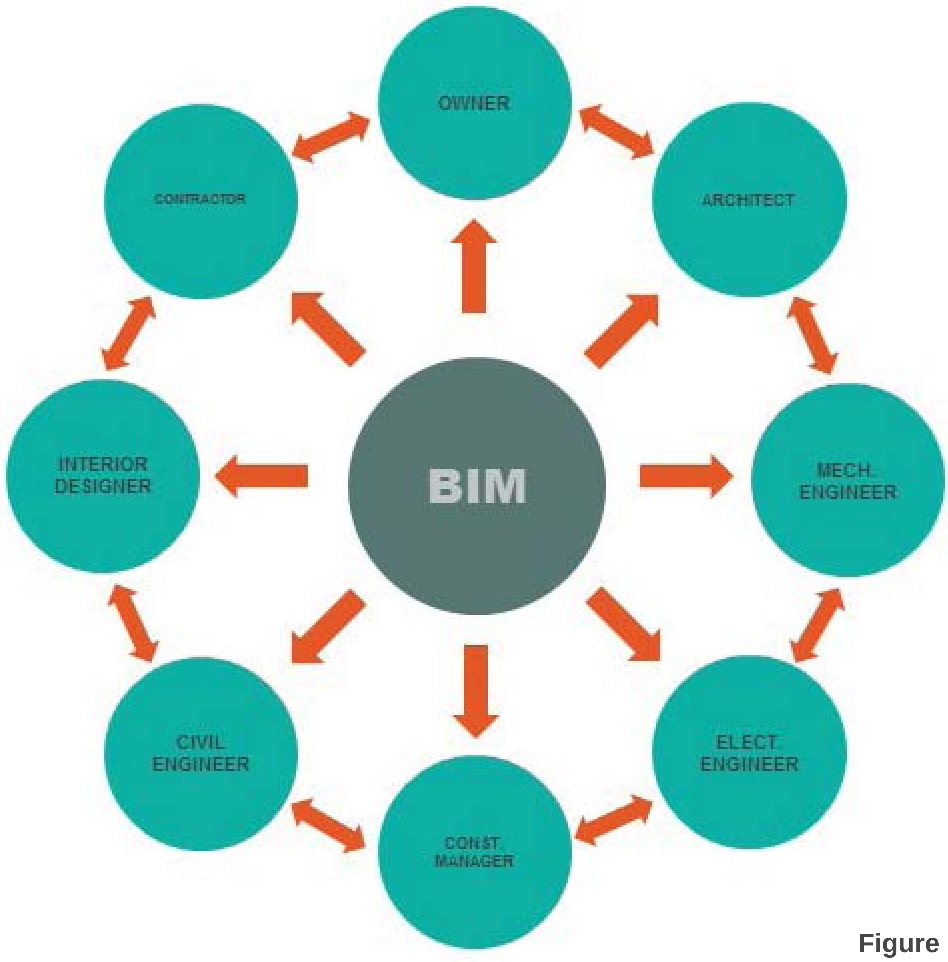

Figure 01

Figure 01 : BIM Collaboration with members of different disciplines.
(Source) : Tekla (2013)
BIM: REVOLUTIONIZING THE BUILDING AND CONSTRUCTION INDUSTRY

• Modeling – by the use of integrated tools the structure is simulated during its building, delivery and operations.

A BIM process operates on a digital database and changes made to the database is automatically reflected throughout the entire drawing. This helps all the owners to get involved in the building life-cycle to synchronize their information at one place. This allows the owners to view and use the BIM model in different ways and effortlessly share the information.

2.2 BIM PROCESS FOR THE OPERATION & MAINTENANCE

To better understand this thesis, it is very important to understand different process that are studied during the course of this thesis. The purpose of using BIM process is to provide a collaborative platform which starts from pre-construction, then leading through construction and finally passed to the operation and maintenance people of the building. It is feasible to start the BIM process at a very early stage of the project, therefore, it requires enthusiasm from the contractors to work and support this process throughout the project. BIM process is implemented in all the stages of the project, which are briefly explained the following:

Design Phase

In the design stages when the architect starts with the schematic design process, BIM provides dual help very initial by providing basic blocking & initial rendering along with a basic set of space information. This helps in setting the foundation stone for the rest of the project. As the project takes off, the same model can be helpful inefficient scheduling (4D) and estimating (5D).

Companies have started adapting this process by using Navisworks for correct scheduling and clash detection. This helps in saving a lot of time in the schedule as the same model is utilized by the estimator for initial costing. Here the elements in the project produce enough information so that estimating knows what material, type, size, etc. of element they are estimating.

One of the most tedious and laborious part of estimating is to count all of the elements of the project from a 2D plan. Here BIM has played a significant role by producing the schedule for each asset of the project having all the information related to it. The collaborative property of this process helps in bringing the architects and engineers, project manager, estimator, scheduler and construction manager on a same frequency at once.

Construction and Operation Phase

As the project steps in the construction phase, a huge amount of information in integrated into this model from different disciplines such as manufactures, MEP coordinators, architects, etc. BIM has a number of relative applications such as Navisworks used in the 4D and 5D modeling. With

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BIM PROCESS

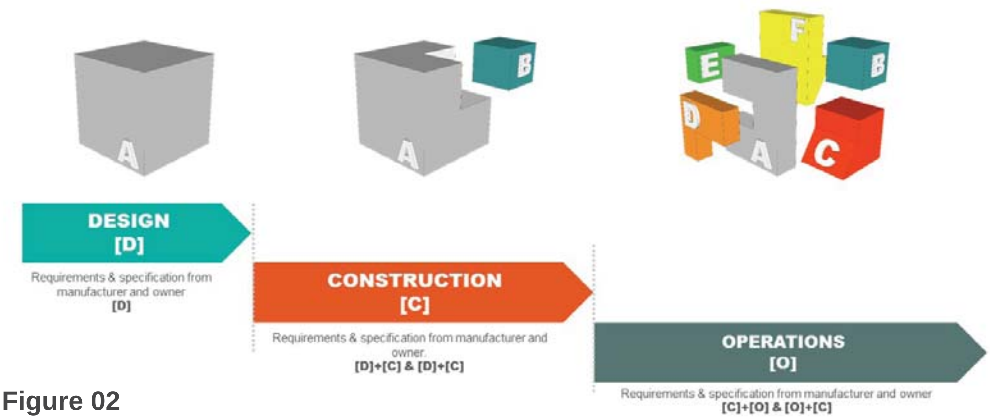

Figure 02

Navisworks monitoring and workflow tools, problems can be easily targeted and fixed efficiently.

This way the construction can be simulated to make sure everything being build have any errors. The final set of the information is then passed over to the operation and maintenance crew who uses different integration tools such as AiM, in data management throughout the life cycle of the building. (Greg Alevras n.d.) [3]

2.3 INTEROPERABILITY OR BUILDING DATA SHARING

After going through the whole process of BIM, Interoperability is one of the most important characteristic that BIM contains. Interoperability is defined as the seamless sharing of building data between multiple applications over any or all lifecycle phases of a building's development. Although BIM may be considered as an independent concept, in practice, the business benefits of BIM are dependent on the shared utilization and value-added creation of integrated model data. (Ballesty 2007) [4]

2.4 POTENTIAL BENEFITS & HINDRANCE OF BIM

BIM is an intelligent modeling process which is based on design process that adds huge value to the entire life-cycle of building and infrastructure

Figure 02 : BIM Process (Source) : Jason A Smith , BIM – A Contractors Perspective 92012)

[3] Greg Alevras, Sam Arabia CM-BIM,. n.d. Incorporating BIM into Facilities Management. North America: IFMA, World Workplace - THe Facility Conference & Expo.

[4] Ballesty, Stephen. 2007. Adopting BIM for Facility Management - Solutions for managing the Sydney Opera House. Brisbane, Qld, Australia: Cooperative Research Centre for Construction Innovation, for Icon.Net Pty Ltd.

projects. Many of the digital modeling researches demonstrates significant benefits in digitizing documentation for operational and maintenance. Few of them are mentioned in the below.

BIM benefits

The key benefit of BIM is its accurate geometrical representation of the parts of a building in an integrated data environment. Some of the benefits are:

Integration – There are huge possibility of integrating BIM with Facility Management system from the initial stages of the project. It can automate the preventive maintenance program for FM and its can correlate with the existing platforms and data information which already exists.

Space Management – Apart from dealing with great detailing capabilities, BIM is very successful in SIM, Space Information Management, as well.

Building Analysis – BIM can continuously update the source for all the data and program in respect to green goals. Therefore, when it comes to LEED, most of the people turn towards BIM as a one stop shop for identifying which new credits to tackle or which can be improved.

Better Design - BIM simulation process can be performed quickly & performance benchmarked, which enables better solutions to control life-cycle costs.

Better Production Quality — Documentation output is flexible and exploits automation.

Automated Assembly — Digital product data can be exploited in downstream processes and manufacturing.

Better Customer Service — Proposals are understood through accurate visualization.

Integration of Planning and Implementation Processes — government, industry and manufacturers have a common data protocol ultimately, a more effective and competitive industry. (autodesk, benefits n.d.)[5]

2.5 CONSTRUCTION OPERATIONS BUILDING INFORMATION EXCHANGE [COBIE]

COBie is a standard method of exchanging information that drives down cost. (Bridge building 2011). It is a data exchange standardized process which records the subsets of BIM and focuses on delivering just the building information not geometric modeling.

COBie was sponsored by NASA and the National Science and Technology Council's Physical Infrastructure and Security Inter agency Working Group to be implemented by the U.S. Army Corps of Engineers' Engineering Research and Development Center's Construction Engineering Research Laboratory by the Project Extranet staff. (Hamil 2011)

Being a very new topic in the industry and boasting about saving time and cost, usually one gets confused about COBie being a software or computer language and hence is usually not considered as an option. Therefore, it is important to bring out what COBie is not.

- "Just" a spreadsheet – IFC, ifcXML, spreadsheet ML
- "Just" a model
- A process
- A specification for naming data
- A product
- A BIM requirement (Michael Schley 2013) [7]

2.6 COBIE PROCESS FOR THE FACILITY MANAGEMENT

Similar to the BIM process COBie is also a collaborative process that also starts at a very early stage of the project. COBie being a very new concept in the construction industry, many have doubts on its capability of delivering information with a completely new way in an electronic format.

[5] autodesk. n.d. http://images.autodesk.com/adsk/files/2011_realizing_bim_final.pdf.
—. n.d. benefits. http://www.autodesk.com/solutions/building-information-modeling/overview.

[6] 2011. "Bridge building." www.thelinkbetweenworlds.com. Feb 16. http://thelinkbetweenworlds.com/2011/02/16/bridge-building/.

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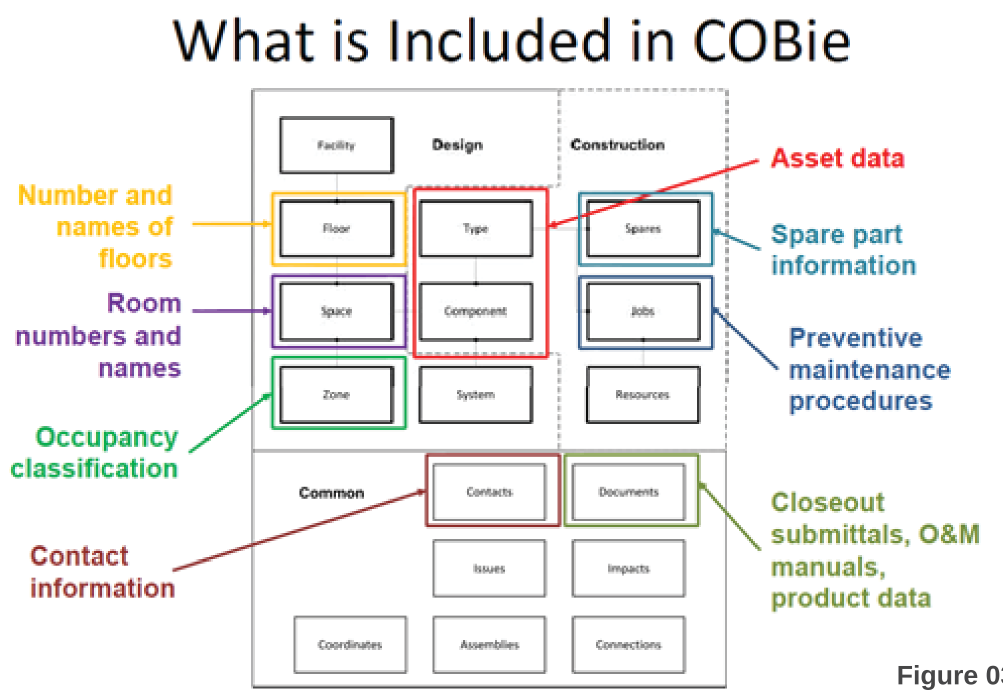

Figure 03

Figure 03 : What is Included in COBie
(Source): Nick Nisbet, RICS BIM: Using COBie to extend the benefits of BIM to building operations and maintenance, (2013)

Alike BIM it also requires an initial investment on software and employees along with willingness of all the contractor and approvals from the client. But there is nothing more to it and this makes it's a simple tool to be used by everyone. In the following diagram the three phase of COBie process is described:

Design Phase

In this phase preferably the architect collaborates with the owner and the manufacturing companies to bring in all the information about types of materials. This information can be in the following:

•Manufacturing number

•Serial code

•Product specifications including the areas, dimensions etc.

•Date of manufacturing

•Expiry date

•Who installed the product?

•Revision date

•Warranty period

•Tutorial videos

[7] Michael Schley, Paul Teicholz, Angela Lewis,. 2013. BIM for Facility. Los Angeles: Center for Integrated Facility Engineering at Stanford University.

[8] Hamil, Dr Stephen. 2011. What is COBie? Article, UK: NBS.

COBie PROCESS

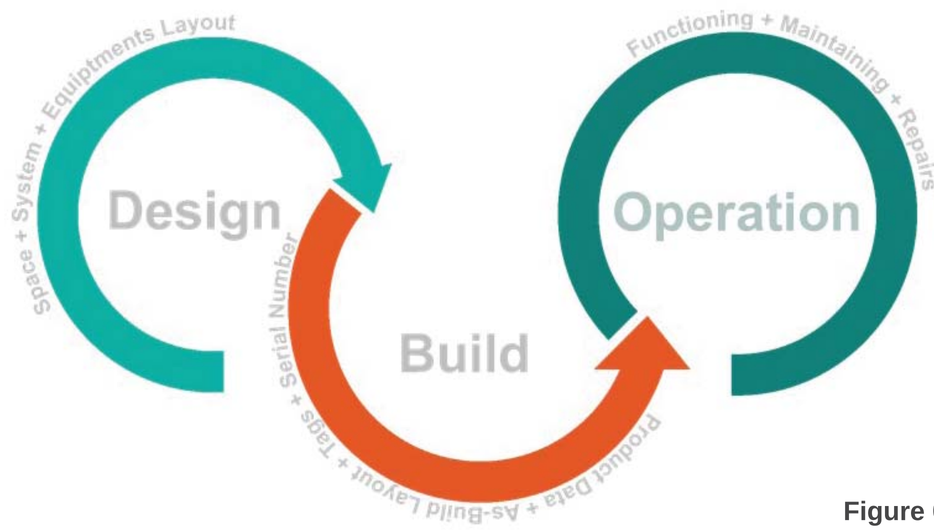

Figure 04

Figure 04 : COBie Process (Source) : BIM Task Group, What is COBie UK 2012 (2012)

•Photographs

The process of data input starts right away in this stage which later makes the whole team to be appointed more aware of all the specifications that are used in the building.

Build Phase

In this phase, as the building starts to get into shape with details provided by the structural and MEP teams. The architect records the spatial information, floor, wall & ceiling information and the component requirement zone for fire, access and construction code. This information is considerably very important because these are the part of the building which are likely to be exposed and most of the systems are too complicated that only a technician can understand the information. Therefore, the facility teams are required to have all the information about these items so that they can be sure during the operation of the building.

OPERATION PHASE

All the final documents are finally passed to the operation team, which

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LITERATURE REVIEW

contains as-built information of the building with all the information about the materials, manufactures, installation dates, warranties, production information, spare part list, suppliers and manufacturer's instruction are included.

OBJECTIVES OF COBIE

• Provide a simple format for real-time information exchange for existing design and construction contract deliverables
• Clearly identify requirements and responsibilities for business processes
• Cost can be reduced significantly compared to current paper-based method
• To act as a generic source of information which can be acceptable to all large and small contractors, suppliers, owners, etc.
• Providing a framework to store information for later exchange/retrieval which can become a standard in the contract documents.
• Add no cost to operations and maintenance
• Permit direct import to owner's maintenance management system (Ainsworth 2013) [9]

2.7 POTENTIAL BENEFITS & HINDRANCE

COBie is designed to be used at all stages of the design, build, and operate and maintain life-cycle when the building is completed and is handed over to the O&M. After the building is commissioned, COBie becomes a medium for conveying organized information about the facility and its equipment to the users and maintenance staff.

By using COBie, it is not required to have a separate manufacturer data spreadsheet. Instead, data collected according to the COBie standards is recognized industry standard and can be modified with future changes.

Data transfer after the completion of construction is very cost effiective because data can be exported from BIM model and imported into a COBie-capable CMMS. (Nisbet 2013) [10]

[9] Ainsworth, Andy. 2013. Basics of COBie. Presenation , NFB Traing .

[10] Nisbet, Nick. 2013. "RICS BIM: Using COBie to extend the benefits of BIM to building operations and maintenance." http://geospatial.blogs.com/. February 19,. Accessed June 27, 2014. http://geospatial.blogs.com/geospatial/2013/02/rics-bim-using-cobie-to-extend-the-benefits-of-bim-to-building-operations-and-maintenance.html.

It prevents loss of data between design and construction to facility management handover. Minimizes data entry in the later stages of the initial work done on it. Use of industry standards reduces cost of software implementation.

In the proceeding chapters the researcher has discussed about few case studies done on real projects to learn more about BIM – COBie. Therefore, it was important to learn how these two processes work and can work in correlation with each other to have a better understanding of this thesis. Learning about the benefits of these processes will help the readers to learn how and why the researcher has performed the interviews and experiment.

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CASE STUDY

Literature Review provides detailed information about BIM and COBie concepts. It also describes the essentials requirements for these concepts while also discussing about the potential benefits & hindrances. Later part of this chapter focuses on the level of data and the kind of information required by the FM for the O&M throughout the life cycle of the building.

4.1 TEXAS A&M HEALTH SCIENCE CENTER

In a case study and survey of the Texas A&M Health Science Center, College Station, TX done by Broaddus & Associates and was presented in the NIBS Annual Conference. The team from Broaddus was looking into the aspect of use of COBie in facility management. The project context for the team were:

- Minimal COBie data within A/E model (2%)
- Information exchanges not structured for COBie use of design & construction deliverables
- No CMMS chosen at the start
- Multiple benefits exist
- Why was COBie format chosen? Open Standard Format.
- How was data assembled?

Challenges

One of the main challenges for the team was to figure a way out to reduce work order cycle time. But it was difficult for them to initiate the study as there was no previous CMMS used at enterprise level. There no BIM or COBie data standards for the project. They also had to determine what

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CASE STUDY

information would reduce the typical work order cycle time.

Matrix

To ensure the next move is correct, the team decided to figure out all the data which were already present and is directly related to the time spent. Therefore, they looked at the O&M data which deploy a crew to the field. They collected information and located all the equipment in the building. They also collected documents which had information about the warranties and other records about the equipment.

Scope

To limit the work to be done and bring out the result in a relevant time frame, there were certain guideline made by the team. They were:

- TAM HSC is not necessarily changing their current processes in terms of workflow, but rather data content by using the latest CMMS software along with the COBie data.
- They are re-baselining the enterprise (8 campuses) with a consistent

WO process inside of the CMMS.

- They are looking at the workflow process blocks to determine what information can be provided in a digital manner (in lieu of hardcopy) to

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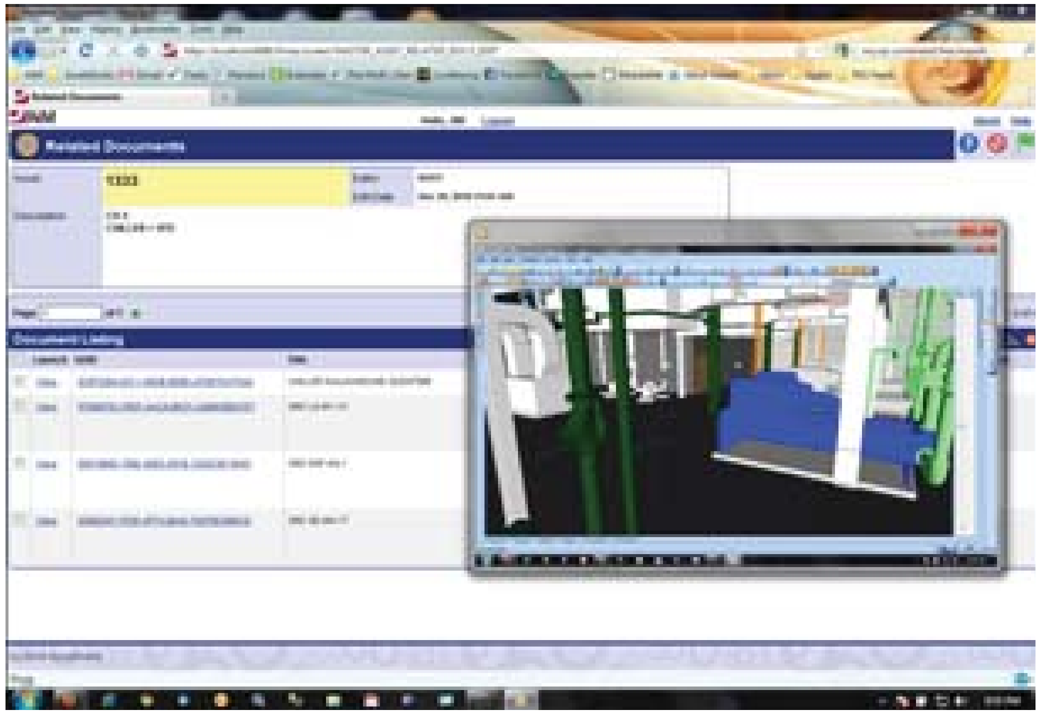
CASE STUDY



- project team deliverable matrix.
- Revise contracts and deliverables that define the content and format for COBie data creation.
- This will create a consistent COBie data deliverable process with repeatable benefits.

Plan Implementation

The team implemented the WO process with CMMS to start up. The next step was to map the COBie data fields and documents to WO flow where provision of digital data will reduce the time. Then they evaluated current COBie data provisions, and created a reconciliation list of any missing data fields / docs. It was important for the team to create a benchmark for them to compare the final result. Hence, they estimated former WO cycle times by interviewing with experienced Facility Managers at each campus by comparison to established flowcharts.

This will establish a base case for the WO cycle times. The next step was to evaluate new WO cycle times with CMMS and fully enabled digital data and documents. After doing another round of survey and experiment, the team observed the data to compare old cycle times to new cycle times.

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CASE STUDY

WO process BEFORE COBie enabled CMMS		Dallas	Bryan	McAllen	
Activity ID	Activity	Estimated Time (min)	Estimated Time (min)	Estimated Time (min)	Average Time
5.01	Review WO	5	5	5	5
5.02	Assign WO contractor	15	12.5	16	14.5
5.03	Assign WO to technician	5	5	2	4
5.04	Review WO	5	5	2	4
5.05	Review drawings	2	11	10	7.7
5.06	Find O & M	1	3	2	2.0
5.07	Review O & M	1	5	2	2.7
5.08	Find Warranty	3	2	2	2.3
5.09	Visit equipment	1	1.25	0.75	1
5.10	Retrieve product data from equipment	0.75	1.25	1	1.0
5.11	Return to shop	0.75	1.25	1	1.0
5.12	Review product data	10	12	13	11.7
5.13	Retrieve needed parts	5	10	15	10
5.14	Retrieve special tools	3	3	2	2.7
5.15	Visit equipment	10	20	5	11.7
5.16	Perform work	45	30	60	45
5.17	External change entered	3	2	7.5	4.2
	Total	115.5	129.25	146.25	130.3

WO process AFTER COBie enabled CMMS		Dallas	Bryan	McAllen	
Activity ID	Activity	Estimated Time (min)	Estimated Time (min)	Estimated Time (min)	Average Time
6.01	Review WO	5	5	5	5
6.02	Assign WO contractor	15	12.5	10	12.5
6.03	Assign WO to technician	5	5	2	4
6.04	Review WO	5	5	2	4
6.05	Review drawings	1.25	8.5	8.5	6.1
5.06	Find O & M	0.26	0.14	0.38	0.3
5.07	Review O & M	1	5	2	2.7
5.08	Find Warranty	0.25	0.25	0.25	0.3
5.09	Visit equipment	0.75	1.25	1	1
5.10	Retrieve product data from equipment	0.25	0.75	0.5	0.5
5.11	Return to shop	0.75	1.25	1	1.0
6.12	Review product data	8.5	7.5	8	8.00
6.13	Retrieve needed parts	5	10	15	10
6.14	Retrieve special tools	3	3	2	2.7
6.15	Visit equipment	10	20	5	11.7
6.16	Perform work	45	30	60	45
6.17	External change entered	3	2	7.5	4.2
	Total	109.01	117.14	130.13	118.8

	Dallas	Bryan	McAllen	Average	Details:
Total Time per WO (Min)	115.5	129.3	146.3	130.3	Average time before COBie (from interviews)
Total Time per WO (Min)	109.0	117.1	130.1	118.8	Average time after COBie (from interviews)
Total Time per WO (Min)	6.5	12.1	16.1	11.6	Average savings per WO realized by COBie data (from interviews)
SAVING per WO (MH)	0.11	0.20	0.27	0.19	Average hour savings per WO realized by use of COBie data (from interview)
TIME SAVINGS (%)	5.6%	9.4%	11.0%	8.7%	WO time savings diveded by total time per WO
Technician Count	16.00	5.00	1.00	n/a	Amount of campus technicians available for WO's
Available Hours/YR	24000	7500	1500	n/a	Technician count multiplied by actual FTE (1,500 MH)
Expected WO's/YR	13210	3842	692	n/a	Available MH's divided by total time per WO
Expected MH Savings/YR	1429	775	186	n/a	Expected WO's/YR mulitplied by MH savings per WO

Assumptions: FTE = 2,000 MH Effeciency 75%; Actual FTE = 1,500
Technicians are serving WO's full time

Conclusion

- Work Order flow processes have proven to be similar across the 8 campuses through dialogue.
- Qualitative understanding that efficiencies can be improved with the availability of digital data. (Avg. 8.7% Prediction)
- Normalization of data to be used across the enterprise is being established and validated. Key Assumption

- Reductions in Work Order cycle times are expected at all 8 locations with consistent application of data needs.
- The CMMS implementation is an optimum time to establish normalized data expectations and prior to full data loading into the CMMS. (Hyde Griffith Dec 2011) [11]

Name	Design Manufacturer	Design Model Number	Installed Manufacturer	Applicable Vendor	Warranty Duration	Expected Life
Air Terminal Unit	Nailor	NAILOR-D3OHQW	MO000001	MO000001	2	10 Years
Air Handler Unit	McQuay	McQuay-CAH017GDAC	MO000002	MO000002	2	10 Years
Split A/C Unit	Carrier	Carrier-40MVC012	MO000003	MO000003	2	5 Years
Supply Fan	Carrier	AirFoil AFMV01181	MO000003	MO000003	2	5 Years
Return Fan	Carrier	AirFoil AFMV01181	MO000003	MO000003	2	5 Years
Hot Water Recirculation Pump	Armstrong	Armstrong 1.258 1050-001	MO000004	MO000004	2	10 Years
Silencer	Vibro-Acoustics	EXPD-MHV-F1-L11165	MO000005	MO000005	2	20 Years
Air Cooled Condenser	Carrier	Carrier-38MVC012	MO000003	MO000003	2	10 Years
F1	Lightolier	LIGHTOLIER CFH2GPF217UNVP2	MO000006	MO000006	2	2000 Hours
F1A	Lightolier	LIGHTOLIER CFH2GPF217UNVP3	MO000006	MO000006	2	2000 Hours
F2	Lightolier	LIGHTOLIER D6132BU-8021CLW	MO000006	MO000006	2	1000 Hours
F3	Lightolier	LIGHTOLIER PTS7T254E8UP2, PTS7248E8UP2, PTS7EP	MO000006	MO000006	2	1000 Hours
F4	Axis	AXIS CUB-F-4-T8-2-AP-X-X-P-UNV-1-CA36	MO000007	MO000007	2	1000 Hours
F5	Lightolier	LIGHTOLIER SS3S125HPFUNVP2	MO000006	MO000006	2	1000 Hours
F6	Lightolier	LIGHTOLIER KW4A232UNVP2	MO000006	MO000006	2	1000 Hours
F7	Lightolier	LIGHTOLIER 22MC6WH	MO000006	MO000006	2	2000 Hours
F8	Lightolier	LIGHTOLIER 6003NWH, 6001NWM	MO000006	MO000006	2	1000 Hours
F9	Kurt Versen	Kurt Versen H8432	MO000008	MO000008	2	50,000 Starts
F10	Kurt Versen	Kurt Versen H8455	MO000008	MO000008	2	50,000 Starts
F11	Lumetta	Lumetta P2094	MO000009	MO000009	2	2000 Hours
X1	Lightolier	LIGHTOLIER MJES2RW23	MO000006	MO000006	2	3 Years
Drinking Fountain	Elkay	Elkay EDFPBMV117C BI-LEVEL	MO000010	MO000010	2	15 Years
Urinal	Toto	TOTO TEU1UN w/ Vitreous China Urinal	MO000011	MO000011	2	10 Years
Water Closet	Toto	TOTO CT708E w/ Vitreous China Elongated Bowl	MO000011	MO000011	2	10 Years
Lavatory	Kohler	Kohler K-2610	MO000012	MO000012	2	10 Years

3.2 UNIVERSITY OF CHICAGO ADMINISTRATION BUILDING RENOVATION

In this case study at the University of Chicago administration building renovation project where the task was to modernize of restrooms and HVAC system. One of the major tasks was to locate the existing complex and tight duct work. The task became more complex because the existing plans were not accurate as the first plan seen were the hand drawn as-built drawing from the year 1947.

To reduce the time to gather the existing information, a laser scanning was done and the BIM information was generated. The result of this documen-

[11] Hyde Griffith, Mark Cervenka,. Dec 2011. COBie Case Study. Case Study, NIBS Annual Conference.

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CASE STUDY

tation was an Asset tab which had most of the information about the asset or component of the building in it such as name, model number, installation date, warranty duration etc.

Conclusion

The team concluded with that there is no 'out of the box' solutions which can be implied in this situation. They were very much in a favor by having a new systematic process of for data management. There were a lot of restraint and decision driver in the current system which consume a lot of energy and hence a lot of time. Implementing the new will also demand for a new skilled worker who know how to run these technologies. And finally, there was a huge point raised that there is no communication between the different disciplines as there is no similar linkage between each other's work (Michael Schley 2013).

[12] Michael Schley, Paul Teicholz, Angela Lewis,. 2013. BIM for Facility. Los Angeles: Center for Integrated Facility Engineering at Stanford University.

04 METHODOLOGY

"Methodology is the most important chapter of this thesis. In this chapter, the researcher explains about the interviews and experiment performing during the whole process. He also explains about the phasing conducted during the thesis and finally concluding the chapter with the type of data collected."

04 METHODOLOGY

4.1 METHODOLOGY SELECTION

Taking inspirations from the conclusions from the case studies done in the previous chapter and trying to focus and present the industry with the benefits of COBie and its Level of Details. The researcher chooses to leave no stone unturned and provide both the qualitative and quantitative analysis for the research questions. These methodologies were – first, Qualitative in which interviews were taken to bring out the reactions from the facility staff at UW. Secondly, Quantitative, in which an experiment was designed to bring out the average time taken by the facility staff to complete the assigning the work order. Bring out the conclusion from these methodologies is more relevant because in the new divergence towards new technologies, especially in the construction industry that doesn't move fast compared to others. It becomes very difficult to leave a benchmark in between the numerous fundamental and theoretical data already present. Therefore, one can only convince the big guns if someone can convince them by presenting them with the sufficient results and explanations over the advantages and potential future perspectives.

4.2 GOALS AND OBJECTIVES

It was important for the researcher to perform both quantitative and qualitative survey and experiments because the motive of this research was to provide results which are as realistic as possible to the real scenario. One of the main intention of the research was to bring out the thoughts about the kind of data that the participants prefer working in the facility department at UW. The other important objective was to collect the time taken by each participant for the completing the initial steps of the work order process. This time could be compared to the existing time taken and show the difference in efficiency of the traditional and the BIM – COBie data. This difference is explained in detail in the next chapter. The researcher also intends to conclude the dichotomy between 2D Vs 3D type of data from the data collected during both the process.

04
METHODOLOGY

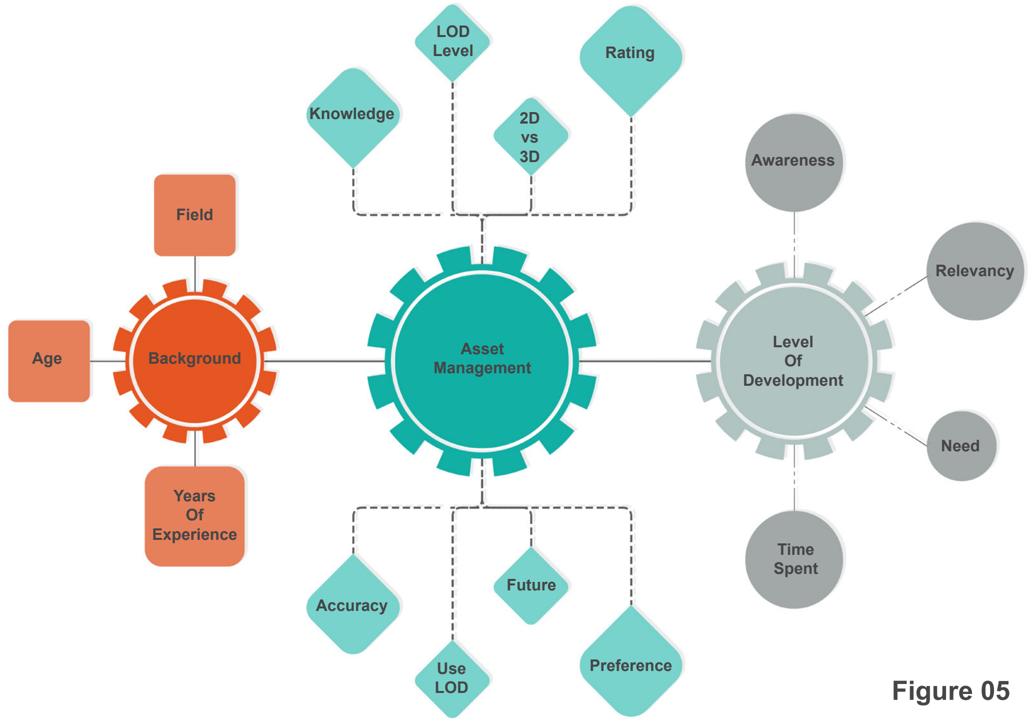

Figure 05

Figure 05 : Qualitative Process Flow Chart

4.3 QUALITATIVE PROCESS

In this part of the research methodology an interview survey was conducted to get the reviews from the industry people regarding their experience of Asset Data and Level of Details. The interview questionnaire had three main parts – Background, Asset Management and Level of Detail.

Background

First part was about the background information about the interviewee was taken. The motive was to collect information about the different age groups of the participants. They were also asked about their professional discipline and their years of experience in their field. This part is important because it gives the reader the reasons to believe of the answers given by the participants are real and authentic.

Asset Management

TThe second part of the questionnaire focused on the asset data information at the University of Washington. In this part of the interview, participants were asked about their knowledge about the asset data and asset list of UW. In this part, they were also asked to review about the kind of

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data and attributes they would prefer for the assets. People were asked about the comment on the kind of information and process that the current system have. It also looked into the aspect of how much do they work with assets during their weekly hours.

Level of Detail

The third part of the interview focused on the level of detail for assets. First, people were asked about the awareness of LOD. They were also asked about their views of the relevancy of LOD of data used for facility management. During this part of the interview, people were asked to review the proposed asset data document. This document was created during the pilot project. This document consisted of new assets, attributes and many documents which are not present in the current system and were included after the discussion and reviewing with the facility staff at UW. Another important aspect of the interview was about the role the geometry plays in the data management. The participant were asked about the kind of data they would like to have in their database in the future projects.

4.4 QUANTITATIVE PROCESS

In this part of the research methodology, an experiment was prepared to determine the time consumed by a facility staff to complete the process of assigning the job for work order. The basis of the experiment was taken from the Re-Baseline the work done during the Pilot Project III. The diagram below is the graphical explanation of the six phases that were conducted in Pilot Project III.

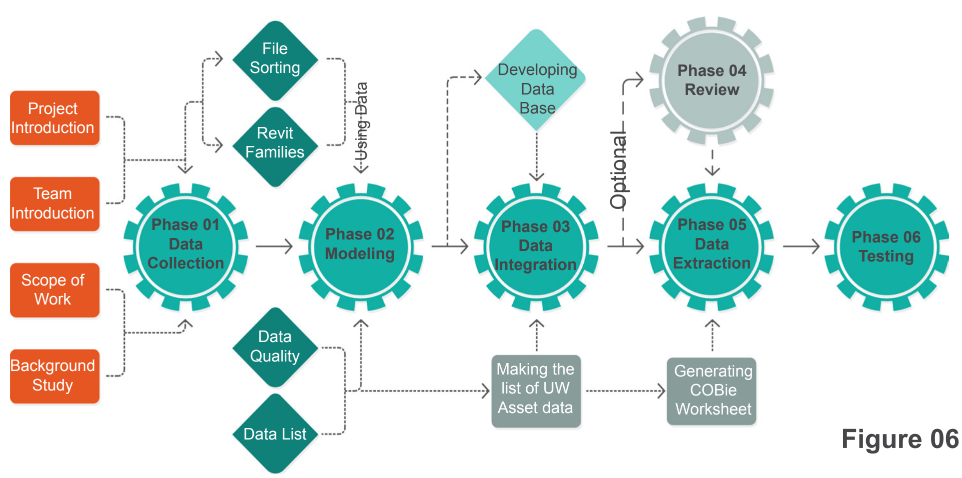


Figure 06

Figure 06 : Flow Chart of Six Phases in Pilot Project III

04 METHODOLOGY

RE-BASELINE PROCESS

DOCUMENTATION
DATA GENERATION
LOD DOCUMENT

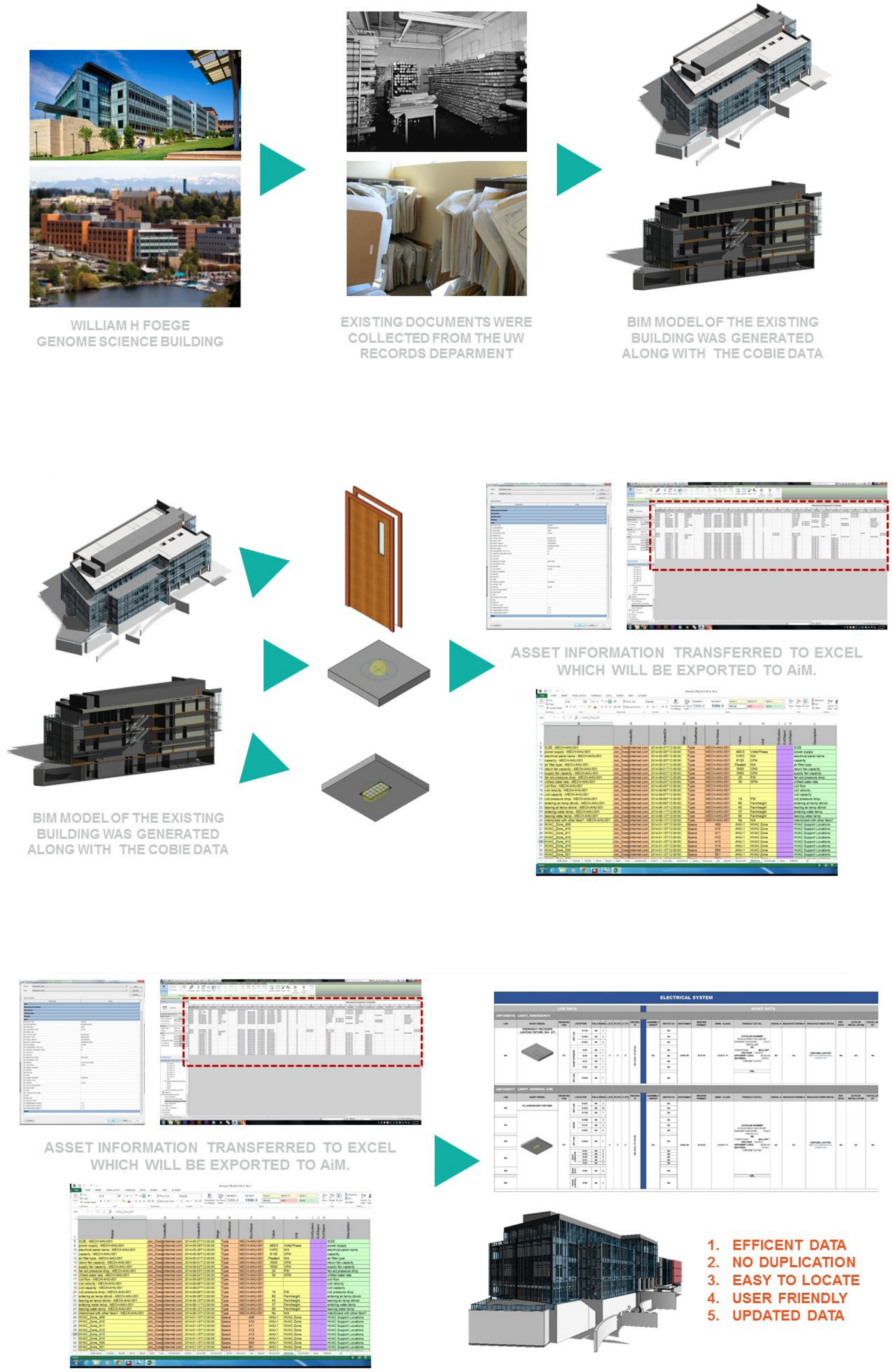


Figure 07 : Flow Chart of Re-Baseline Process

Figure 07

04 METHODOLOGY

According to the UW Facility Department, there are seven different categories of work orders that are functioned in the university.

They are mentioned below:
1. Assist
2. Call-out
3. Corrective
4. Event
5. Planned
6. Preventive
7. Routine

Figure 08 : Experiment Process Design

Re-Baseline of Existing Data

In this research, I used the BIM and COBie data sets that were developed in pilot project III. The pilot project III development included a 3D model as well as COBie data per the UW COBie standard. This section presents this pilot project III, and the qualitative methods will be discussed in the following sections. During the pilot project III, William H Foege, Genome Science Building was taken, as the case study project to produce a BIM model with COBie standardized data.

In this process, from the existing data available in the UW Records Department and taking Revit 2015 as the medium, a BIM Model was built. Then all the data was integrated in this model. This data was filled in according to the COBie standards. After all the information was integrated in the model. The schedules from the model were exported to excel worksheets. These were then reviewed by the facility staff to verify the authentication to the data. The diagram below is the graphical representation of the whole process. The diagram below is the graphical representation of the complete Re-Baseline process.

Work Order Data

With the help of the AiM Data Department at UW, a set of data for the all the work orders that took place in the Genome Science Building from the year 2009 to 2013 was collected. This huge amount of information was

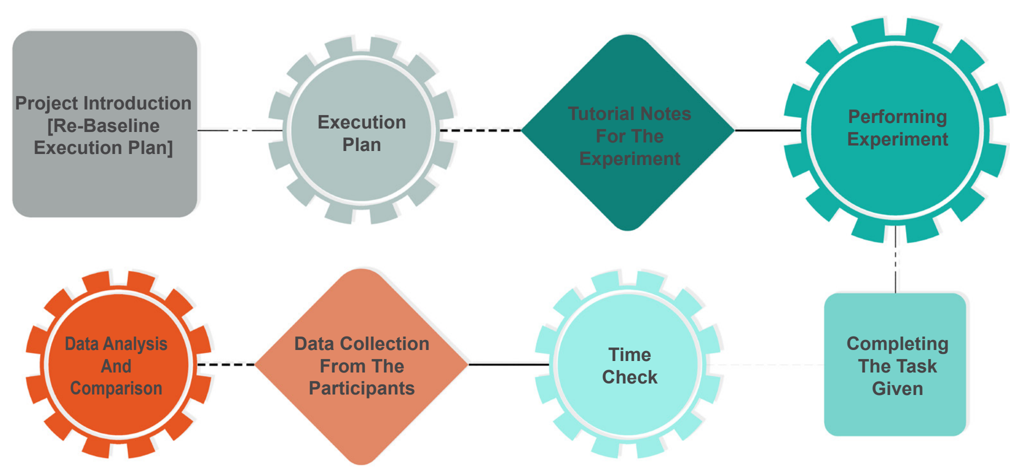


Figure 09

04 METHODOLOGY

in excel format which contained the unique UW tag number, description of WO, location and starting & ending time was mentioned. All the data collected was then separated according to the year they were operated. In the following table, all the data collected is graphically represented. This data was then taken as the benchmark for comparing the data from the

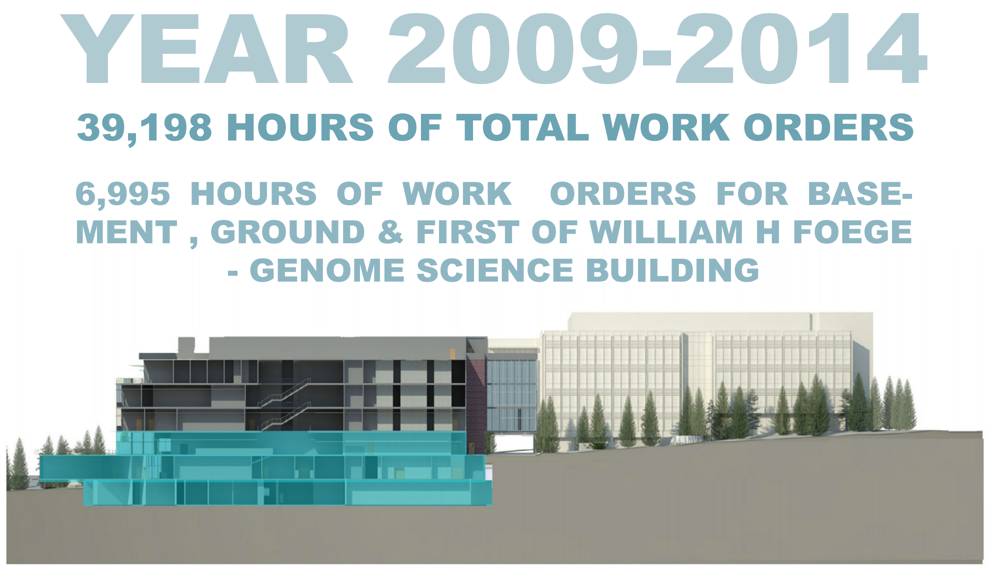


Figure 08

experiment

Baseline Data

The data that was collected consisted of about 12,000 different work orders from the year 2009 to 2013. The total working hours taken by these work order was about 39,000 working hours. They were later separated according to the years and different types. A detailed explanation is given is above diagram. About 7000 working hours for work orders were further separated according to the area of interest for the experiment. This area of interest for this experiment was Genome Science building's mechanical basement, ground floor and first floor.

Experiment Design

Coming back to the experiment, it was designed to depict the real scenario in the UW Facility Department. This experiment was extracted from the six phases of the Re-Baseline project for Pilot Project III. At the start of the experiment, each participant was given an introduction about the project

Figure 09 : Depiction of Number of Working Hours for the Work Orders in WIlliam H Foege - Genome Science Building

along with a detail explanation about the execution plan carried out for the Re-Baseline project. They were also given a set of tutorial flowchart for them to use during the experiment. A list of steps to follow for completing 10 to 15 tasks in the experiment was also provided. These tasks were selected randomly for each participant from the data list which was provided AiM department at UW. At the end of the experiment, about 240 work orders were covered with all the 16 participants.

During the experiment, the researcher observed the starting and the ending time for each participant along with their reactions towards either using 2D or 3D format of data from the Revit file provided. It took about 40 minutes per participant for explaining the whole process of giving the tutorial review to the participant to complete the experiment. It took about 3 weeks to complete the whole experiment with 16 different participants. The diagram below is the graphical representation of the complete experiment process

4.5 EXPERIMENT INFORMATION

The experiment was conducted with 16 facility staff and construction management students. The list consisted from the GIS specialist to mechanical and electrical engineers. We had students who were from a civil engineering background and had no experience of BIM before. Their role was depicted as the potential new employee in the facility services department and who have no experience in the industry. This mix of the different participants with different background and experience could bring a more diverse reactions in the methodology processes adopted. But due to the time limitations the experiment was restricted to a limited number and area of experiment. The experiment and survey was completed over a period of 3 weeks.

4.6 LIMITATIONS

There were many challenges that were encountered in the course of this research. First, one of the main challenges was to constrain the research to affordable size. BIM – COBie concepts are very interesting which are not much explored. Therefore, it was difficult for the researcher to limit himself to a certain point. Secondly, the busy schedules of the participant meant that interview survey and conducting experiment was a one-off process. Therefore, following up for the second time was not considered to be an option. Due to which, many participants were not able to perform the experiment.

Thirdly, the data from facility services could not be retrieved as expected in regard to time due to their busy schedule. Hence, a part of the data were collected from the students of Construction Management at UW. Therefore, with the researcher's exception to the statistical data collected, the authentication of the data may differ to the actual scenario by 3 per cent to 5 per cent.

Finally, as BIM – COBie has great potential for the industry, which have more than 10,000 professionals working throughout the world with BIM concepts in the United States itself. It would have been good exercise of performing the experiment and collecting the data from the construction firms of different sizes, large, medium and small.

05

DATA ANALYSIS

“ Analysis chapter is the output of the chapter 05. It brings out the results about the experiment conducted. In this chapter, the comparative analysis is also done which respect to the time & cost. There is a detailed explanation about the result from the interview for the kind of information required for FM i.e. 2D Vs 3D. in the final part of the thesis, there a comparative analysis of time take in the whole process by calculating the time form the experiment and total time taken during the complete pilot project. ”

05

DATA ANALYSIS

5.1 ANALYSIS OF THE DATA COLLECTED

The previous chapter exemplified the methodologies adapted for the research. Following from the framework laid out in the previous chapter, the findings of this research are based on the two research objectives, namely: to look into the kind of the data either 2D or 3D, a facility manager would like to have for the operation and maintenance. Secondly, what are the time impact on the kind of data available for the operation and maintenance?

The findings are presented under two sections, qualitative data analysis and quantitative analysis. **The first section includes qualitative analysis which presents the outcome of the interview conducted. The second section provides average time differences between the time taken for the initial work order process by existing traditional process to experiment process and data.**

PERSONAL INFORMATION

AGE
BACKGROUND
EXPERIENCE

Participants were 41 years or older.
Only 17% were of age between 31-40 year.
And 33% were of age between 20 to 30 years.

Each of the Participants were Mechanical or Civil Engineers.
Only 15% each were either from Architecture background or others.
Only 8% were from Electrical background

Of the Participants had more then 20 years of experience.
33% of the them had only 1 to 5 years of experience.
25% of them had experience between 6 to 15 years.

5.2 INTERVIEW DATA ANALYSIS

The first part presents the data collected for the personal information about the participants. According to the data, about 50 per cent of the participants were above the age 41 to 50 years or more. Amongst them only 31 per cent each of the participants were from the mechanical engineering or civil engineers respectively. About 15 per cent were architects or from other design disciplines. Surprisingly people with over 20 years of experience were just 42 per cent. Whereas, about 33 per cent of the participants had an experience of 1 to 5 years. Only about 17 percent each with 11 to 15 years of experience.

Asset Information

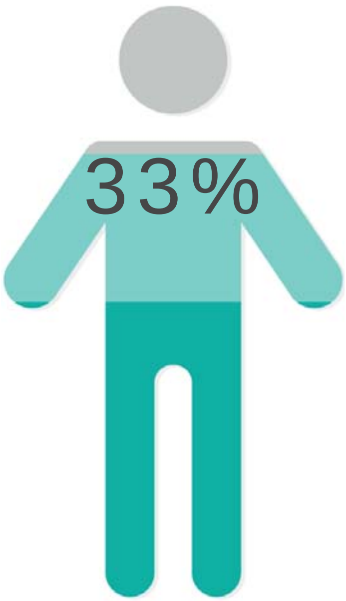
According to the second part of the survey, 50 per cent of the participants were not aware about the assets in UW completely. 25 per cent had some knowledge about it and about 17 per cent had some knowledge but were not completely convinced. When the participants were asked about how much time they refer to the UW asset list during your official hours of working. Only 25 per cent of them answered in favor, but at the same time 25 per cent answered negative each that they hardly use it.

When the participants were asked about the relevancy of the attributes in asset data information for the operation and maintenance. Surprisingly 70 per cent stood up in favor of the data, but still 30 per cent were not convinced by it and replied that there is huge scope of improvement required for a better information. Asking participants about whether there should be a change in the type of information provided, about 50 per cent of them vote to have information which is more relevant and helpful for their respective disciplines. But at the same time, about 40 per cent of them thought the information was relevant. About 34 per cent of them thought the information provided is good but at the same time 50 per cent thought that there is huge scope of improvement. Asking to comment and suggest some changes, 42 per cent of the people were not in favor of adding new attributes such as 3D models, video tutorials, shop drawings pdf version, etc. But at the same time, about 33 per cent wanted to include this information.

05
DATA ANALYSIS

ASSET INFORMATION

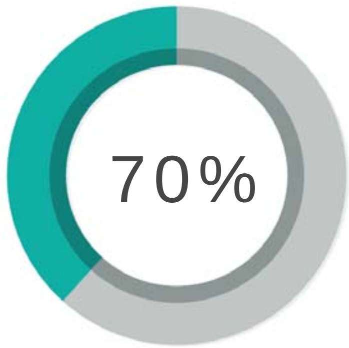
AWARENESS RELEVANCY ALTERATION TIME FUTURE SUGGESTIONS



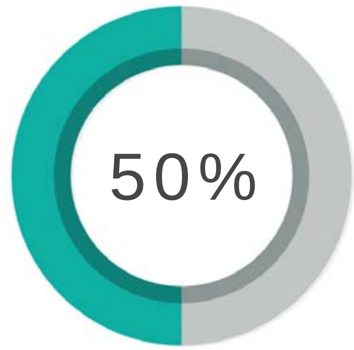
Participants were aware about the UW Asset Information. At the same time 33%were not aware.

23% had some idea but were not sure about it.

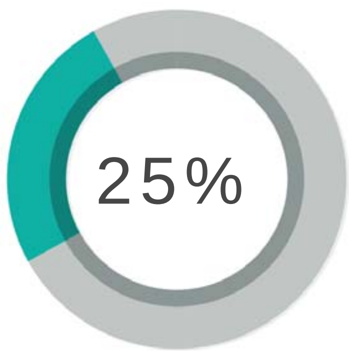
About 11% completely had no knowledge about Asset Set.



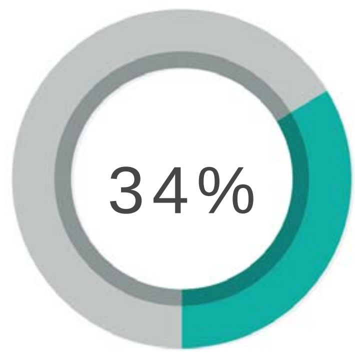
Relevancy of Asset Information



Alteration in Asset List



Time Spent on Asset Data



Revision in Asset Data

Level of Development

Moving into the third and the longest part of the interview, people were asked about their knowledge on Level of Detail for the assets information. About 41 per cent had no clue about the LOD of Data. But 25 per cent of the participants had some idea about it. When people were presented with a proposed LOD document that was developed during the Pilot Project III, which consisted of new attributes and information for the assets. About 66 per cent were very positive about it, but still 34 per cent thought there was some scope of improvement.

When participants were asked about how much this research relevancy in their profession, about 42 per cent were really excited to use the informa-

05

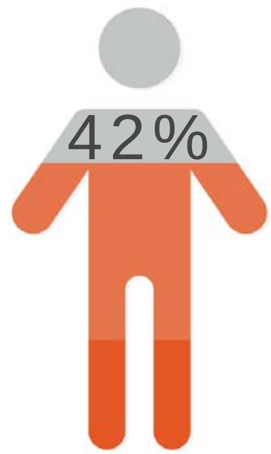
DATA ANALYSIS

LOD INFORMATION

2D OVER 3D
ACCURACY
3D FUTURE
BIM FUTURE

KNOWLEDGE
RELEVANCY
IMPORTANCE

Participants were 41 years or older.
Only 17% were of age between 31-40 year.
And 33% were of age between 20 to 30 years.



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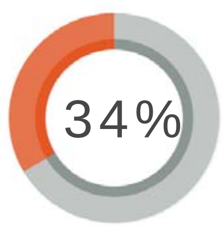
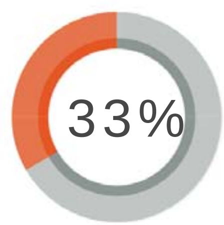
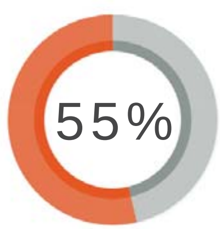
25% of them had experience between 6 to 15 years.



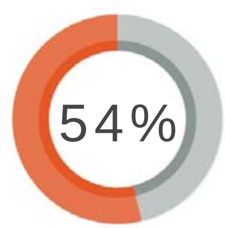
2D Data Over 3D Data



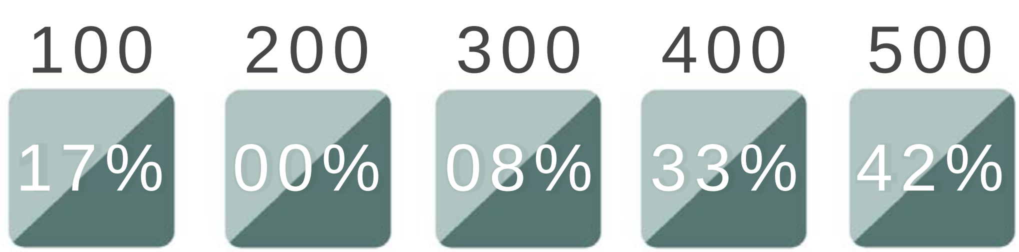
Accuracy of 3D Data



3D Data as the Future



BIM Incorporation in Future



tion followed by about 58 per cent of the people answered they might use it but they still trust the existing sources more. When they were explained about the different levels of detail done for different components of the BIM model for LOD, about 42 per cent wanted level 500, 33 per cent wanted 400 level, 8 per cent wanted 300 and only about 17 per cent wanted to have 100 level.

2D Vs 3D Type of Data

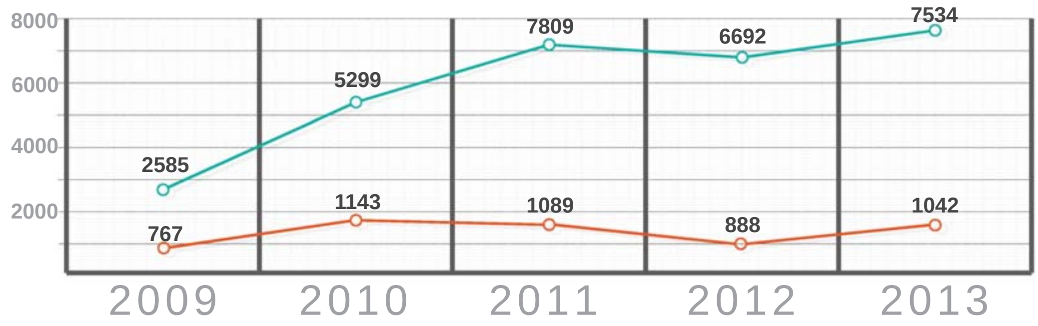
Moving forward towards the relevancy for the type of geometry of the data preferred. About 44 per cent of the people wanted the inclusion of a new dimension in the future data system and at the same time 41 per of the people were happy with the 2D data which is already present. Asking participants about the accuracy of 3D data, surprisingly 33 per cent did felt adding a new dimension to the information would be helpful. Whereas, 42 per cent of the people were not sure about it. When participant were asked about is 3D the future in the facility industry, about 55 per cent of the participants agreed to it but at the same time, about 11 per happy with 2D.

When people were asked about the inclusion of BIM – COBie concept in their running projects. About 54 per cent strongly agreed to include BIM – COBie processes, whereas only 23 per cent were thinking about not using it but as they had no experience with it. But when they were asked for using BIM concepts for some new upcoming projects 66 per cent of showed positive sign whereas 17 per cent said no.

5.3 EXPERIMENT ANALYSIS

The whole process was a depiction of the real scenario. This starts from when a complaint is brought to the shop lead at UW. The shop lead, then finds all the details and data related to the work order. And finally, he assigns a person from the field to complete the respective work order. In the similar way, each participant was given a set of work orders to perform. They were supposed to find the information about the components for which the complaint was brought up. With the help of the briefing given

05
DATA ANALYSIS



Total number of Hours Spent During the Work Order for William Foege - Genome Science Building, University of Washington from the Year 2009 - 2013

Total number of Hours Spent During the Work Order for William Foege - Genome Science Building, University of Washington from the Year 2009 - 2013 for only Mechanical Basement, Ground Floor and First Floor

before the experiment along with the tutorial notes provided for them to use. There were 16 participants, including 11 from the facility staff and 5 from the construction management program at UW.

During the experiment, the time was recorded from the start to the end for the 15 tasks each that were given to participants to complete. Along with the time, each participant's reaction was also noted down to see how they navigate through the model. Revit interface being new to the people, they were helped whenever they were stuck. It was noted that the average time taken by each participant to complete the task was 1 minute 40 seconds. This time excluded computer login and signing the work order letter.

During the interview, apart from the scheduled questions, they were also asked about the time they take while assigning a job for the field person to perform. From the data collected during the interviews, it was concluded that the average time taken by the staff member to complete the task in the traditional way is about 16 minutes. The calculation is explained in the Annex C. Below is the graphical representation for the amount of overall data and data used from the area of interest.

05
DATA ANALYSIS

EXPERIMENT RESULTS

TIME
COST
DATA

16 NOS

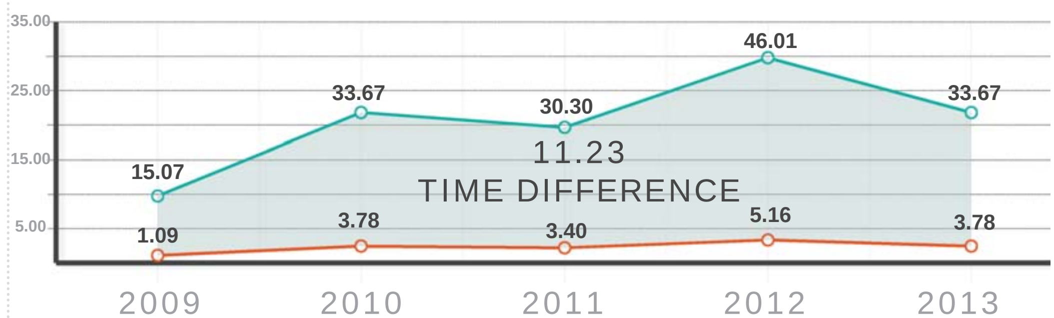
Of Participants did the Experiment which Included 15 Tasks taken the Provided Data.

In the whole process of experiment, we covered the following data:

ASSIST - 70 Work Orders
CALL-OUT - 70 Work Orders
CORRECTIVE - 40 Work Orders
EVENT - 2 Work Orders
PLANNED - 18 Work Orders
PREVENTIVE - 20 Work Orders
ROUTINE - 20 Work Orders

According to the Different Facility Staff Members, a Work Order Task Takes Approximately 16 Minutes on an Average.

According to the Experiments Conducted with the Facility Staff and Students, 1:40 Minutes Per Work Order Task was Calculated.



Total number of Hours Spent on the Work Order for William Foege - Genome Science Building, University of Washington from the Year 2009 - 2013 As Per Facility Staff.

Total number of Hours Spent on the Work Order for William Foege - Genome Science Building, University of Washington from the Year 2009 - 2013 As Per Experiment Conducted.

05

DATA ANALYSIS

When the calculation was completed, it was observed that there is a huge difference of 11.23 times in the time taken between traditional and experimental process. This clearly shows that adding a new dimension and presenting the data according to the COBie standards can be very beneficial. But more importantly, in this experiment, it was to experience that most of the participants were able to perform the task with the given tutorial notes. This shows the BIM-COBie process if implemented in the real scenario can prove to be really beneficial for the UW.

06
CONCLUSION

"Conclusion states the final results of the research. It also presents the researcher opinions over the questions asked by him and the conclusion of the interviews and experiments."

06 CONCLUSION

Implementation of both BIM - COBie as a data processing are relatively new to the industry. As the construction industry modifies its current procedure very slowly, it is very hard to bring in a new concept in the construction industry. But it was found that most of the participants were open to new ideas, but still wanted to keep the basic of existing systems. BIM is a concept which is recently introduced in construction has many long term advantages throughout the building life-cycle. But there is a long way for this concept to travel into the industry. Similarly, COBie being even newer concept in the industry, the reactions of people towards it is not convincing enough. Yet looking into the benefits that BIM can provide, people have high hopes from COBie. The following paragraph outlines major conclusion and suggestions of this research in terms of: first, the kind of the data either 2D or 3D, a facility manager would like to have for the operation and maintenance. Secondly, what are the time impact on the kind of data available for the operation and maintenance?

6.1 FINAL RESULT

From the interviews result provided in the previous chapter, it was observed that the majority of the answers of the participants were influenced by the skill set they have. It was also observed that facility staff and student of UW were amazed to see the layout of the whole data set at one place. This did eventually diverged them towards the new technologies and different arrangement of the data provided according to BIM-COBie standards. By looking into the data provided earlier in the chapter 5, where about 55 per cent of the participants want to include BIM and other related concepts in their projects, it could save them time and money. Certainly we can conclude that this research work have spread the word for BIM – CObie technologies with the facility staff and student groups at the UW.

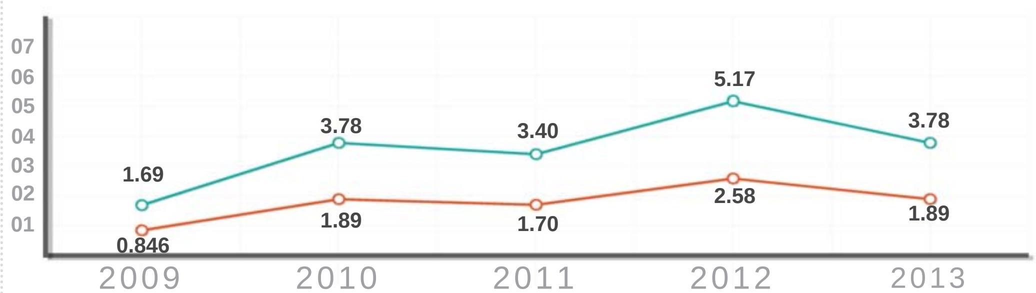
With the interviews conducted, one of the most important and interesting part was the reactions of individual participants towards the kind of data interface provided in the BIM – COBie model which included all the asset information at one place. It would not be incorrect to state that the partici-

06
CONCLUSION

pant were overwhelmed to see all the information on third dimensional geometry. One of the most important answers that came from one the facility staff member that, they would welcome 100 level of geometry along with 500 level of data attached to the component in the BIM – COBie model.

Unfortunately, it was observed that in the illusion and excitement, most of the participants forgot about the data and the answered were influenced accordingly. This made it more difficult to trust their answers and reactions as they were not clear. It was later decided that it is important to look this matter by moving one step ahead and conducting an experiment to back the data collected in the interview process. Hence, an experiment was prepared for people to get an experience of BIM 3D data.

The experiment helped the researcher to look more closely, how the participant reacted towards the data in a practical way. The experiment was a great success as it brought out clearer reactions of the participants and at the same time it was recording the time of performing the tasks. The experiment concluded that participants took about 1 minute and 40 seconds on an average to find the data to assigning the job to field person in-charge.



Total number of Hours Spent During the Work Order for William Foege - Genome Science Building, University of Washington from the Year 2009 - 2013 for only Mechanical Basement, Ground Floor and First Floor - By Facility Staff

Total number of Hours Spent During the Work Order for William Foege - Genome Science Building, University of Washington from the Year 2009 - 2013 for only Mechanical Basement, Ground Floor and First Floor - By CM Students

06 CONCLUSION

The graph below shows the comparison between two processes. It was now clearly seen that there is a difference of 11.23 of time differences between both the processes. Going deep in this data, we can see that 11 facility staff members took about 2 minutes and 13 seconds to complete the tasks. Whereas, the student took about 1 minute and 6 seconds to complete the tasks. This clearly indicates that even though the facility staff are used to the current data system, the student tool almost half the time per task. This can the influence of the kind of skill sets that are being taught to the student which clearly states the technologies are overcoming the existing system in the future.

6.2 FUTURE STUDIES

Looking into the percentage of time saved, it becomes an important issue of discussion for the university to think in a different direction with more concern as the University of Washington have a huge budget of 6 billion allotted to the operation and maintenance every year. Therefore, we can conclude that a project such as BIM – COBie Pilot Project for Re-Baselining of the existing building can definitely help to reduce the cost for the facility services in the complete life cycle of the building.

6.3 THESIS CONTRIBUTIONS

Completing the thesis in a period of three quarters, the experience that this project has provided to the researcher was truly magnificent in respect of learning new things and systems. The Pilots Project III certainly helped the research topic and researcher to go deep into the system and let the existing staff members know about the benefits of BIM – COBie concepts. With the results gathered in this thesis, it is certain that people in the industry are willing to the technological push in their systems beside them being comfortable with their experience with the current system. The reason behind this sheer acceptance is certainly the economics of the country which is always fluctuating and the increasing competition in the construction industry everyone faces.

06
CONCLUSION

With a much more developed and clear path defined in this thesis for gathering information to the systematically arranging the data, can be really helpful for the facility services to modify the process according to the resources available at the university. This process can then be implemented in the future upcoming projects. Gradually, this can help FS to develop the BIM – COBie data information for the entire university over the period of time.

With the time difference of 11.23, it can be assumed that if by implementing the BIM-COBie process in the construction project at an early stage. The owners can control the life-cycle cost of the building to a great extent and make more profit. With the process that was developed by the researcher during this study can become a benchmark for the future projects. The future researchers can further simplify the adapted process used in this thesis. This will certainly help the university to save the cost of the upcoming projects as well as broaden the scope of future researchers. Apart from influencing the staff and student, this research has motivated them to learn more about the BIM – COBie concept and implement in their projects which is and was the ultimate goal of this research work.

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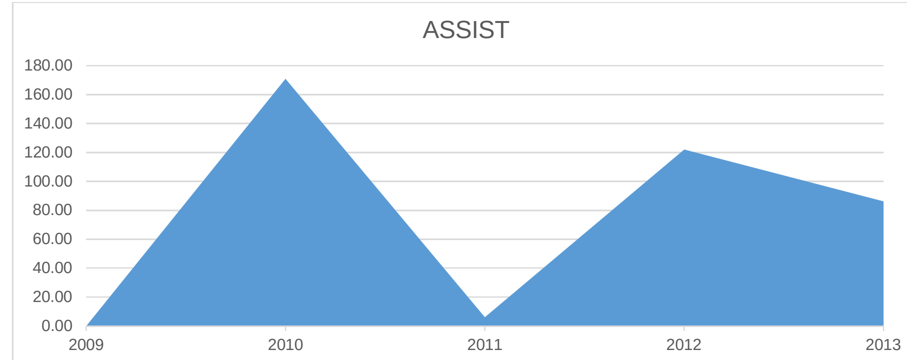
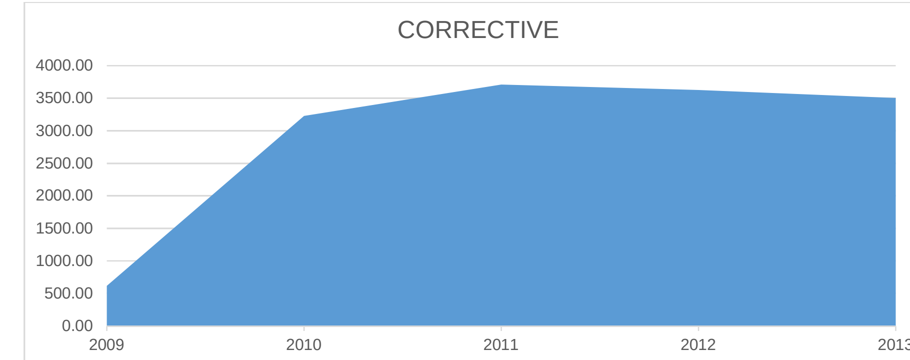
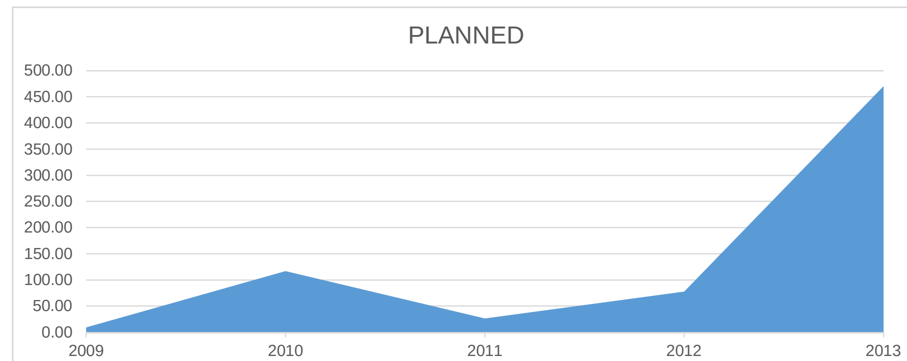
A

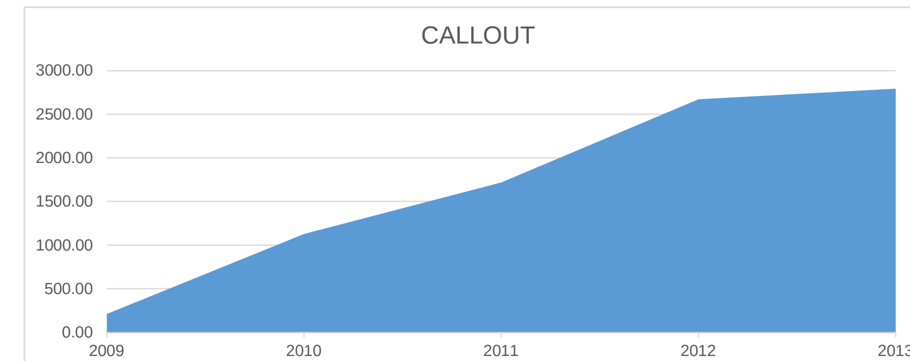
APPENDIX

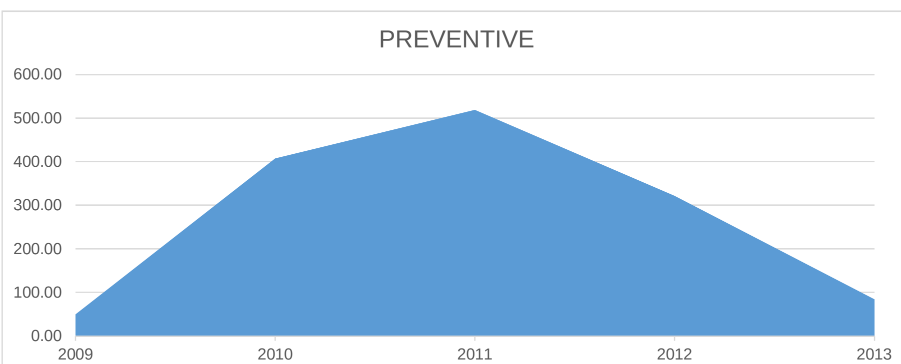
TOTAL WORKING HOUR SPENT IN WORK ORDERS					
	2009	**2010**	**2011**	**2012**	**2013**
ASSIST	0.00	171.00	6.00	122.00	86.00
CALLOUT	209.00	1127.00	1718.50	2670.25	2792.75
CORRECTIVE	616.00	3225.50	3707.80	3624.00	3503.00
EVENT	2.50	0.00	0.00	0.00	0.00
PLANNED	9.00	117.00	26.50	78.00	470.75
PREVENTIVE	49.50	407.50	519.00	321.50	83.50
ROUTINE	2.00	2.00	3.00	104.50	82.00
	888.00	**5050.00**	**5980.80**	**6920.25**	**7018.00**

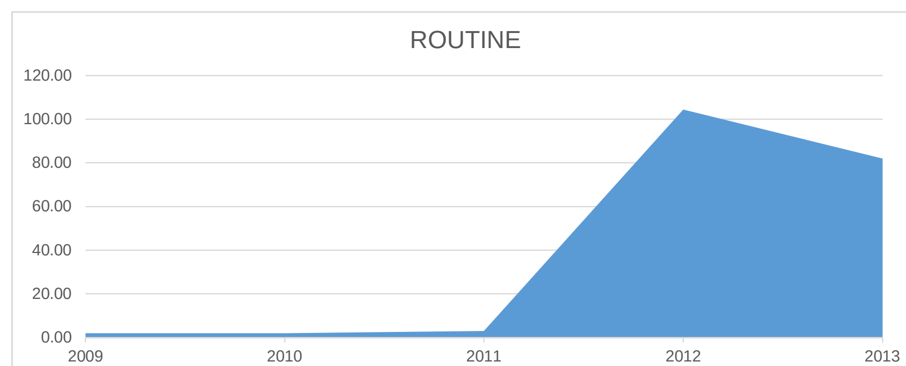


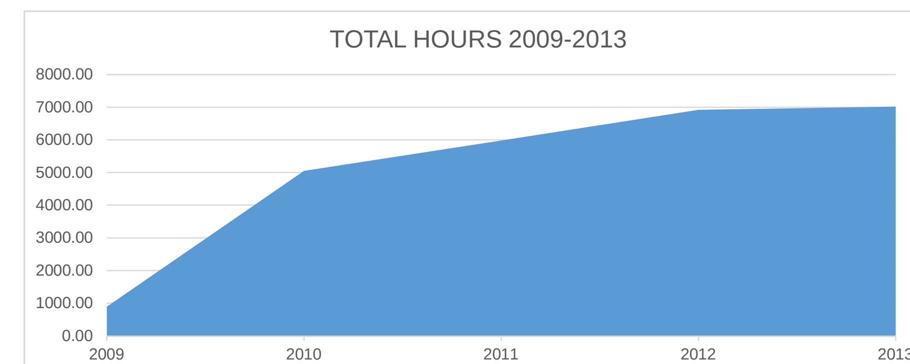












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013011	CORRECTIVE	MAINTENANCE	8/24/2009 10:48:05 AM			11/5/2009 1:05:44 PM	8/25/2009 12:00:01 AM	8/27/2009 12:00:01 AM	7
000583	CORRECTIVE	MAINTENANCE	6/27/2009 8:56:51 AM			10/1/2009 3:22:57 PM	7/20/2009 12:00:01 AM	7/20/2009 12:00:01 AM	1
006271	CORRECTIVE	MAINTENANCE	7/20/2009 11:34:09 AM			10/1/2009 3:21:14 PM	7/24/2009 12:00:01 AM	8/14/2009 12:00:01 AM	4.5
013169	CORRECTIVE	MAINTENANCE	8/25/2009 8:41:43 AM			10/20/2009 2:14:16 PM	8/31/2009 12:00:01 AM	9/10/2009 12:00:01 AM	5.5
005940	CORRECTIVE	MAINTENANCE	7/17/2009 9:13:25 AM			9/2/2009 2:56:07 PM	7/28/2009 12:00:01 AM	7/29/2009 12:00:01 AM	8.5
007082	CORRECTIVE	MAINTENANCE	7/23/2009 7:15:55 AM			12/2/2009 3:04:06 PM	8/10/2009 12:00:01 AM	8/11/2009 12:00:01 AM	4
009250	CORRECTIVE	MAINTENANCE	8/3/2009 2:05:43 PM			10/1/2009 3:19:39 PM	8/10/2009 12:00:01 AM	8/10/2009 12:00:01 AM	1
006437	CORRECTIVE	MAINTENANCE	7/21/2009 8:02:24 AM			10/1/2009 3:20:57 PM	7/23/2009 12:00:01 AM	7/23/2009 12:00:01 AM	1
012682	CORRECTIVE	MAINTENANCE	8/21/2009 9:36:17 AM			12/2/2009 3:03:07 PM	8/21/2009 12:00:01 AM	8/28/2009 12:00:01 AM	4.5
016439	CORRECTIVE	MAINTENANCE	9/17/2009 8:17:45 AM			11/5/2009 12:57:35 PM	9/23/2009 12:00:01 AM	9/23/2009 12:00:01 AM	1
006400	CORRECTIVE	MAINTENANCE	7/21/2009 6:35:08 AM			10/1/2009 3:21:09 PM	7/20/2009 12:00:01 AM	7/20/2009 12:00:01 AM	2
013465	CORRECTIVE	MAINTENANCE	8/26/2009 12:20:27 PM			12/2/2009 3:03:06 PM	8/26/2009 12:00:01 AM	8/28/2009 12:00:01 AM	5
021306	CORRECTIVE	MAINTENANCE	10/14/2009 7:05:32 AM			12/2/2009 3:10:43 PM	10/14/2009 12:00:01 AM	10/14/2009 12:00:01 AM	2.5
007304	CORRECTIVE	MAINTENANCE	7/24/2009 8:18:41 AM			10/1/2009 3:20:29 PM	7/27/2009 12:00:01 AM	7/27/2009 12:00:01 AM	1
020566	CORRECTIVE	MAINTENANCE	10/9/2009 7:09:54 AM			12/2/2009 2:54:54 PM	10/12/2009 12:00:01 AM	10/13/2009 12:00:01 AM	1.5
007964	CORRECTIVE	MAINTENANCE	7/28/2009 9:22:48 AM			10/19/2009 2:16:27 PM	7/28/2009 12:00:01 AM	7/30/2009 12:00:01 AM	2
021598	CORRECTIVE	MAINTENANCE	10/15/2009 10:40:13 AM			12/2/2009 3:10:47 PM	10/15/2009 12:00:01 AM	10/15/2009 12:00:01 AM	1
005351	CORRECTIVE	MAINTENANCE	7/14/2009 1:08:05 PM			10/1/2009 3:21:43 PM	7/14/2009 12:00:01 AM	7/15/2009 12:00:01 AM	2.5
005330	CORRECTIVE	MAINTENANCE	7/14/2009 12:25:17 PM			11/5/2009 1:13:42 PM	7/15/2009 12:00:01 AM	7/31/2009 12:00:01 AM	4
013931	CORRECTIVE	MAINTENANCE	8/31/2009 10:46:38 AM			11/5/2009 1:02:41 PM	9/14/2009 12:00:01 AM	9/14/2009 12:00:01 AM	5
001183	CORRECTIVE	MAINTENANCE	7/1/2009 10:02:45 AM			7/23/2009 1:59:48 PM	7/1/2009 12:00:01 AM	7/1/2009 12:00:01 AM	2
001183	CORRECTIVE	MAINTENANCE	7/1/2009 10:02:45 AM			10/1/2009 3:22:55 PM	7/1/2009 12:00:01 AM	7/1/2009 12:00:01 AM	2
014026	CORRECTIVE	MAINTENANCE	8/31/2009 2:36:46 PM			11/5/2009 1:02:55 PM	9/10/2009 12:00:01 AM	9/10/2009 12:00:01 AM	1
010107	CORRECTIVE	MAINTENANCE	8/10/2009 7:21:13 AM			10/1/2009 3:18:56 PM	8/12/2009 12:00:01 AM	8/12/2009 12:00:01 AM	1.5
010113	CORRECTIVE	MAINTENANCE	8/10/2009 7:24:23 AM			10/1/2009 3:19:03 PM	8/11/2009 12:00:01 AM	8/11/2009 12:00:01 AM	1
005734	CORRECTIVE	MAINTENANCE	7/16/2009 9:45:06 AM			9/2/2009 2:56:17 PM	7/16/2009 12:00:01 AM	7/22/2009 12:00:01 AM	3
005579	CORRECTIVE	MAINTENANCE	7/15/2009 12:33:58 PM			9/2/2009 2:56:10 PM	7/15/2009 12:00:01 AM	7/15/2009 12:00:01 AM	1
012538	CORRECTIVE	MAINTENANCE	8/20/2009 11:21:03 AM			11/5/2009 1:06:03 PM	8/27/2009 12:00:01 AM	9/15/2009 12:00:01 AM	4
005682	CORRECTIVE	MAINTENANCE	7/16/2009 6:36:02 AM			10/1/2009 3:21:41 PM	7/16/2009 12:00:01 AM	7/17/2009 12:00:01 AM	5
016720	CORRECTIVE	MAINTENANCE	9/18/2009 2:31:40 PM			11/5/2009 12:54:39 PM	9/18/2009 12:00:01 AM	9/29/2009 12:00:01 AM	9.5
005300	CORRECTIVE	MAINTENANCE	7/14/2009 11:32:52 AM			9/2/2009 2:56:04 PM	7/14/2009 12:00:01 AM	7/14/2009 12:00:01 AM	2
016602	CORRECTIVE	MAINTENANCE	9/18/2009 7:06:25 AM			12/2/2009 3:01:41 PM	9/18/2009 12:00:01 AM	9/18/2009 12:00:01 AM	1
001044	CORRECTIVE	MAINTENANCE	7/1/2009 7:26:19 AM			9/2/2009 2:59:40 PM	7/1/2009 12:00:01 AM	7/1/2009 12:00:01 AM	2
006404	CORRECTIVE	MAINTENANCE	7/21/2009 7:06:40 AM			9/2/2009 2:56:06 PM	7/21/2009 12:00:01 AM	7/21/2009 12:00:01 AM	2.5
006808	CORRECTIVE	MAINTENANCE	7/21/2009 2:25:01 PM			10/1/2009 3:21:01 PM	7/23/2009 12:00:01 AM	7/23/2009 12:00:01 AM	1.5
011833	CORRECTIVE	MAINTENANCE	8/17/2009 1:55:28 PM			10/1/2009 3:18:28 PM	8/17/2009 12:00:01 AM	8/17/2009 12:00:01 AM	1
013161	CORRECTIVE	MAINTENANCE	8/25/2009 8:28:07 AM			10/20/2009 11:52:47 AM	9/8/2009 12:00:01 AM	9/21/2009 12:00:01 AM	9
005028	CORRECTIVE	MAINTENANCE	7/13/2009 11:51:13 AM			10/1/2009 3:21:36 PM	7/15/2009 12:00:01 AM	7/15/2009 12:00:01 AM	2
005028	CORRECTIVE	MAINTENANCE	7/13/2009 11:51:13 AM			10/5/2009 2:31:47 PM	7/15/2009 12:00:01 AM	7/15/2009 12:00:01 AM	2
007912	CORRECTIVE	MAINTENANCE	7/28/2009 7:32:33 AM			10/1/2009 3:20:37 PM	8/10/2009 12:00:01 AM	8/10/2009 12:00:01 AM	1
015686	CORRECTIVE	MAINTENANCE	9/11/2009 7:41:35 AM			12/2/2009 3:01:33 PM	9/14/2009 12:00:01 AM	9/22/2009 12:00:01 AM	8.5
010420	CORRECTIVE	MAINTENANCE	8/11/2009 9:51:10 AM			10/22/2009 11:24:52 AM	8/11/2009 12:00:01 AM	8/11/2009 12:00:01 AM	1.5
021280	CORRECTIVE	MAINTENANCE	10/13/2009 4:10:44 PM			12/2/2009 3:10:41 PM	10/13/2009 12:00:01 AM	10/13/2009 12:00:01 AM	1
003296	CORRECTIVE	MAINTENANCE	7/6/2009 4:03:37 PM			10/1/2009 3:22:15 PM	7/10/2009 12:00:01 AM	7/10/2009 12:00:01 AM	3.5
020817	CORRECTIVE	MAINTENANCE	10/12/2009 8:30:29 AM			12/2/2009 2:54:20 PM	10/12/2009 12:00:01 AM	10/12/2009 12:00:01 AM	1.5
016912	CORRECTIVE	MAINTENANCE	9/21/2009 11:00:18 AM			11/5/2009 12:54:53 PM	10/5/2009 12:00:01 AM	10/5/2009 12:00:01 AM	2.5
010106	CORRECTIVE	MAINTENANCE	8/10/2009 7:20:06 AM			10/1/2009 3:19:00 PM	8/11/2009 12:00:01 AM	8/11/2009 12:00:01 AM	1
015899	CORRECTIVE	MAINTENANCE	9/14/2009 7:39:43 AM			12/2/2009 3:01:45 PM	9/14/2009 12:00:01 AM	9/14/2009 12:00:01 AM	1
013176	CORRECTIVE	MAINTENANCE	8/25/2009 8:47:02 AM			11/5/2009 1:06:02 PM	8/26/2009 12:00:01 AM	8/26/2009 12:00:01 AM	1
001050	CORRECTIVE	MAINTENANCE	7/1/2009 7:37:24 AM			9/2/2009 2:59:43 PM	7/7/2009 12:00:01 AM	7/20/2009 12:00:01 AM	2
008481	CORRECTIVE	MAINTENANCE	7/30/2009 9:51:01 AM			11/5/2009 1:10:24 PM	8/12/2009 12:00:01 AM	8/13/2009 12:00:01 AM	4
017416	CORRECTIVE	MAINTENANCE	9/24/2009 8:03:43 AM			12/2/2009 3:00:23 PM	9/25/2009 12:00:01 AM	9/25/2009 12:00:01 AM	1
002344	CORRECTIVE	MAINTENANCE	7/2/2009 9:01:19 AM			10/1/2009 3:22:23 PM	7/6/2009 12:00:01 AM	7/6/2009 12:00:01 AM	2
018780	CORRECTIVE	MAINTENANCE	10/1/2009 7:16:25 AM			11/5/2009 12:52:32 PM	10/1/2009 12:00:01 AM	10/1/2009 12:00:01 AM	1.75
014024	CORRECTIVE	MAINTENANCE	8/31/2009 2:34:50 PM			11/5/2009 1:02:57 PM	9/1/2009 12:00:01 AM	9/3/2009 12:00:01 AM	7
016186	CORRECTIVE	MAINTENANCE	9/15/2009 1:06:23 PM			10/19/2009 2:16:06 PM	9/15/2009 12:00:01 AM	9/17/2009 12:00:01 AM	7
003566	CORRECTIVE	MAINTENANCE	7/7/2009 10:45:09 AM			12/2/2009 3:04:40 PM	9/24/2009 12:00:01 AM	9/24/2009 12:00:01 AM	1.5
001415	CORRECTIVE	MAINTENANCE	7/1/2009 1:21:06 PM			9/2/2009 2:59:53 PM	7/7/2009 12:00:01 AM	7/7/2009 12:00:01 AM	2
017894	CORRECTIVE	MAINTENANCE	9/28/2009 9:36:08 AM			12/2/2009 3:00:34 PM	9/28/2009 12:00:01 AM	9/28/2009 12:00:01 AM	3
008651	CORRECTIVE	MAINTENANCE	7/31/2009 7:57:13 AM			11/5/2009 1:10:21 PM	7/31/2009 12:00:01 AM	7/31/2009 12:00:01 AM	3
016913	CORRECTIVE	MAINTENANCE	9/21/2009 11:01:29 AM			12/2/2009 3:01:41 PM	9/22/2009 12:00:01 AM	9/23/2009 12:00:01 AM	2
000987	CORRECTIVE	MAINTENANCE	6/30/2009 4:08:38 PM			9/2/2009 2:59:44 PM	7/1/2009 12:00:01 AM	7/2/2009 12:00:01 AM	15
001478	CORRECTIVE	MAINTENANCE	7/1/2009 1:49:36 PM			10/1/2009 3:22:25 PM	7/20/2009 12:00:01 AM	7/20/2009 12:00:01 AM	1
011736	CORRECTIVE	MAINTENANCE	8/17/2009 10:42:44 AM			12/2/2009 3:02:42 PM	9/2/2009 12:00:01 AM	9/2/2009 12:00:01 AM	1
002535	CORRECTIVE	MAINTENANCE	7/2/2009 12:03:51 PM			11/5/2009 1:13:46 PM	7/28/2009 12:00:01 AM	7/28/2009 12:00:01 AM	0.5
012737	CORRECTIVE	MAINTENANCE	8/21/2009 12:56:59 PM			11/5/2009 1:05:40 PM	8/21/2009 12:00:01 AM	8/21/2009 12:00:01 AM	1
005214	CORRECTIVE	MAINTENANCE	7/14/2009 7:48:17 AM			10/1/2009 3:21:38 PM	7/20/2009 12:00:01 AM	7/20/2009 12:00:01 AM	1
011515	CORRECTIVE	MAINTENANCE	8/14/2009 1:09:49 PM			10/1/2009 3:18:22 PM	8/14/2009 12:00:01 AM	8/14/2009 12:00:01 AM	1
013143	CORRECTIVE	MAINTENANCE	8/25/2009 6:47:11 AM			11/5/2009 1:05:52 PM	8/25/2009 12:00:01 AM	8/25/2009 12:00:01 AM	4
015280	CORRECTIVE	MAINTENANCE	9/8/2009 2:49:51 PM			12/2/2009 3:01:30 PM	9/9/2009 12:00:01 AM	10/13/2009 12:00:01 AM	12
005632	CORRECTIVE	MAINTENANCE	7/15/2009 2:48:44 PM			10/1/2009 3:21:47 PM	7/15/2009 12:00:01 AM	7/17/2009 12:00:01 AM	4
019862	CORRECTIVE	MAINTENANCE	10/7/2009 11:33:44 AM			12/2/2009 2:56:52 PM	10/7/2009 12:00:01 AM	10/7/2009 12:00:01 AM	2
013702	CORRECTIVE	MAINTENANCE	8/28/2009 7:48:08 AM			10/1/2009 3:17:50 PM	8/31/2009 12:00:01 AM	8/31/2009 12:00:01 AM	2.5
005391	CORRECTIVE	MAINTENANCE	7/14/2009 2:15:45 PM			10/1/2009 3:21:41 PM	7/21/2009 12:00:01 AM	7/22/2009 12:00:01 AM	6
005391	CORRECTIVE	MAINTENANCE	7/14/2009 2:15:45 PM			8/5/2009 12:24:22 PM	7/21/2009 12:00:01 AM	7/22/2009 12:00:01 AM	6
013382	CORRECTIVE	MAINTENANCE	8/26/2009 9:01:16 AM			11/5/2009 1:02:49 PM	8/26/2009 12:00:01 AM	8/28/2009 12:00:01 AM	4
018730	CORRECTIVE	MAINTENANCE	9/30/2009 2:58:38 PM			12/2/2009 2:59:27 PM	10/2/2009 12:00:01 AM	10/2/2009 12:00:01 AM	1
008213	CORRECTIVE	MAINTENANCE	7/29/2009 9:48:23 AM			10/1/2009 3:20:30 PM	7/29/2009 12:00:01 AM	7/30/2009 12:00:01 AM	3
008213	CORRECTIVE	MAINTENANCE	7/29/2009 9:48:23 AM			10/5/2009 2:30:19 PM	7/29/2009 12:00:01 AM	7/30/2009 12:00:01 AM	3
013551	CORRECTIVE	MAINTENANCE	8/27/2009 8:32:15 AM			11/5/2009 1:02:57 PM	9/8/2009 12:00:01 AM	9/8/2009 12:00:01 AM	3
013172	CORRECTIVE	MAINTENANCE	8/25/2009 8:43:42 AM			10/20/2009 1:18:57 PM	8/31/2009 12:00:01 AM	9/14/2009 12:00:01 AM	10
020839	CORRECTIVE	MAINTENANCE	10/12/2009 9:11:48 AM			11/19/2009 9:55:39 AM	10/12/2009 12:00:01 AM	10/15/2009 12:00:01 AM	13.5
006803	CORRECTIVE	MAINTENANCE	7/21/2009 2:14:50 PM			10/1/2009 3:21:10 PM	7/21/2009 12:00:01 AM	7/23/2009 12:00:01 AM	7.5
012508	CORRECTIVE	MAINTENANCE	8/20/2009 10:07:05 AM			11/5/2009 1:05:46 PM	8/27/2009 12:00:01 AM	8/27/2009 12:00:01 AM	3.5
003726	CORRECTIVE	MAINTENANCE	7/7/2009 12:32:43 PM			9/2/2009 2:58:56 PM	7/8/2009 12:00:01 AM	7/9/2009 12:00:01 AM	3.5
008728	CORRECTIVE	MAINTENANCE	7/31/2009 11:47:42 AM			11/5/2009 1:10:45 PM	7/31/2009 12:00:01 AM	8/7/2009 12:00:01 AM	5
022256	CORRECTIVE	MAINTENANCE	10/20/2009 10:26:24 AM			12/2/2009 3:09:18 PM	10/27/2009 12:00:01 AM	10/27/2009 12:00:01 AM	5
016012	CORRECTIVE	MAINTENANCE	9/14/2009 1:47:36 PM			12/2/2009 3:01:18 PM	9/17/2009 12:00:01 AM	9/17/2009 12:00:01 AM	1
018442	CORRECTIVE	MAINTENANCE	9/30/2009 7:08:02 AM			11/5/2009 12:52:49 PM	9/30/2009 12:00:01 AM	9/30/2009 12:00:01 AM	2.5
005585	CORRECTIVE	MAINTENANCE	7/15/2009 12:37:24 PM			10/1/2009 3:21:46 PM	7/15/2009 12:00:01 AM	7/21/2009 12:00:01 AM	9.5
017989	CORRECTIVE	MAINTENANCE	9/28/2009 12:17:30 PM			10/21/2009 10:22:23 AM	9/28/2009 12:00:01 AM	9/28/2009 12:00:01 AM	1
002456	CORRECTIVE	MAINTENANCE	7/2/2009 10:57:01 AM			9/2/2009 2:59:42 PM	7/6/2009 12:00:01 AM	7/7/2009 12:00:01 AM	2
011660	CORRECTIVE	MAINTENANCE	8/17/2009 7:17:28 AM			11/5/2009 1:08:11 PM	8/17/2009 12:00:01 AM	9/1/2009 12:00:01 AM	4
016331	CORRECTIVE	MAINTENANCE	9/16/2009 11:42:58 AM			12/2/2009 3:01:39 PM	9/24/2009 12:00:01 AM	9/24/2009 12:00:01 AM	1
015325	CORRECTIVE	MAINTENANCE	9/9/2009 7:48:12 AM			11/5/2009 12:59:06 PM	9/16/2009 12:00:01 AM	9/16/2009 12:00:01 AM	1
013552	CORRECTIVE	MAINTENANCE	8/27/2009 8:32:52 AM			10/21/2009 11:31:05 AM	8/28/2009 12:00:01 AM	9/1/2009 12:00:01 AM	2
004476	CORRECTIVE	MAINTENANCE	7/9/2009 10:48:25 AM			10/1/2009 3:22:26 PM	7/27/2009 12:00:01 AM	7/27/2009 12:00:01 AM	8
013144	CORRECTIVE	MAINTENANCE	8/25/2009 6:49:55 AM			12/2/2009 3:03:01 PM	8/25/2009 12:00:01 AM	9/15/2009 12:00:01 AM	13.5
010956	CORRECTIVE	MAINTENANCE	8/12/2009 7:07:16 AM			10/20/2009 12:28:04 PM	8/12/2009 12:00:01 AM	9/16/2009 12:00:01 AM	6
015670	CORRECTIVE	MAINTENANCE	9/11/2009 6:28:21 AM			11/5/2009 12:58:38 PM	9/11/2009 12:00:01 AM	9/11/2009 12:00:01 AM	2.5
009051	CORRECTIVE	MAINTENANCE	8/3/2009 7:26:44 AM			10/1/2009 3:19:50 PM	8/11/2009 12:00:01 AM	8/11/2009 12:00:01 AM	1
011804	CORRECTIVE	MAINTENANCE	8/17/2009 12:17:02 PM			11/5/2009 1:05:34 PM	8/31/2009 12:00:01 AM	8/31/2009 12:00:01 AM	1
002204	CORRECTIVE	MAINTENANCE	7/2/2009 7:06:21 AM			9/2/2009 2:59:39 PM	7/1/2009 12:00:01 AM	7/9/2009 12:00:01 AM	6
013035	CORRECTIVE	MAINTENANCE	8/24/2009 11:44:31 AM			11/5/2009 1:06:00 PM	8/31/2009 12:00:01 AM	8/31/2009 12:00:01 AM	1
016647	CORRECTIVE	MAINTENANCE	9/18/2009 9:42:32 AM			12/2/2009 3:01:45 PM	9/22/2009 12:00:01 AM	9/22/2009 12:00:01 AM	3.5
010854	CORRECTIVE	MAINTENANCE	8/11/2009 1:35:48 PM			11/5/2009 1:07:52 PM	9/10/2009 12:00:01 AM	9/10/2009 12:00:01 AM	2.5
000634	CORRECTIVE	MAINTENANCE	6/27/2009 11:13:36 AM			10/1/2009 3:22:58 PM	8/12/2009 12:00:01 AM	8/12/2009 12:00:01 AM	1.5
000622	CORRECTIVE	MAINTENANCE	6/27/2009 10:47:10 AM			10/1/2009 3:22:54 PM	7/13/2009 12:00:01 AM	7/21/2009 12:00:01 AM	37.5
005634	CORRECTIVE	MAINTENANCE	7/15/2009 2:51:48 PM			10/1/2009 3:21:35 PM	7/15/2009 12:00:01 AM	7/28/2009 12:00:01 AM	10
023379	CORRECTIVE	MAINTENANCE	10/27/2009 3:05:02 PM			12/2/2009 3:08:02 PM	10/28/2009 12:00:01 AM	10/28/2009 12:00:01 AM	2
014035	CORRECTIVE	MAINTENANCE	8/31/2009 2:46:46 PM			11/5/2009 1:03:01 PM	9/9/2009 12:00:01 AM	9/9/2009 12:00:01 AM	2
008345	CORRECTIVE	MAINTENANCE	7/29/2009 1:45:56 PM			10/1/2009 3:20:30 PM	7/29/2009 12:00:01 AM	7/30/2009 12:00:01 AM	2
000599	CORRECTIVE	MAINTENANCE	6/27/2009 9:50:10 AM			10/1/2009 3:22:58 PM	7/1/2009 12:00:01 AM	7/6/2009 12:00:01 AM	3.5
000599	CORRECTIVE	MAINTENANCE	6/27/2009 9:50:10 AM			11/5/2009 1:27:26 PM	7/1/2009 12:00:01 AM	7/6/2009 12:00:01 AM	3.5
002193	CORRECTIVE	MAINTENANCE	7/2/2009 6:47:28 AM			10/1/2009 3:22:16 PM	7/1/2009 12:00:01 AM	7/1/2009 12:00:01 AM	2
008078	CORRECTIVE	MAINTENANCE	7/28/2009 2:17:37 PM			12/2/2009 3:04:24 PM	7/29/2009 12:00:01 AM	7/29/2009 12:00:01 AM	4
008095	CORRECTIVE	MAINTENANCE	7/28/2009 2:43:08 PM			10/1/2009 3:20:32 PM	8/10/2009 12:00:01 AM	8/10/2009 12:00:01 AM	1
008254	CORRECTIVE	MAINTENANCE	7/29/2009 11:05:54 AM			9/2/2009 2:55:33 PM	7/29/2009 12:00:01 AM	7/29/2009 12:00:01 AM	2
003138	CORRECTIVE	MAINTENANCE	7/6/2009 12:20:49 PM			9/2/2009 2:59:06 PM	7/7/2009 12:00:01 AM	7/7/2009 12:00:01 AM	3.5
015450	CORRECTIVE	MAINTENANCE	9/9/2009 3:06:52 PM			11/5/2009 12:58:47 PM	9/17/2009 12:00:01 AM	9/17/2009 12:00:01 AM	1.5
005731	CORRECTIVE	MAINTENANCE	7/16/2009 9:40:45 AM			9/2/2009 2:56:12 PM	7/17/2009 12:00:01 AM	7/17/2009 12:00:01 AM	1
011404	CORRECTIVE	MAINTENANCE	8/14/2009 8:07:09 AM			11/5/2009 1:07:56 PM	8/14/2009 12:00:01 AM	8/14/2009 12:00:01 AM	1
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013174	CORRECTIVE	MAINTENANCE	8/25/2009 8:45:22 AM			11/5/2009 1:05:59 PM	8/26/2009 12:00:01 AM	8/26/2009 12:00:01 AM	1
012619	CORRECTIVE	MAINTENANCE	8/20/2009 4:05:09 PM			11/5/2009 1:05:53 PM	8/20/2009 12:00:01 AM	8/24/2009 12:00:01 AM	3
011991	CORRECTIVE	MAINTENANCE	8/18/2009 10:36:01 AM			10/1/2009 3:18:21 PM	8/18/2009 12:00:01 AM	8/18/2009 12:00:01 AM	2
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009744	CORRECTIVE	MAINTENANCE	8/6/2009 10:03:16 AM			10/1/2009 3:19:02 PM	8/6/2009 12:00:01 AM	8/6/2009 12:00:01 AM	2
016809	CORRECTIVE	MAINTENANCE	9/21/2009 7:10:32 AM			11/5/2009 12:54:39 PM	9/23/2009 12:00:01 AM	9/23/2009 12:00:01 AM	1
017911	CORRECTIVE	MAINTENANCE	9/28/2009 10:18:29 AM			12/2/2009 3:00:33 PM	9/28/2009 12:00:01 AM	9/28/2009 12:00:01 AM	1.5
011455	CORRECTIVE	MAINTENANCE	8/14/2009 10:14:46 AM			12/2/2009 3:02:51 PM	8/17/2009 12:00:01 AM	8/25/2009 12:00:01 AM	6.5
003658	CORRECTIVE	MAINTENANCE	7/7/2009 11:45:20 AM			9/2/2009 2:59:07 PM	7/15/2009 12:00:01 AM	7/15/2009 12:00:01 AM	1.5
017709	CORRECTIVE	MAINTENANCE	9/25/2009 12:54:25 PM			12/2/2009 3:00:46 PM	10/20/2009 12:00:01 AM	10/28/2009 12:00:01 AM	2.5
									616

proposal	category	order type	open date	active date	complete date	closed date	Timecard min date	Timecard max date	total hrs
004890	CALLOUT	MAINTENANCE	7/12/2009 4:55:45 PM			10/1/2009 3:16:08 PM	7/12/2009 12:00:01 AM	8/4/2009 12:00:01 AM	3.5
013796	CALLOUT	MAINTENANCE	8/28/2009 3:12:29 PM			11/5/2009 12:49:29 PM	8/28/2009 12:00:01 AM	8/28/2009 12:00:01 AM	1
007564	CALLOUT	MAINTENANCE	7/25/2009 1:32:53 PM			9/2/2009 2:45:49 PM	7/25/2009 12:00:01 AM	7/25/2009 12:00:01 AM	2.5
003319	CALLOUT	MAINTENANCE	7/6/2009 8:14:21 PM			9/2/2009 2:47:08 PM	7/6/2009 12:00:01 AM	7/6/2009 12:00:01 AM	1
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020779	CALLOUT	MAINTENANCE	10/11/2009 9:53:32 PM			12/2/2009 2:52:40 PM	10/11/2009 12:00:01 AM	10/11/2009 12:00:01 AM	2
015818	CALLOUT	MAINTENANCE	9/11/2009 8:57:30 PM			11/5/2009 12:49:11 PM	9/11/2009 12:00:01 AM	9/11/2009 12:00:01 AM	1
022920	CALLOUT	MAINTENANCE	10/23/2009 8:00:16 PM			12/2/2009 2:50:41 PM	10/23/2009 12:00:01 AM	10/23/2009 12:00:01 AM	1
008124	CALLOUT	MAINTENANCE	7/28/2009 7:45:05 PM			10/1/2009 3:16:09 PM	7/28/2009 12:00:01 AM	7/29/2009 12:00:01 AM	2.5
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005439	CALLOUT	MAINTENANCE	7/14/2009 7:23:31 PM			9/2/2009 2:46:00 PM	7/14/2009 12:00:01 AM	7/14/2009 12:00:01 AM	3
011599	CALLOUT	MAINTENANCE	8/15/2009 5:36:04 PM			10/1/2009 3:15:04 PM	8/15/2009 12:00:01 AM	8/15/2009 12:00:01 AM	1
002872	CALLOUT	MAINTENANCE	7/5/2009 9:15:29 PM			9/2/2009 2:47:13 PM	7/5/2009 12:00:01 AM	7/5/2009 12:00:01 AM	1
016793	CALLOUT	MAINTENANCE	9/20/2009 10:03:23 PM			11/5/2009 12:47:58 PM	9/20/2009 12:00:01 AM	9/20/2009 12:00:01 AM	1
019207	CALLOUT	MAINTENANCE	10/3/2009 11:49:53 AM			11/5/2009 12:47:38 PM	10/3/2009 12:00:01 AM	10/3/2009 12:00:01 AM	3
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011614	CALLOUT	MAINTENANCE	8/16/2009 6:10:54 AM			10/1/2009 3:14:54 PM	8/16/2009 12:00:01 AM	8/16/2009 12:00:01 AM	1
020780	CALLOUT	MAINTENANCE	10/11/2009 9:55:05 PM			12/2/2009 2:52:23 PM	10/11/2009 12:00:01 AM	10/11/2009 12:00:01 AM	2
002870	CALLOUT	MAINTENANCE	7/5/2009 4:20:29 PM			11/5/2009 12:49:17 PM	7/5/2009 12:00:01 AM	7/30/2009 12:00:01 AM	6
012896	CALLOUT	MAINTENANCE	8/23/2009 8:34:42 PM			10/1/2009 3:15:06 PM	8/22/2009 12:00:01 AM	8/23/2009 12:00:01 AM	4
004862	CALLOUT	MAINTENANCE	7/11/2009 2:04:37 PM			9/2/2009 2:46:01 PM	7/10/2009 12:00:01 AM	7/11/2009 12:00:01 AM	3
002854	CALLOUT	MAINTENANCE	7/4/2009 5:57:09 PM			9/2/2009 2:47:10 PM	7/4/2009 12:00:01 AM	7/7/2009 12:00:01 AM	4.5
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021933	CALLOUT	MAINTENANCE	10/18/2009 10:17:06 PM			12/2/2009 2:51:15 PM	10/18/2009 12:00:01 AM	10/18/2009 12:00:01 AM	5
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005659	CALLOUT	MAINTENANCE	7/15/2009 5:09:05 PM			11/5/2009 12:49:25 PM	7/15/2009 12:00:01 AM	7/16/2009 12:00:01 AM	5
021511	CALLOUT	MAINTENANCE	10/14/2009 10:22:59 PM			12/2/2009 2:51:02 PM	10/14/2009 12:00:01 AM	10/14/2009 12:00:01 AM	9
011636	CALLOUT	MAINTENANCE	8/16/2009 12:39:38 PM			10/1/2009 3:15:00 PM	8/16/2009 12:00:01 AM	8/16/2009 12:00:01 AM	1
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008413	CALLOUT	MAINTENANCE	7/30/2009 2:43:14 AM			10/1/2009 3:16:04 PM	7/30/2009 12:00:01 AM	7/30/2009 12:00:01 AM	2.5
014720	CALLOUT	MAINTENANCE	9/6/2009 3:19:08 PM			11/5/2009 12:49:22 PM	9/6/2009 12:00:01 AM	9/6/2009 12:00:01 AM	1
012902	CALLOUT	MAINTENANCE	8/23/2009 9:04:08 PM			10/1/2009 3:15:02 PM	8/23/2009 12:00:01 AM	8/23/2009 12:00:01 AM	1
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002849	CALLOUT	MAINTENANCE	7/4/2009 2:27:09 PM			9/2/2009 2:47:14 PM	7/4/2009 12:00:01 AM	7/4/2009 12:00:01 AM	3
007873	CALLOUT	MAINTENANCE	7/27/2009 9:52:18 PM			11/5/2009 12:49:23 PM	7/27/2009 12:00:01 AM	7/28/2009 12:00:01 AM	2.5
014054	CALLOUT	MAINTENANCE	8/31/2009 5:16:25 PM			10/1/2009 3:15:00 PM	8/31/2009 12:00:01 AM	8/31/2009 12:00:01 AM	0.5
014748	CALLOUT	MAINTENANCE	9/7/2009 3:21:01 PM			11/5/2009 12:49:18 PM	9/7/2009 12:00:01 AM	9/7/2009 12:00:01 AM	1
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006152	CALLOUT	MAINTENANCE	7/19/2009 10:10:12 PM			9/2/2009 2:46:04 PM	7/20/2009 12:00:01 AM	7/20/2009 12:00:01 AM	9
017390	CALLOUT	MAINTENANCE	9/23/2009 8:54:03 PM			11/5/2009 12:47:28 PM	9/22/2009 12:00:01 AM	9/22/2009 12:00:01 AM	1
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016248	CALLOUT	MAINTENANCE	9/15/2009 5:32:46 PM			11/5/2009 12:47:58 PM	9/15/2009 12:00:01 AM	9/15/2009 12:00:01 AM	1
019970	CALLOUT	MAINTENANCE	10/7/2009 10:47:40 PM			12/2/2009 2:52:21 PM	10/7/2009 12:00:01 AM	10/7/2009 12:00:01 AM	2
022564	CALLOUT	MAINTENANCE	10/21/2009 10:19:54 PM			12/2/2009 2:50:45 PM	10/21/2009 12:00:01 AM	10/22/2009 12:00:01 AM	2
014386	CALLOUT	MAINTENANCE	9/2/2009 3:01:18 PM			10/5/2009 2:22:14 PM	9/2/2009 12:00:01 AM	9/2/2009 12:00:01 AM	1
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021882	CALLOUT	MAINTENANCE	10/17/2009 11:13:07 AM			12/2/2009 2:51:08 PM	10/17/2009 12:00:01 AM	10/17/2009 12:00:01 AM	2
006053	CALLOUT	MAINTENANCE	7/17/2009 8:29:16 PM			10/1/2009 3:16:06 PM	7/17/2009 12:00:01 AM	7/21/2009 12:00:01 AM	4
019241	CALLOUT	MAINTENANCE	10/4/2009 8:14:19 PM			11/5/2009 12:47:48 PM	10/4/2009 12:00:01 AM	10/4/2009 12:00:01 AM	1
007580	CALLOUT	MAINTENANCE	7/26/2009 10:55:07 AM			10/1/2009 3:15:59 PM	7/26/2009 12:00:01 AM	7/29/2009 12:00:01 AM	7.5
011590	CALLOUT	MAINTENANCE	8/15/2009 12:48:40 PM			10/1/2009 3:14:59 PM	8/15/2009 12:00:01 AM	8/15/2009 12:00:01 AM	1
021883	CALLOUT	MAINTENANCE	10/17/2009 11:16:10 AM			12/2/2009 2:51:13 PM	10/17/2009 12:00:01 AM	10/17/2009 12:00:01 AM	1
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019731	CALLOUT	MAINTENANCE	10/6/2009 3:17:22 PM			11/5/2009 12:47:49 PM	10/6/2009 12:00:01 AM	10/6/2009 12:00:01 AM	1
022966	CALLOUT	MAINTENANCE	10/25/2009 7:33:38 PM			11/6/2009 9:39:38 AM	10/26/2009 12:00:01 AM	10/27/2009 12:00:01 AM	2
020741	CALLOUT	MAINTENANCE	10/10/2009 11:07:03 AM			12/2/2009 2:52:29 PM	10/10/2009 12:00:01 AM	10/10/2009 12:00:01 AM	2
008408	CALLOUT	MAINTENANCE	7/29/2009 9:37:57 PM			9/2/2009 2:45:48 PM	7/29/2009 12:00:01 AM	7/29/2009 12:00:01 AM	1
004891	CALLOUT	MAINTENANCE	7/12/2009 5:05:04 PM			9/2/2009 2:46:01 PM	7/11/2009 12:00:01 AM	7/12/2009 12:00:01 AM	2
011584	CALLOUT	MAINTENANCE	8/15/2009 9:02:59 AM			10/1/2009 3:15:02 PM	8/15/2009 12:00:01 AM	8/15/2009 12:00:01 AM	2
013825	CALLOUT	MAINTENANCE	8/29/2009 3:58:57 PM			10/1/2009 3:14:55 PM	8/29/2009 12:00:01 AM	8/29/2009 12:00:01 AM	1
002818	CALLOUT	MAINTENANCE	7/3/2009 1:47:13 PM			9/2/2009 2:47:13 PM	7/3/2009 12:00:01 AM	7/3/2009 12:00:01 AM	2
012436	CALLOUT	MAINTENANCE	8/19/2009 8:43:23 PM			10/21/2009 10:44:20 AM	8/19/2009 12:00:01 AM	8/20/2009 12:00:01 AM	7.5
006141	CALLOUT	MAINTENANCE	7/19/2009 11:47:21 AM			9/2/2009 2:46:03 PM	7/19/2009 12:00:01 AM	7/19/2009 12:00:01 AM	2
019515	CALLOUT	MAINTENANCE	10/5/2009 8:02:22 PM			12/2/2009 2:52:37 PM	10/5/2009 12:00:01 AM	10/6/2009 12:00:01 AM	2.5
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016750	CALLOUT	MAINTENANCE	9/19/2009 12:35:36 PM			11/5/2009 12:47:50 PM	9/19/2009 12:00:01 AM	9/19/2009 12:00:01 AM	2
010068	CALLOUT	MAINTENANCE	8/8/2009 2:30:30 PM			10/1/2009 3:15:59 PM	8/8/2009 12:00:01 AM	8/8/2009 12:00:01 AM	2
021934	CALLOUT	MAINTENANCE	10/18/2009 10:18:44 PM			12/2/2009 2:51:12 PM	10/18/2009 12:00:01 AM	10/18/2009 12:00:01 AM	5
007804	CALLOUT	MAINTENANCE	7/27/2009 1:49:34 PM			11/5/2009 12:49:21 PM	7/27/2009 12:00:01 AM	7/27/2009 12:00:01 AM	1
									209

B

APPENDIX

University of Washington
Department of Construction Management

William H Foege Building
Re-Baseline Execution Plan

COBie

SECTIONS

SECTION A
PROJECT INFORMATION

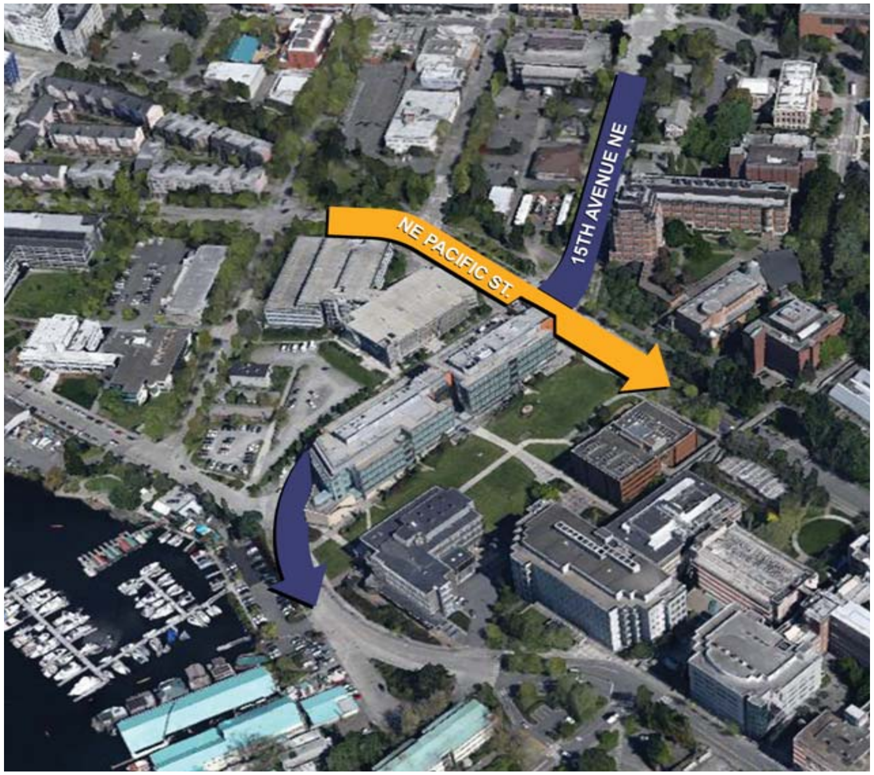
The Bioengineering-Genome Sciences building inaugurated on **March 8, 2006**, by former U.S. President Jimmy Carter and the building was named after **Dr. William H. Foege.** Anshen and Allen of Los Angeles designed the building. The general contractor and construction manager is **Hoffman Construction.** The cost of the building cost was around **$150 million** and has **265,000 square feet** (123,000 dedicated to Bioengineering), including offices, research laboratories, and support facilities.[1]

PROJECT OWNER
College of Engineering
University of Washington, Seattle

PROJECT NAME
W.H. Foege Building
Bio Engineering Building [North]
Genome Sciences Building [South]

PROJECT LOCATION
Department of Bio Engineering
3720 15th Ave NE
Seattle, WA 98105

Department of Genome Sciences
3720 15th Ave NE
Seattle, WA 98105



GEOGRAPHICAL LOCATION
Latitude: 47°39’8.09”N Longitude: 122°18’46.38”W

[1] http://www.engr.washington.edu/about/bldgs/bioe

SECTION A
PROJECT INFORMATION

PROJECT DESCRIPTION

Over the past **150 years**, the University of Washington and the people of Washington state have been working to create one of the most livable, innovative and vibrant university in the country. Facility Services plays a important role in preserving its rich building facilities all through out the **three university campuses** which includes over 500 hundred building with over 20 million gross square footage of space including the University of Washington Plaza, consisting of the 325-foot [99 m] UW Tower and conference center. It's operating expenses and research budget is close to $6.4 billion every year.[2]

Facility services at UW, Seattle has constantly working to upgrade its systems to efficiently process the work orders for the maintenance of the buildings in the campus. **F2 COBie Pilot Phase III** provides a hand in this process by doing a re-baseline process for an existing building in the campus. Foege building is one of the latest addition to this remarkable university and building a COBie data can be a beneficial step in this up-gradation process.

TEAM INFORMATION

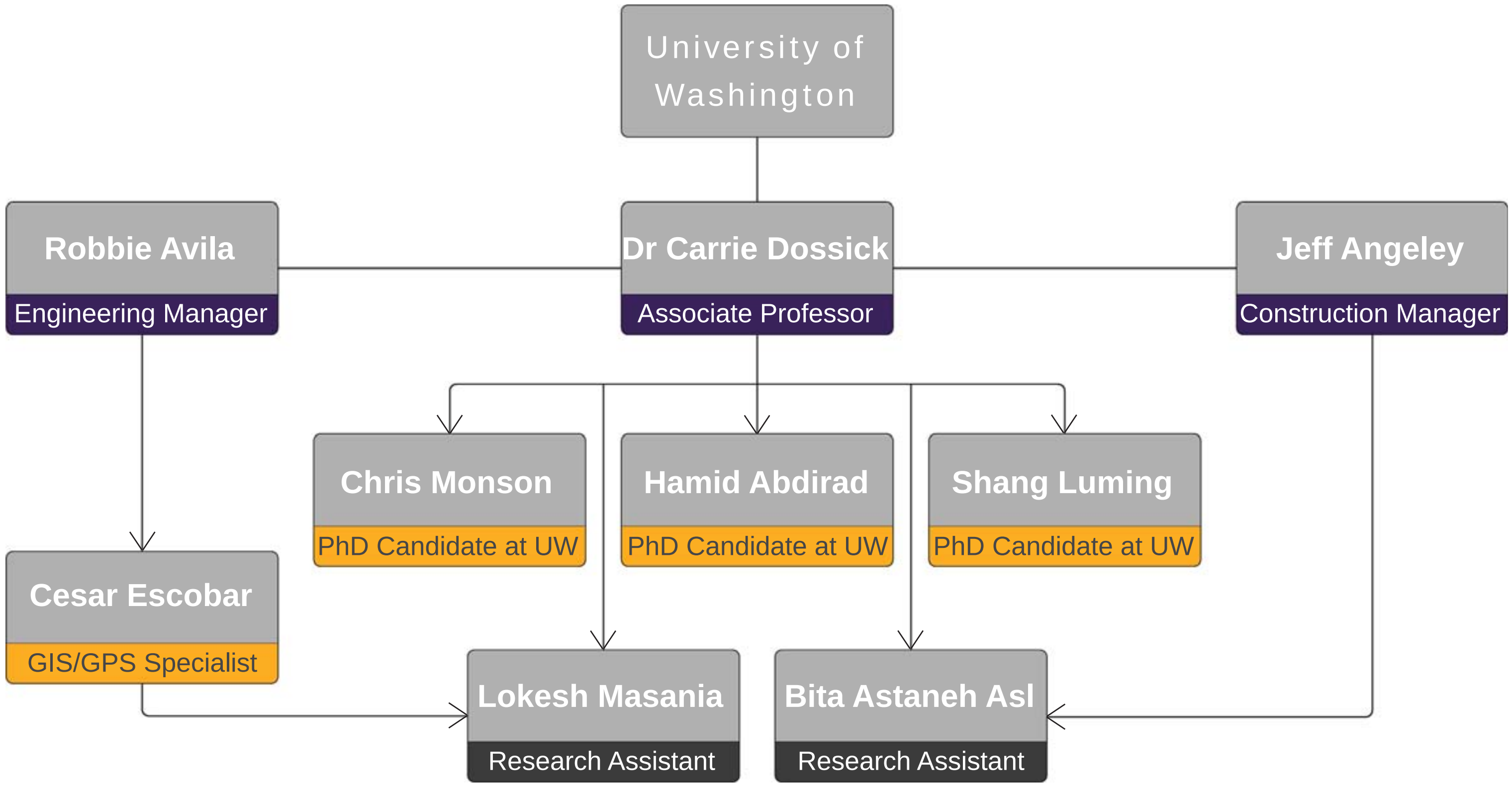
This project will be conducted under the facilitation of the Department of Construction Management at UW in a collaboration with Capital Project Office. As the diagram below shows, there are two projects within this research. First the ARCF work order study will aim at bringing out the data for its efficiency. The second project aims at **Re-Baseline of William H Foege Building**.

[2] http://en.wikipedia.org/wiki/University_of_Washington

SECTION A
PROJECT INFORMATION

TEAM STRUCTURE

Below is the diagram showing the organization chart for this project.



SECTION B
PROJECT CONTACT

TEAM

It is important to know before hand about the people who we need to deal with during this research process. Following are the roles and contact information of the research team for **F2 COBie Pilot project Phase III.**

NAME	ROLE	LOCATION	E-MAIL
Dr. Carrie Dossick	Associate Professor	Department of Construction Management	**cdossick@uw.edu**
Christopher Monson	Research Mentor		**cmonson2@uw.edu**
Jeff Angeley	Sr. Construction Manager	UW Capital Project Office	**angeley@uw.edu**
Robbie Avila	Engineering Manager	FS Campus Engineering	**ravila@uw.edu**
Cesar Escobar	GIS/GPS Specialist		**cesare@uw.edu**
Hamid Abdirad	Research Mentor	Department of Construction Management	**habdirad@uw.edu**
Shang Luming			**ls3053@columbia.edu**
Bita Astaneh Asl	Research Assistant [ARCF & Foege]		**astaneh@uw.edu**
Lokesh Masania			**lmasania@uw.edu**

SECTION C
PROJECT
GOALS

GOALS

Team Goal

To effectively facilitate teamwork between Campus Engineering and Department of Construction Management at University of Washington to produce a high quality technical data, efficiently and in a reasonable cost for the effective use of BIM technologies.

Technical Goal

Build the BIM Revit model for the existing **Dr. William H. Foege** building to generate the COBie data set for the operations and maintenance. Also provide information on **Level of Development [LOD]** about the geometry and data to be included in the model.

Cost Goal

The whole process should be designed in a very efficient and very systematic way so that it takes less working hours for the future researchers to do the re-baseline process for the future projects. Hence, **limiting the cost on the project to be as minimum as possible.**

BIM Goal

Use BIM software to create a 3D and input the data from the record system at UW. After the modeling is completed, it is important to test the model in AiM system at CPO to check the efficiency of the whole project and further **provide better way to improve the process.**

SECTION C
PROJECT GOALS

Collaborative Goal:

Creation of decision matrix for the LOD document for the systems listed in UW asset groups list.

SECTION D
PROJECT PHASING

The table provided explains the roles of the team members and people associated with this research. It also gives an idea about what phase should they be contact so that there is least wastage of time by both the personals.

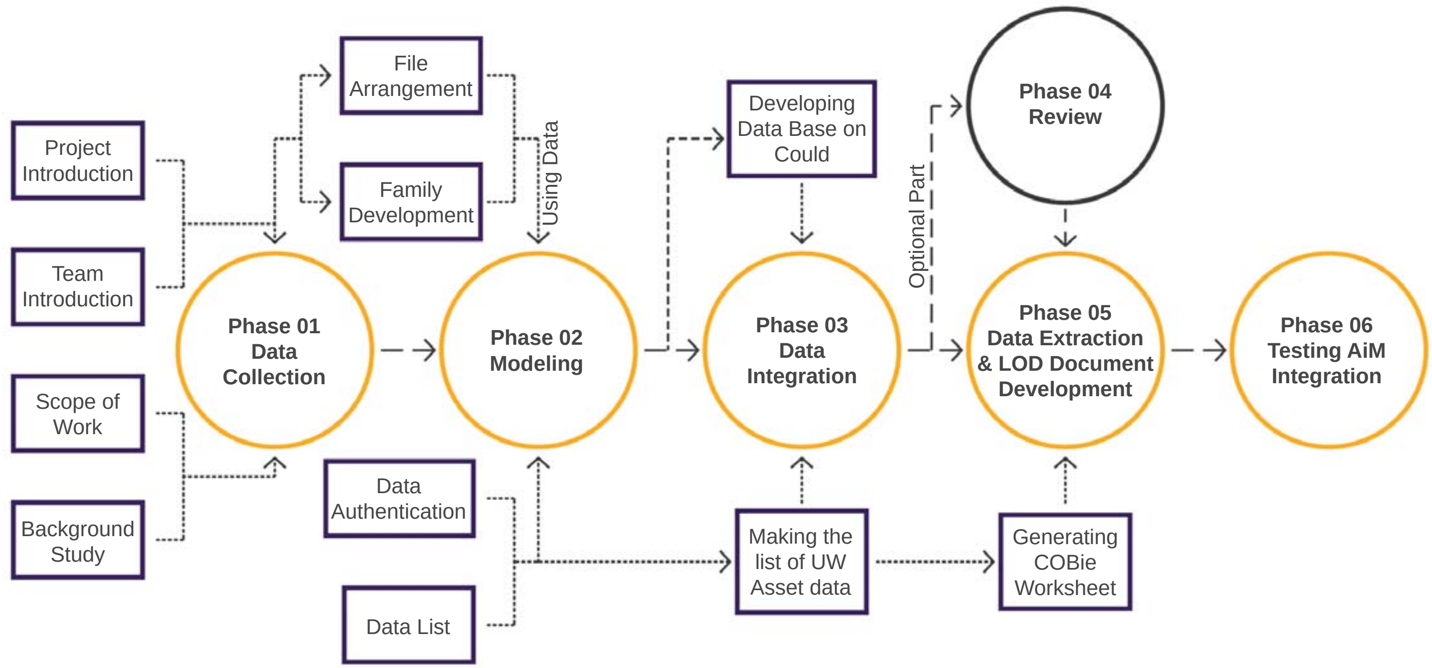
BIM USES	PRIORITY [HIGH/MED/LOW]	RESPONSIBILITIES	AREA
	PHASE 1		
Data Collection	High	Ensure the data collected is As-Built drawings and information of the building.	**Records System**
Manager Meeting	Med	Ensure the scope of work is decided and verification of the data is done	**Facility Services**
	PHASE 2		
Modeling	High	Ensure that the modeling is as per the drawing and higher priority should be given to more important aspects of the building such as MEP.	**BIM Modeling**
	PHASE 3		
Data Integration	High	Ensure that the data input should be accurate and stored in the systematic way.	**BIM Modeling**

Editing Family	High	Ensure that the Revit families are stored separately.	**BIM Modeling**
PHASE 4			
Review	Low	Ensure that unknown systems incorporated in the building are in the system even though if they are missing in the As-Built drawings.	**Facility Services**
PHASE 5			
Data Extraction	High	Ensure that the data extracted is correctly placed in the AiM sys-tem at the time of the first trail and hence make changes if required.	**CPO, BIM Modeling**
LOD Document	Med	Ensure that the LOD document is providing only information which is required by the FS. Hence, elimi-nate the rest of the data.	**LOD**
PHASE 6			
Testing	High	Ensure that the data exported in the AiM system is correctly placed and ready to be used.	**CPO, Facility Services**

SECTION D
PROJECT PHASING

PHASING FLOW CHART

For an efficient project planning for the current pilot project and upcoming projects, it is important to do the brainstorming to minimize the step in the whole process. Diagram below provides the graphical representation of the above mentioned table.



SECTION E
PROJECT ROLE TABLE

The table provided explains the roles of the team members and people associated with this research. It also gives an idea about what phase should they be contact so that there is least wastage of time by both the personals.

MEMBER	PHASE 1	PHASE 2	PHASE 3	PHASE 4	PHASE 5	PHASE 6
Owner [CPO]				X		
Project Lead	X			X		**X**
Research Assistant	X	X	X	X	X	**X**
Campus Engineering			X	X		
Records Department	X					
AiM Department						**X**

BIM USE STAFFING

MEMBER	HIGH PRIORITY BIM USES RESPONSIBLE FOR	NUMBER OF TOTAL STAFF FOR BIM USE	ESTIMATED WORKING HOURS PER WEEK	LOCATION	LEAD
Owner [CPO]	Approving the data built	1	10	CPO, FS	**Robbie Avila**
Project Lead	Providing the project brief and reviewing the work done as per stages.	1	10	Department of Construction Management	**Dr. Carrie Sturts Dossick**
Research Assistant	Modeling, Data Collection, Data Integration, LOD Document, AiM integration	2	20	Department of Construction Management	**Christopher Monson + Lokesh Masania**
Campus Engineering	Providing data information, CAD drawings, O&M manuals	2	5	CPO, FS	**Tony Fragada + Cesar Escobar**
Records Department	Providing up-dated data. Soft-Hard Copy	2	2	UW Records Department	**Virginia Telmo + SunRyoung Kim**

SECTION G
ALLIANCE PROCEDURE

COLLABORATION STRATEGY

There will be weekly team meetings facilitated by **Prof. Carrie Sturts Dossick and the** entire team is required to attend it in order to update everyone with the weekly progress as well as offer collaboration on similar deliverables or challenges.

MEETING PROCEDURES

Weekly meetings will begin with introduction to the agenda followed by team member updates, and finish with questions and plans for moving forward

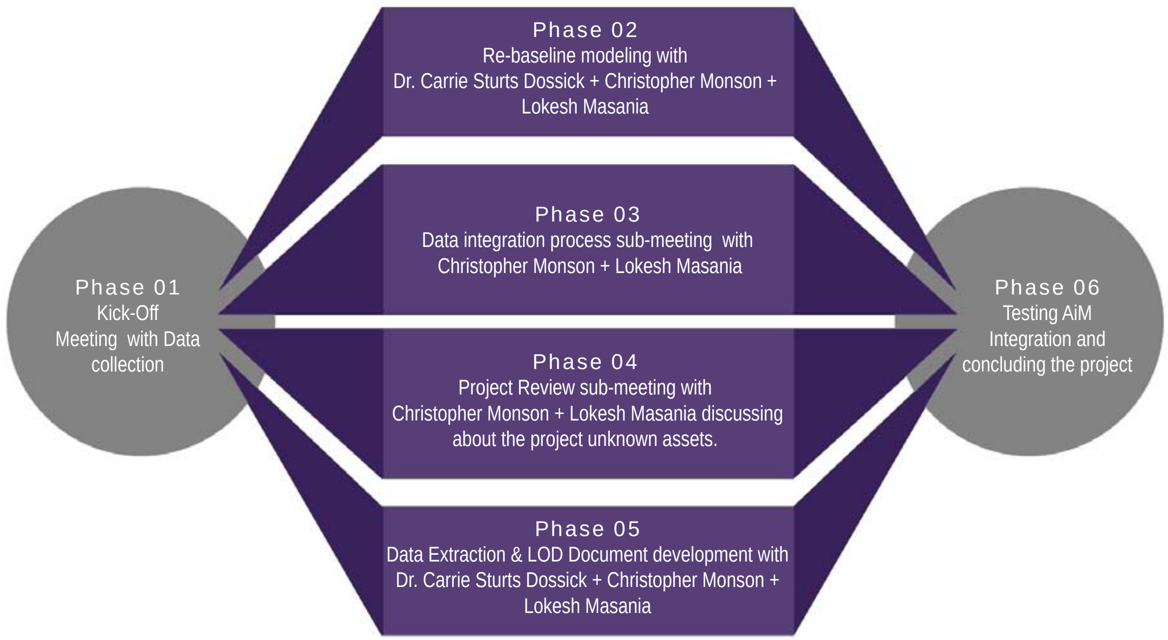
MEETING TYPE	PROJECT STAGE	FREQUENCY [PER WEEK]	PARTICIPANTS	LOCATION
Kick-Off	Phase 1	1	Dr. Carrie Sturts Dossick Christopher Monson Lokesh Masania	**Department of Construction Management**
Project Updates	Phase 2, 3, 4, 5, 6	1	Same as above	**Department of Construction Management**
Sub-Group Meeting	Phase 3, 6	2	Christopher Monson Lokesh Masania	**Department of Construction Management**

Team members are encouraged to meet as often as necessary (minimum once weekly) in order to complete the deliverables expected of them by the project deadline. It is up to the team members to coordinate these meetings.

INTERACTIVE WORKSPACE

All meetings scheduled as described above will be notified by emails and Google calender should be set up for all the updated meeting. Sococo is a program, which allows for the creation of a virtual office and team members are open to use for the sub group meetings. This platform provides verbal as well as visual conversations and we can share documents in order to optimally explain or demonstrate project updates or challenges. Department of Construction Management's meeting room will be reserved in the beginning of the quarter by the team.

PROCESS OVERVIEW



SECTION H
TECHNOLOGY REQUIRED

SOFTWARE

BIM USE	DISCIPLINE	SOFTWARE	FILE FORMAT
3D Modeling	Architecture + MEP	Revit 2015	**.rvt**
Drawing	Architecture + MEP	AutoCAD	**.dwg**
O & M	Architecture + MEP	Adobe Reader	**.pdf**
Tutorials	MEP	MS Media Player	**.avi**
LOD	Architecture + MEP	MS Excel	**.exl**

HARDWARE

BIM USE	OPERATING SYSTEM	OWNER OF HARD-WARE	SPECIFICATIONS
3D Modeling	Microsoft® Windows Server® 2012 R2 64-bit	FS Campus Engineering	**Minimum of 4+ cores 2.6 GHz, Minimum of 4 GB RAM memory, Min-imum of 7,200+ RPM Hard Drive**
MS Excel	Microsoft® Windows Server® 2012 R2 64-bit	FS Campus Engineering	

SECTION I
MODEL STRUCTURE

For Example – light fixture:

+ **100** cost/sf attached to floor slabs
+ **200** light fixture, generic/approximate size/shape/location
+ **300** Design specified 2x4 troffer, specific size/shape/location
+ **350** Actual model, Lightolier DPA2G12LS232, specific size/shape/location
+ **400 As 350**, plus special mounting details, as in a decorative soffit

FILE NAMING STRUCTURE

Files should be named according to their discipline (titles listed below), date (Day. Month. Year), draft number, authoring university abbreviation (as established above), and author's first name.

FILE TOPIC	DISCIPLINE CODE
Architectural Model	ARCH
Electrical Lighting Model	ELEC_LIGHT
Electrical Power Model	ELEC_POWER
Plumbing Model	PLUM
Mechanical Model	MECH

For example - **UW_ARCH_04022015_<Model Type>_Lokesh**

BIM & CAD STANDARDS

The Level of Development (LOD) framework that addresses several issues that arise when BIM/Revit is used as a communication or collaboration tool, i.e., when someone other than the author extracts information from it. For this project the LOD varies from 100 – 300 only.

MODEL STRUCTURE

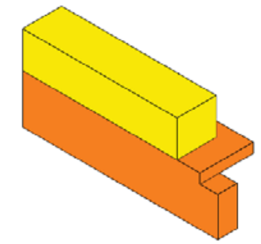
This project have different disciplines required to be detailed out. The correct level of detail will project a better information for the 4D modeling. Therefore, it is important to decide the level of development of the model. Following are the description of the LOD for different disciplines in general.

SECTION I
MODEL STRUCTURE

FUNDAMENTAL LOD DEFINITION

LOD 100

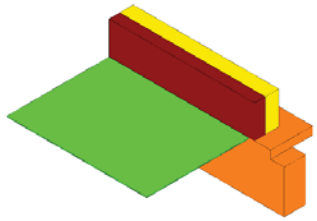
The Model Element may be graphically represented in the Model with a symbol or other generic representation, but does not satisfy the requirements for LOD 200. Information related to the Model Element (i.e. cost per square foot, tonnage of HVAC, etc.) can be derived from other Model Elements.



LOD-100 Exterior Wall Veneer

LOD 200

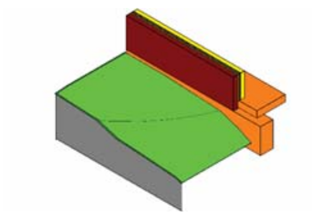
The Model Element is graphically represented within the Model as a generic system, object, or assembly with approximate quantities, size, shape, location, and orientation. Non-graphic information may also be attached to the Model Element.



LOD-200 Exterior Wall Veneer

LOD 300

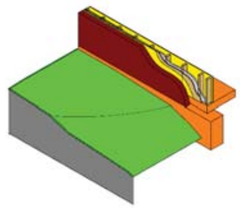
The Model Element is graphically represented within the Model as a specific system, object or assembly in terms of quantity, size, shape, location, and orientation. Non-graphic information may also be attached to the Model Element.



LOD-300 Exterior Wall Veneer

LOD 350

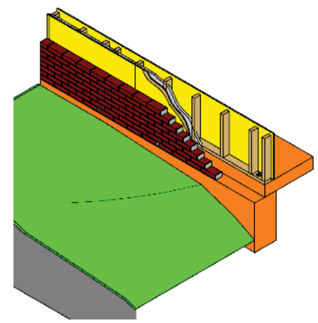
The Model Element is graphically represented within the Model as a specific system, object, or assembly in terms of quantity, size, shape, orientation, and interfaces with other building systems. Non-graphic information may also be attached to the Model Element.



LOD-350 Exterior Wall Veneer

LOD 400

The Model Element is graphically represented within the Model as a specific system, object or assembly in terms of size, shape, location, quantity, and orientation with detailing, fabrication, assembly, and installation information. Non-graphic information may also be attached to the model element.



LOD-400 - 500
Exterior Wall Veneer

LOD 500

The Model Element is a field verified representation in terms of size, shape, location, quantity, and orientation. Non-graphic information may also be attached to the Model Elements.[3]

UW Asset Group	Asset Group Description	LOD Level	Foege Building
D10151001	Elevator, Cable, Electric, Passenger / Freight	100	X
D10151101	Elevator, Hydraulic, Passenger / Freight	100	X
D10153101	Wheelchair Lift	100	X
D10251001	Escalator, Electric	100	X
D10951001	Dumbwaiter, Electric	100	X
D10952001	Pneumatic Tube System	100	X
D20151005	Showers	100	X
D20251201	Valve, Butterfly, Above 4"	300	X
D20251251	Valve, Check, Above 4"	300	X
D20251301	Valve, Ball, Above 4"	300	X
D20251401	Valve, Gate, Above 4"	300	
D20251451	Valve, Globe, Above 4"	300	
D20251551	Valve, Os And Y, Above 4"	300	
D20252603	Water Heater, Steam 2500 Gal.	100	
D20252621	Valve, Pressure Relief, Above 4"	100	

[3] Level of Development, Specification, Version: 2014

D20252651	Valve, Pressure Regular, Above 4"	100	
D20252701	Valve, Sediment Strainer, Above 4"	100	
D20959051	Duplex Sump	100	
D30253102	Pump, Condensate Return, Over 1 H.P.	100	
D30253103	Pump, Condensate Return Unit, 2 Pumps	100	
D30351701	Evaporative Cooler	100	
D30451201	Fan Coil Unit	100	
D30451601	Vav Boxes	100	
D30451701	Fire Dampers	100	
D30454201	Pump W/ Oil Reservoir, Electric	100	
D30456001	Heat Exchanger, Steam	100	
D30551103	Unit Heater, Steam	100	
D30651001	Controls, Central System, Electro/Pneumatic	100	
D30952101	Steam Humidification System	100	
D40151501	Extinguishing System, Wet Pipe		
D40151801	Extinguishing System, Deluge / Preaction		
D40153101	Extinguishing System, Dry Pipe		
D40951001	Extinguishing System, Co2		
D40954001	Extinguishing System, Dry Chemical		
D40954501	Extinguishing System, Halon		
D50152101	Switchboard		
D50152141	Switchboard, With Air Circuit Breaker		
D50152171	Switchboard, With Air Circuit Breaker And Tie Switch		
D50152201	Circuit Breaker, High Voltage Air		
D50152221	Circuit Breaker, High Voltage Oil		
D50152301	Switch, Selector, High Voltage, Air		
D50152321	Switch, Selector, High Voltage, Oil		
D50152341	Switch, Automatic Transfer		
D50152361	Switch, Interrupt, High Voltage, Fused Air		
D50152381	Switch, Interrupt, High Voltage, W/ Aux Fuses, Air		
D50152401	Transformer, Dry Type 500 Kva And Over		

D50152402	Transformer, Oil Pad Mounted		
D50152403	Transformer, Oil Pad Mounted, Pcb		
D50152601	Panelboard, 225 A And Above		
D50356101	Central Clock Systems		
D50357101	Fire Alarm Annuciator System		
D50358101	Security, Intrusion Alarm System		
D50952101	Generator, Emergency Diesel Or Gas, Up To 15 Kva		
D50952102	Generator, Emergency Diesel Or Gas, Over 15 Kva		
D50952401	Battery System And Charger		
E10351001	Hydraulic Lift		
E10951261	Hoist / Winch, Chain / Cable, Electric		
E10953021	Beverage Dispensing Unit		
E10953321	Disposal, Garbage, Electric		
E10953501	Kettle, Steam, Fixed Or Tilt		
G30151161	Water Flow Meter, Turbine		
G30151264	Pump, Mixed Or Axial Flow		
G30151265	Pump, Reciprocating Displacement		
G30151267	Pump, Sump, Up To 1 H.P.		
G30151269	Pump, Vacuum		
G30154101	Fire Hydrant		
G30154201	Valve, Post Indicator		
G30156321	Reverse Osmosis System		
G30156501	Water Softner		
G30254101	Ejector, Sewage		
G30254122	Ejector Pump, Sump Type		
G40951101	Cathodic Protection System		
UW1000000	Backflow Prevention Device		
UW1000001	Boiler (Pv)		
UW1000002	Chiller, Air Cooled		
UW1000003	Chiller, Water Cooled		
UW1000004	Door, Exterior		

UW1000005	Door, Interior		
UW1000006	Fan, Axial		
UW1000007	Fan, Centrifugal		
UW1000008	Door, Fire		
UW1000009	Sewage Lift Station		
UW1000010	Showers, Emergency		
UW1000011	Fire Pump		
UW1000012	Heat Pump, Air Cooled		
UW1000013	Heat Pump, Water Cooled		
UW1000014	Ice Machine, Air Cooled		
UW1000015	Ice Machine, Water Cooled		
UW1000016	Light, Emergency		
UW1000017	Light, General Use		
UW1000018	Motor Control Center		
UW1000019	Refer, Air Cooled		
UW1000020	Refer, Water Cooled		
UW1000021	Uninterrupted Power System		
UW1000022	Cooling Tower, Open Loop		
UW1000023	Cooling Tower, Closed Loop		
UW1000024	Water Heater (Pv)		
UW1000025	Water Heater, Electric		
UW1000026	Steam/Hot Water Converter		
UW1000027	Air Handling Unit		
UW1000028	Auto Scrubber, Ride On		
UW1000029	Auto Scrubber, Walk Behind		
UW1000030	Vacuum, Back-Pack		
UW1000031	Vacuum, Upright		
UW1000032	Vacuum, Wet-Dry		
UW1000033	Vacuum, Cordless		
UW1000034	Buffer, 16"		
UW1000035	Buffer, 19"		

UW1000036	Extractor, Under 19 Gallon		
UW1000037	Extractor, Under 27 Gallon		
UW1000038	Extractor, Under 28 And Larger Gallon		
UW1000039	Restroom Cleaner		
UW1000040	Burnisher, Battery		
UW1000041	Burnisher, Corded		
UW1000042	Upholstery Cleaner		
UW1000043	Carpet Extractor, Compact		
UW1000044	Carpet Extractor, Battery		
UW1000045	Back Pack Sprayer, Battery		
UW1000046	Ropes, Window Wash		
UW1000047	Harness, Window Wash		
UW1000048	Swing Stage, Window Wash		
UW1000049	Bowsain Chair, Window Wash		
UW1000050	Rope Grap, Window Wash		
UW1000051	Rolling Hook, Window Wash		
UW1000052	Stack Ladder, Window Wash		
UW1000053	Lanyards, Window Wash		
UW1000054	Telephone, Emergency		
UW1000055	Telephone, Emergency, Code Blue		
UW1000056	Refer, Domestic		
UW1000057	Refer, Ultra		
UW1000058	Recovery Cylinder, 30 Lbs		
UW1000059	Recovery Cylinder, 100 Lbs		
UW1000060	Recovery Cylinder, 125 Lbs		
UW1000061	A/C, Server Room, Air Cooled		
UW1000062	A/C, Server Room, Water Cooled		
UW1000063	Fire Alarm System		
UW1000064	Smoke Detectors		
UW1000065	Fire Alarm Dialer		
UW1000066	Fire Alarm Receiver		

UW1000067	A/C, Water Cooled		
UW1000068	A/C, Air Cooled		
UW1000069	Elevator		
UW1000070	Air Dryer		
UW1000071	Air Compressor		
UW1000072	Fan, Exhaust		
UW1000073	Fan, Supply		
UW1000074	Loading Dock Leveler		
UW1000075	Pump, Condensate Air		
UW1000076	Pump, Condensate Steam		
UW1000077	Pump, Sump		
UW1000078	Refrigeration		
UW1000079	Departmental Equipment (Asset)		
UW1000080	Generator		
UW1000081	Grounds Maintenance Equipment		
UW1000082	Heavy Equipment		
UW1000083	Fire Extinguisher		
UW1000084	Air Seperator (Pv)		
UW1000085	Chiller (Pv)		
UW1000086	Economizer (Pv)		
UW1000087	Heat Exchange (Pv)		
UW1000088	Jacketed Kettle (Pv)		
UW1000089	Refrigeration (Pv)		
UW1000090	Tank (Pv)		
UW1000091	Unfired (Pv)		
UW1000092	Pump, Circulation		
UW1000093	Uw Campus Art Collection		
UW1000094	Door, Roll Up, Interior		
UW1000095	Door, Roll Up, Exterior		
UW1000096	Condenser Unit, Air Cooled		
UW1000097	Unit Heaters, Cabinet, Electric		
UW1000098	Air Unit, Make Up		

UW1000099	Panel Pcm Ctr Main		
UW1000100	Xfmr Dry <500kva		
UW1000101	Drive Variable Speed		
UW1000102	Return Fans		
UW1000103	Intake Hoods		
UW1000104	Supply, Return, Relief & Exhaust Fans		
UW1000105	Coils, Heating		
UW1000106	Circuit Breaker, Medium Voltage, Air		
UW1000107	Circuit Breaker,Low Voltage, Air		
UW1000108	Unit Heater (Gas)		
UW1000109	Terminal Unit		
UW1000110	Roof Ventilator		

SECTION J
QUALITY CONTROL

Overall Strategy/ Quality Control Checks

The following checks will be performed to assure quality and members will seek to capture the process as we proceed through the project.

CHECKS	DEFINITION	MEMBER	SOFTWARE PROGRAM(S)	FREQUENCY
Visual Check	Ensure there are no unintended model components and the design intent has been followed	Lokesh Masania	Revit	**Upon receiving new draft.**
Interference Check	Detect problems in the model where two building components are clashing including soft and hard	Christopher Monson Lokesh Masania	Revit	**Upon receiving new draft.**
Standards Check	Ensure that the BIM and AEC CADD Standard have been followed (fonts, dimensions, line styles, levels/layers, etc)	Christopher Monson Lokesh Masania	Revit	**Upon receiving new draft.**
Model Integrity Checks	Describe the QC validation process used to ensure that the Project Facility Data set has no undefined, incorrectly defined or duplicated elements and the reporting process on non-compliant elements and corrective action plans	Christopher Monson Lokesh Masania	Revit	**Upon receiving new draft.**

SECTION J
QUALITY CONTROL

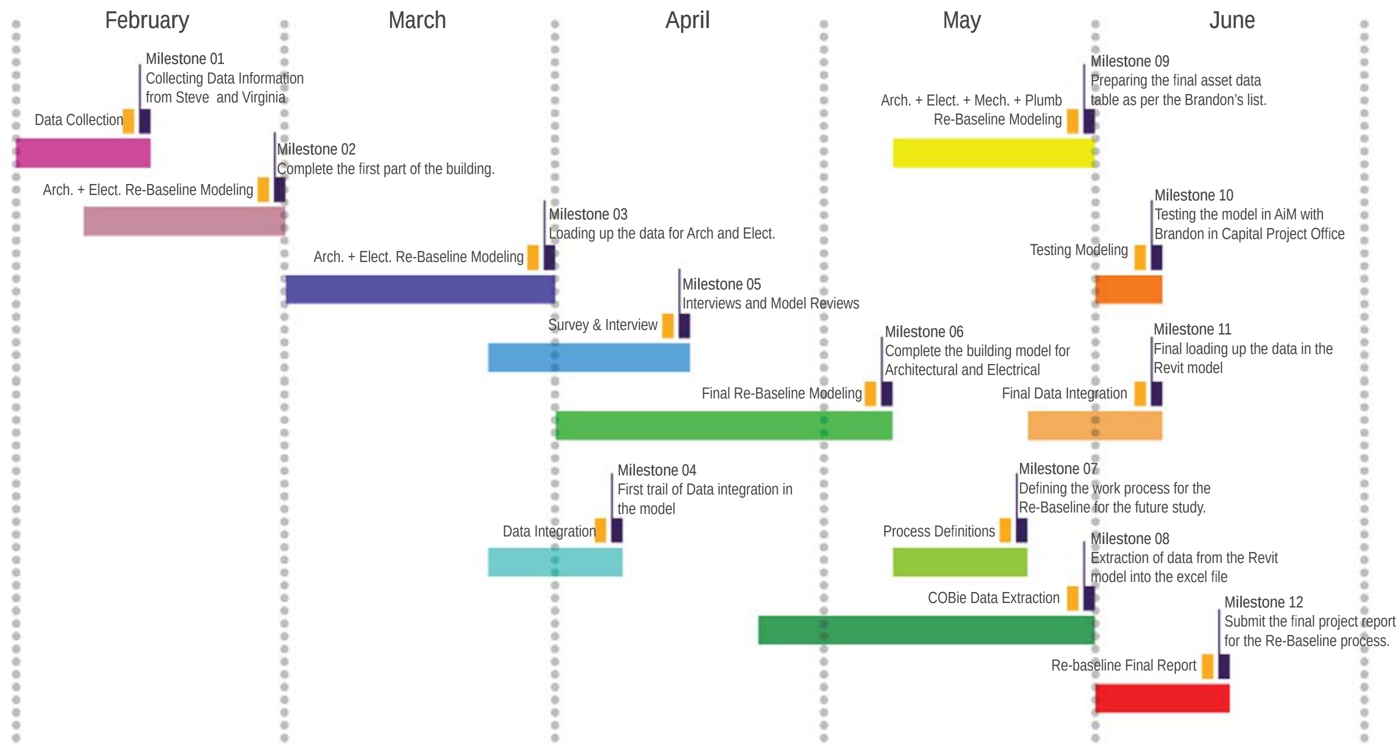
MODEL ACCURACY AND TOLERANCES

Models should include all appropriate dimensioning as needed for design intent, analysis, and construction. Level of detail and included model elements are provided in the Information Exchange Worksheet in Appendix **.

PHASE	DISCIPLINE	TOLERANCE
Design Model	Architectural	**Existing structural columns and beams were modeled on the basis of SBC of the location. Footprint of the masonry structure is approximate based on data provided. Light fixtures, plumbing fixtures and toilet accessories are accurately located but the objects are not representative of the actual fixtures.**
Electrical Model	Electrical	**All structural system components shall be fully coordinated by the contractor's prior to installation. What is specified and shown in the model is not necessarily what will be submitted, approved, and or installed. Due to the scale of the drawings bid/CD drawings are diagrammatic in nature.** **The creation of a 3D model in REVIT is done to assure that the major coordination issues can be resolved prior to installation; the 3D model will then be passed onto the respective teams for their use in creating the as-built model with updated information and content, at a scale suitable to reflect the installation clearly on a printed sheet.**

SECTION K
PROJECT
SCHEDULE

MILESTONES



Phase 01 10%	Phase 02 30%	Phase 03 50%	Phase 04 60%	Phase 05 80%	Phase 05 100%
Ensure the data collected is As-Built drawings and information of the building. Ensure the scope of work is decided and verification of the data is done	Ensure that the modeling is as per the drawing and higher priority should be given to more important aspects of the building such as MEP.	Ensure that the data input should be accurate and stored in the systematic way. Ensure that the Revit families are stored separately.	Ensure that unknown systems incorporated in the building are in the system even though if they are missing in the As-Built drawings.	Ensure that the data extracted is correctly placed in the AiM system at the time of the first trail and hence make changes if required. Ensure that the LOD document is providing only information which is required by the FS. Hence, eliminate the rest of the data.	Ensure that the data exported in the AiM system is correctly placed and ready to be used.

SECTION L PROJECT EXCLUSION

The tables provide below enlists the objects that are not in the scope of work for this project. It should be noted that there is no **structural systems** in the **UW Asset List** and therefore is not included in this project.

Architectural Systems		Notes
Door Hardware	Not to be included in the model	**Use LOD 100 for doors**
Window Harware	Not to be included in the model	**Use LOD 100 for windows**
Walls Finish	Material is not required to be included in the model	**Use generic walls types**
Flooring	Not to be included in the model	
Ceiling	Material is not required to be included in the model	**Use generic ceiling types**
Furniture	Not to be included in the model except in the auditorium hall.	

Electrical Systems		Notes
Layout	Wire layout is not to be included in the model	
Fitting	Not to be included in the model	**Use LOD 100 for Equipments**
Switch Boards	Not to be included in the model	**Use generic symbols**
Lighting Equipment	Not to be included in the model	**Use only generic models**

Mechanical Systems		Notes
Ducking	Not fixtures to be included in the model	**Use generic duct types**
Insulations	Not to be included in the model	**Use generic duct types**

Plumbing Systems		Notes
Fixtures	Not to be included in the model unless mentioned in the scope of work	**Use generic plumbing types**

SECTION M
PROJECT DELIVERABLE

In this section, list the BIM deliverables for the project and the format in which the information are listed below.

Items	Responsible Party	Deadlin
Data collected report	Lokesh Masania	15th Feb 2015
Re-Baseline model Part 01	Lokesh Masania	28th Feb 2015
First draft Re-Baseline model for the complete building	Lokesh Masania	25th March 2015
COBie data worksheet for the complete building	Lokesh Masania	10th April 2015
Survey and Interviews	Lokesh Masania	20th April 2015
Final Re-Baseline model for the complete building	Lokesh Masania	10th May 2015
Testing part of the model	Lokesh Masania	31st May 2015
Testing the model in AiM	Lokesh Masania	5th June 2015
Report on AiM test	Lokesh Masania	8th June 2015
Re-Baseline final report	Lokesh Masania	10th June 2015

C

APPENDIX

CM 700 Thesis Survey

Clash Between 2D Vs 3D Data for Facility Management

Name:
Date:
Time [start & end]:

Read to participants

Anything you say may be recorded but will not be shared or used outside of this research study. Information that could link you to your employer will not be recorded. Upon completing the dataset for this study all original information will be destroyed. If you feel uncomfortable sharing information you may say pass.

Personal Information

Age

☐ 20-30 ☐ 31-40 ☐ 41-50 ☐ >50

Background

Architecture ☐
Civil Engineer ☐
Electrical ☐
Mechanical ☐
Others ☐

Years in construction

☐ 1-5 ☐ 6-10 ☐ 11-15 ☐ >15

Skill Level

1. Rate your general computer proficiency

2. Number of hours you work in office or site [weekly]

3. How much time do you spend on records during your working hours during the week?

4. Are you aware of what Building Information Modeling is?

5. What are the benefits you aware of about BIM?

6. Are you aware of the different levels of BIM LOD standards?

7. If 'Yes', what are the level(s) of BIM are you aware of?

8. Do you agree that adopting BIM can bring more direct cost saving and improve efficiency to smaller practices than their larger counterparts?

Asset Information

1. Are you aware about the UW asset set of your respective field?

2. Do you think, the components in the UW asset list are relevant for the operation purpose?

3. Do you think, the information required in the UW asset list are relevant?

4. How much time do you refer to the UW asset list during your official hours of working?

5. Do you think there is a need to revise the UW asset list for the future projects?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
Strong Weak

6. What are the suggestions that should be added in the list?

....

....

Level of Development

1. Rate your knowledge of LOD in BIM models provided?

2. Do you prefer 2D over 3D type of information for O&M?

3. Do you think 3D is more accurate information than 2D type?

4. Do you think 3D information is the future?

5. Rate the type of data provided in the model provided?

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
Strong Weak

6. How much is the relevance of this study in your professional field?

7. What LOD do you prefer in your respective field?

8. Will you or are thinking of incorporating BIM in the future

in your work?

9. What LOD will you prefer in your respective field?

☐ 100 ☐ 200 ☐ 300 ☐ 400 ☐ 500

What are the things that are missing according to you experience?

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10. Will you or are thinking of incorporating BIM in the future in your work?

11. If the given information was provided early how much would you use it?

Thank you for your participation.

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