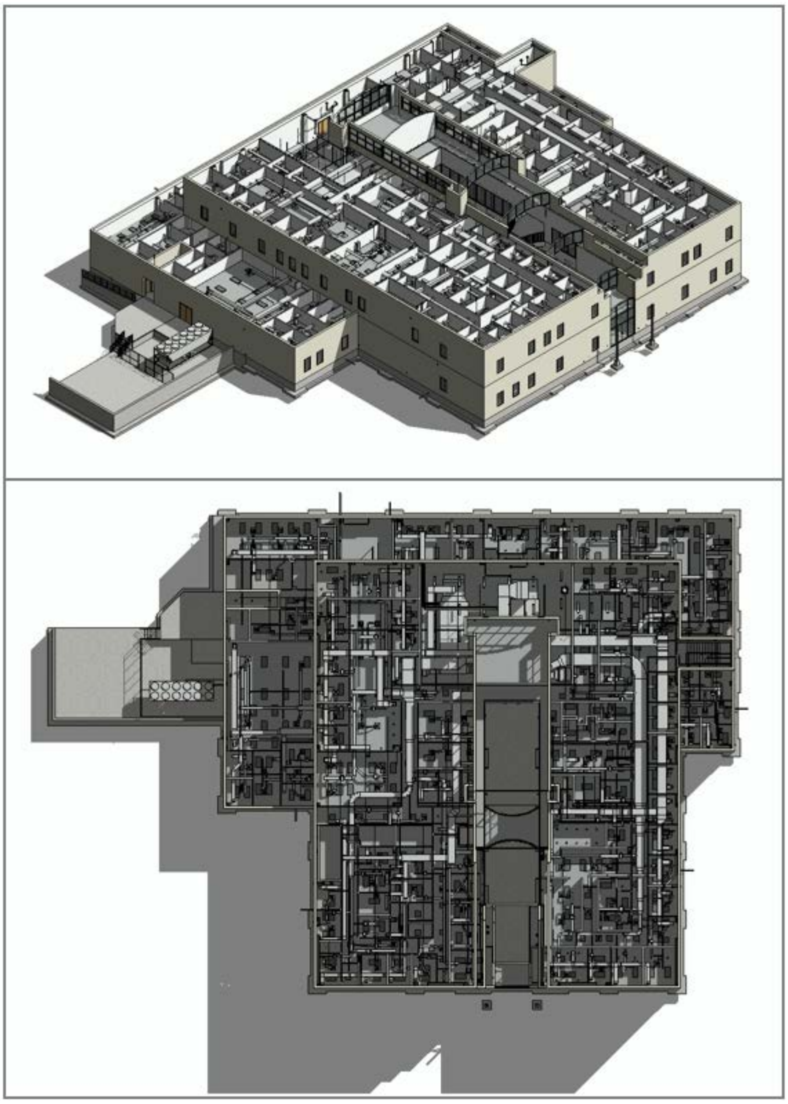
BIM FOR FACILITY MANAGEMENT

Version 2.1



Prepared for the BIM-FM Consortium

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Background

BIM has transformed architecture, engineering and construction. However the great potential of BIM is to provide accurate, timely and relevant information not just during design and construction for a single building, but also throughout the lifecycle of an entire portfolio of facilities. The use of BIM technology in the operational phase of a building's lifecycle is just beginning to take hold as building owners look for new ways to improve the effectiveness of their facility operations.

Purpose

The BIM FM Consortium is a special interest group with the purpose of creating practical and pragmatic guidelines that can help guide the facilities management profession from theory to practice in the use of BIM for the building lifecycle.

TABLE OF CONTENTS

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1 THE BIM FM CONSORTIUM

1.1 BIM CONSORTIUM

In order to more fully understand the current operationalization of BIM in Facility Management, FM:Systems partnered with Georgia Institute of Technology to develop a group of BIM FM users and work with them to understand their issues, successes and failings. The development of this guide was steered by these Consortium members' input. Their contributions provided the data and feedback to make this Guide a snapshot of current BIM use in facility management. Users, providers and researchers worked together to better understand issues and provide guidance as a result.

The BIM in FM Consortium began work in early 2015 to discuss what members perceived could be missing from current literature on BIM in FM. Ideally, the group wanted to write a guide to share experiences and expertise that others could utilize. An initial one year timeline was set and input from additional BIM in FM users was also included in a survey to identify issues. This brought additional industries, experience and levels of users into the information pool.

1.2 BIM CONSORTIUM COMPOSITION

BIM FM Consortium participating organizations who provided input and review for this guide are as follows:

- RSP i_SPACE
- Little Diversified Architectural Consulting
- CADD Microsystems
- SmithGroupJJR
- Christner
- Boston Scientific
- Xavier University
- Ridgeview Medical Center
- Autodesk
- FM:Systems
- Georgia Tech
- Kennesaw State University
- Turner Construction
- DPR Construction

Georgia Tech University was the research collaborator for this guide with Professor Kathy Roper providing general oversight and guidance.

1.3 THE BIM CONSORTIUM SURVEY

As part of the research portion of the Consortium's work, a survey of BIM in FM use and issues was prepared by Consortium members. The participants of the survey were solicited to ensure broad responses in order to identify unique issues by industry or other key concerns. Participants were targeted towards current BIM and FM primary users, large corporations, healthcare, higher education and others who could potentially provide insights on the use of BIM in operations. The Health Care Institute of IFMA and the Campus Facility Technology Association (CFTA) were included in this survey and members provided a unique health care and higher education viewpoint in some areas.

1.4 SURVEY METHOD

The purpose of the primary survey results which are shared in this guide was to gather feedback on how building owners are managing and categorizing their facilities assets. The survey was conducted from 8/24/2015-9/28/2015 with 116 participants completing the survey.

1.4.1 SURVEY FINDINGS

Most of the survey results were not a surprise, but validation of expectations Consortium members had discussed prior to the survey. Facility Managers/Directors were by far the largest job title of respondents to the survey, at 24.5%, as expected. The next largest category of job titles were in the "Other" category. Many of these could have been re-categorized into listed titles, but this raw response demonstrated the diversity of job titles still found in FM. Space Planner, Architectural Drafter, BIM Manager and Administrative Assistant with CAFM admin/management responsibilities were just a few. While it is gratifying to note that several BIM Manager's or similar titles were now in use by respondents, these titles identify specializations in FM that in many cases may replace older titles like CAD Drafter, Facilities Technical Specialist or other early titles for technologists in FM.

It was also important to note that a few Senior VP's, Chief Executives and Financial Directors also responded to the survey, demonstrating the level of importance that BIM is gaining in organizations. We suspect that these senior management respondents are highly interested in the value and savings that BIM can ultimately bring to the FM function and they are aware of BIM's contribution in this area which is good news for the prospects of BIM in FM use.

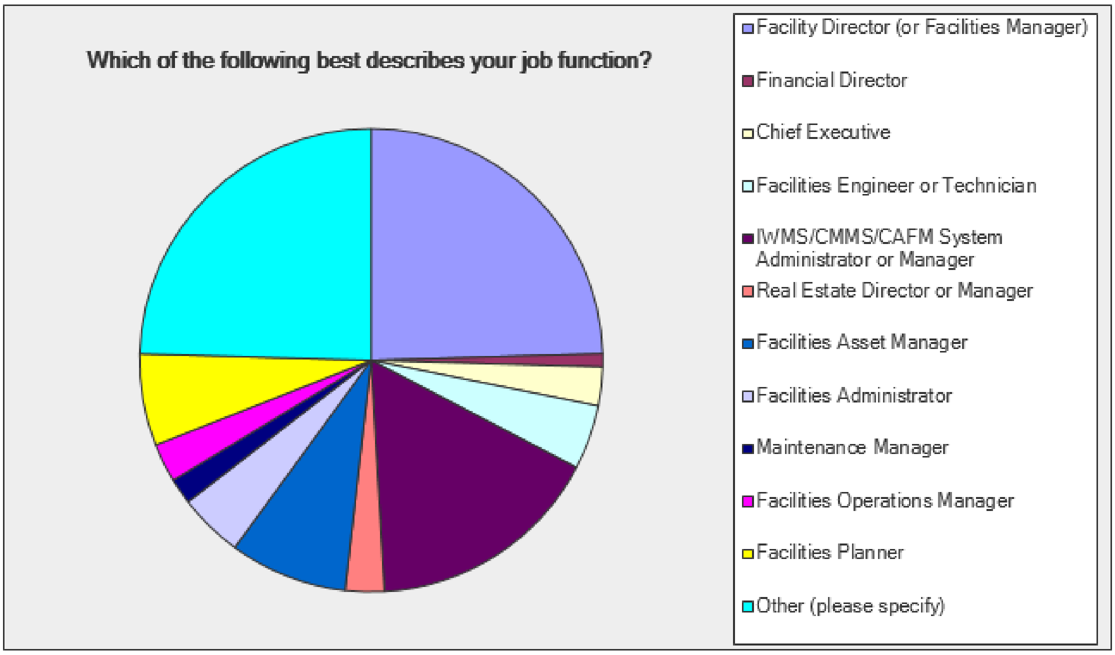

Figure 1 - BIM FM Consortium survey results showing surveyed job roles

Validation of expectations for industry utilization of BIM in FM was also confirmed with 33% of responses coming from the education industry and 25% from healthcare. Currently, the largest users of BIM are in these growth and expansion industries. Corporates and smaller organizations have not had as much new build opportunity and typically their facilities are not as large or complex.

Government was a third place respondent at nine percent, although many large government projects are now mandated to utilize BIM from concept through operations.

One somewhat surprising finding from the survey was that just over half of respondents manage more than 50 buildings. The Consortium expected primarily large users, but 74% of respondents monitored more than 10 buildings. Limited use of BIM in smaller portfolios was not necessarily expected which could be another relationship based on value in these busier organizations.

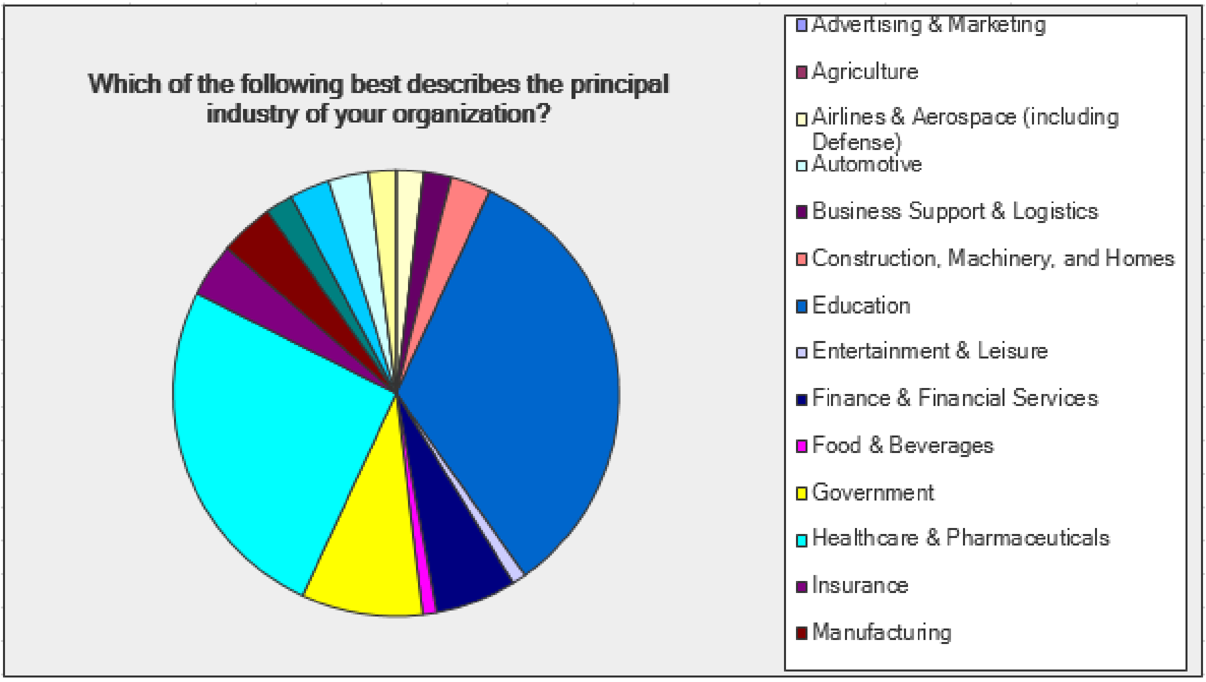

Figure 2- BIM FM Consortium survey results showing surveyed organizations

2 Principles of BIM for Facility Management

2.1 Introduction

Over the past decade many building owners have adopted Building Information Modeling (BIM) as a core part of their design and construction process. The next step for the building owners is to expand the use of BIM to the entire lifecycle of their facilities.

Developing a plan to implement Lifecycle BIM is essential to success for facilities owners. Although implementing a BIM plan works best when invoked at the beginning of a project, there is value in undertaking the plan at any stage of the design, construction or occupancy lifecycle.

The plan should address three main issues:

- The information needed in the model to support building operations and lifecycle planning.
- The process and responsibilities for creating and maintaining that data.
- When the data should be gathered and which methods should be used to populate the model.
- The level of model information that needs to be incorporated into the actual model including both graphical and data elements.

This document will serve as a guide in using BIM for ongoing building operations throughout a building's lifecycle.

2.2 BIM Uses for Facilities Management

Lifecycle BIM is the practice of creating, maintaining and utilizing building information to manage operations and maintenance of buildings throughout their operational lifecycles. Facility managers are finding value in a number of areas of building operations that benefit from enhanced data. Some areas of value are as follows:

- Improved Space Management
  By understanding the details of how space is used, facility professionals can reduce vacancy and ultimately achieve major reductions in real estate expenses. The room and area information in BIM models are the foundation for good space management.

- Streamlined Maintenance
  The key challenge in developing a maintenance program is entering the product and asset information required for preventive maintenance. The information about building equipment stored in BIM models can eliminate months of effort to accurately populate maintenance systems.

- Efficient Use of Energy
  BIM can help facilitate the analysis and comparisons of various energy alternatives to help facility managers dramatically reduce environmental impacts and operating costs. By analyzing the costs and the savings of various facility improvements and building system retrofits, facility managers gain a tool to optimize building performance over the life of the building.

- Economical Retrofits and Renovations
  A "living" BIM model provides an easier means of representing three-dimensional aspects of the building. Better information about existing conditions reduces the cost and complexity of building renovation and retrofit projects. By providing more accurate and dependable information to contractors, change orders resulting from "surprises" in as-built conditions can be greatly reduced.

- Enhanced Lifecycle Management
  Some building design professionals are embedding data on life expectancy and replacement costs in BIM models, thereby helping an owner understand benefits of investing in materials and systems that may cost more initially but have a better payback over the life of the building. For example, using vinyl wall covering for interior wall finishes is more expensive than paint initially, but may result in reduced overall lifecycle costs since it is more durable. The lifecycle data is also very valuable for forecasting ongoing capital improvement costs.

2.3 The Modeling Gaps between Architecture, Engineering, Construction and FM

One of the challenges that building owners implementing Lifecycle BIM face is the difference between the BIM models created for design and construction and the BIM models needed for operation. Although with proper procedures building data can and should flow from one phase to the next, it is useful to identify at least four types of BIM models as seen below in figure 3:

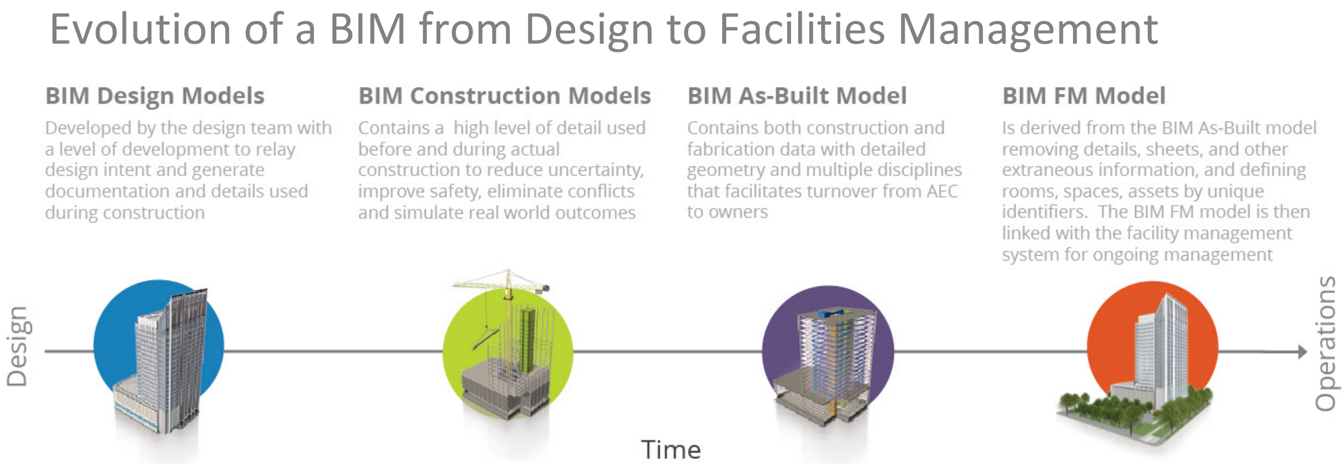

Figure 3 – BIM Models from design through facility management

2.3.1 BIM Design Models

These are created by architects and engineers with the objective of first defining the conceptual design and ultimately producing construction documents. Building materials and equipment are defined generically, allowing the contractor the freedom to competitively bid and price equivalent alternatives. For example, air handling units are described by general dimensions and performance requirements by the engineer without knowledge of who the selected manufacturer will be.

2.3.2 BIM Construction Models

Contractors and subcontractors will use these models to aid in staging and detect potential conflicts using clash detection before encountering the issues in the field as well as for material takeoffs (estimating) and procurement. BIM Construction Models typically contain a high level of detail used before and during construction to reduce uncertainty in the construction process. Additional benefits include enhancing safety on the job, limiting conflicts and the simulation of real world outcomes.

2.3.3 BIM As-Built Model

This is created by the general contractor, subcontractors and suppliers. Traditionally this information has been provided as a set of paper working drawings that were annotated to reflect change orders and field changes and was accompanied by equipment cut sheets and shop drawings depicting specific equipment selection.

In the BIM era, this information needs to be entered back into the BIM model by the contractor or a specialist in building commissioning. Information in the BIM As-Built Model will include details, annotation, dimensions, building sections, schedules and elevations. The BIM As-Built Model will also include material and equipment properties as determined during the construction process. The BIM standards are critical for defining the information that is required.

The building owner should retain the as-built model as the authoritative source and a reference for the building as-constructed.

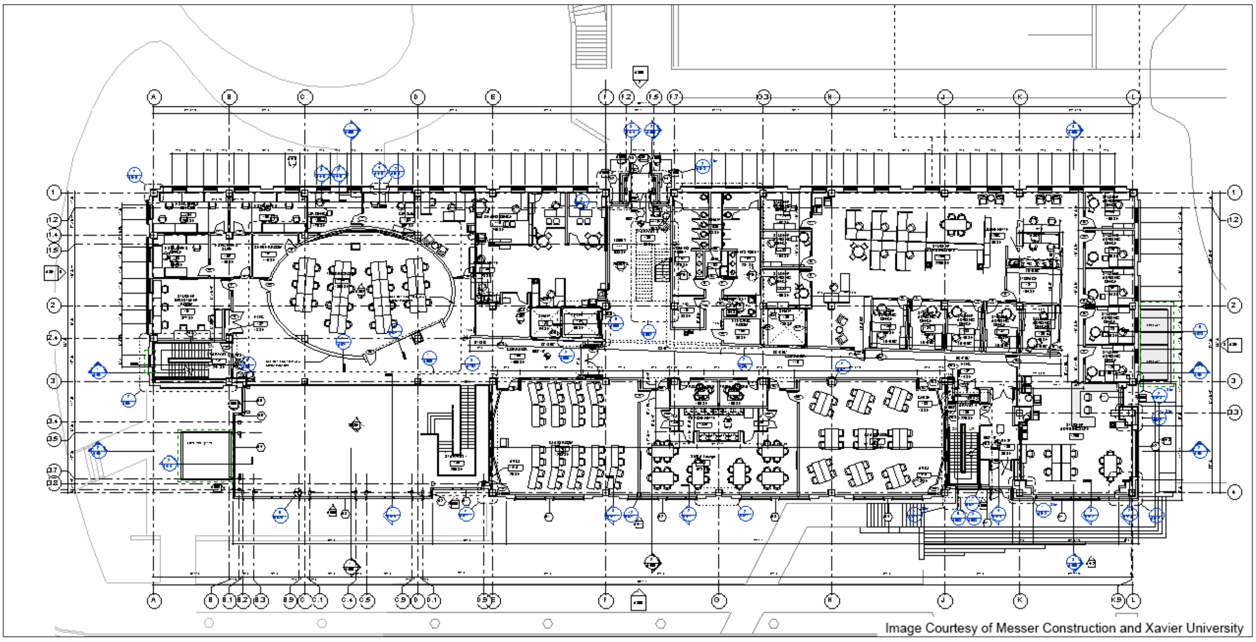

Figure 4 – Floor plan in a construction BIM Model with annotation and dimensions. Refer to section 2 for more information.

2.3.4 BIM FM Model

The BIM FM Model is derived from the BIM As-Built Model. Additional information is included in section 3. When creating the BIM FM Model, the following modifications are made:

- Extraneous information is removed including construction details and working drawing sheets. This information can be obtained from the as-built model if needed, but otherwise encumbers the BIM FM Model.
- Where linked models have been used to distinctly represent building core, building shell and tenant improvements, these are merged into a single model.
- If practical, linked models representing architectural, mechanical, electrical, fire protection and specialized equipment are merged. For large buildings this may not be practical with current technology, so there may be the need to maintain multiple models that are linked.
- Occupancy room numbers are derived from construction room numbers with numbers matching building signage.
- For office space, workstations and offices are defined separately from rooms and are numbered with an occupancy numbering system. This is key to matching office occupants to desks, cubicles and offices and is also essential for management of work orders.
- Building equipment items are numbered with unique asset ID's.
- The BIM FM Model is linked to the facility management system which tracks ongoing work orders, maintenance operations, occupancy information, equipment and material replacement costs and other data related to building operations.

Figure 5– Floor plan in a BIM FM Model without annotation but with space definition.

2.4 INTEGRATION WITH FACILITY MANAGEMENT SYSTEMS

The BIM model is the authoritative source for the physical aspects of a building including the structural system, walls and doors, room finishes, lighting, power, plumbing, fire protection and HVAC systems. It is not designed to manage data for ongoing operations and occupancy; this information is best handled by a facility management system. In this document, we use the general term "facility management system," but this might alternatively be known by one of the following designations:

- Computer-Aided Facility Management (CAFM) System – These are systems integrated with CAD or BIM and are used to track space and maintenance at a departmental (rather than enterprise) level.
- Computerized Maintenance Management System (CMMS) – These are systems designed to track remedial and scheduled maintenance.
- Integrated Workplace Management Systems (IWMS) – These are systems that manage space, maintenance, real estate, move management, strategic planning, project management and other facility functions and are deployed on an enterprise rather than departmental basis.

2.5 Organization of Information

Although much information may be tracked by both the BIM model and the facility management system, it is critical to determine the authoritative source for each set of data. The following guidelines should be followed:

BIM FM Model is Authoritative	Facility Management System is Authoritative
Building structure and base building architecture including structure, walls, doors, stairs, elevators and building core areas.	Real estate information including property records and lease information.
Interior architecture including walls, doors, floors and ceilings.	N/A
Rooms with "as-occupied" room numbers consistent with building signage. Room numbers should be unique by building.	N/A
Workspace areas which include closed-wall offices but also include open-plan workstations. Areas should include space ID numbers that are consistent with occupancy management systems for occupant workspace assignment. Workspace numbers should be unique by building.	Occupants with unique occupant ID's and referencing workspace numbers. Move management information including from, to, move date, move project and move details. Department or cost center codes.
Building equipment by general type and dimensions with unique asset ID numbers for reference by other systems. The BIM model should also carry the model, manufacturer and serial number for major equipment. BIM is typically authoritative on the existence of an item of equipment. In other words, it is placed in BIM first and if removed from the building, deleted from the BIM model.	Equipment warranty information, information on date placed in service, replacement costs, asset values, depreciation schedules and service contracts. Equipment preventative maintenance schedules and inspection results. Work requests and work orders. Service level agreements by activity.
Furniture panels, desks and work surfaces but not fittings, components, shelves or drawers.	N/A
Electrical outlets and switches with circuit information.	N/A
Lighting fixtures with circuit information.	N/A
Plumbing fixtures and piping.	N/A
Fire sprinklers and fire protection systems.	N/A
Special equipment such as food service equipment and lab equipment.	N/A
N/A	System user information including system privileges.
N/A	Project management schedules and costs.
N/A	Sustainability information including certifications and resource initiatives.
N/A	Strategic plans.
N/A	Lifecycle management information including service life by system, replacement costs, annual upkeep costs and capital budget forecasts.

Table 1

Note that most owners and building operators will choose to manage the information in the above lists that is most critical for effective building operations. Very few owners track all of the information above and owners should consider a phased approach when implementing a system.

2.5.1 CLASSIFICATION OF MODEL DATA AND STANDARDS

Organizations which own and operate facilities portfolios can increase the accuracy and integrity of their data by implementing modeling and data standards enterprise-wide. It is strongly recommended that each organization implement and enforce the adoption of well-defined standards. This can provide stronger, more accurate reporting, ease of high quality data integration and a method for communicating expected results to AEC partners and consultants, who may be providing modeling and data collection services for new construction, renovations or retrofit projects for building owners and operators. Standards can include naming conventions, formats and classifications. Several existing industry data standards already exist and can be used as is or adjusted for each building owner as necessary. Examples of standards and classifications systems are covered in the following sections.

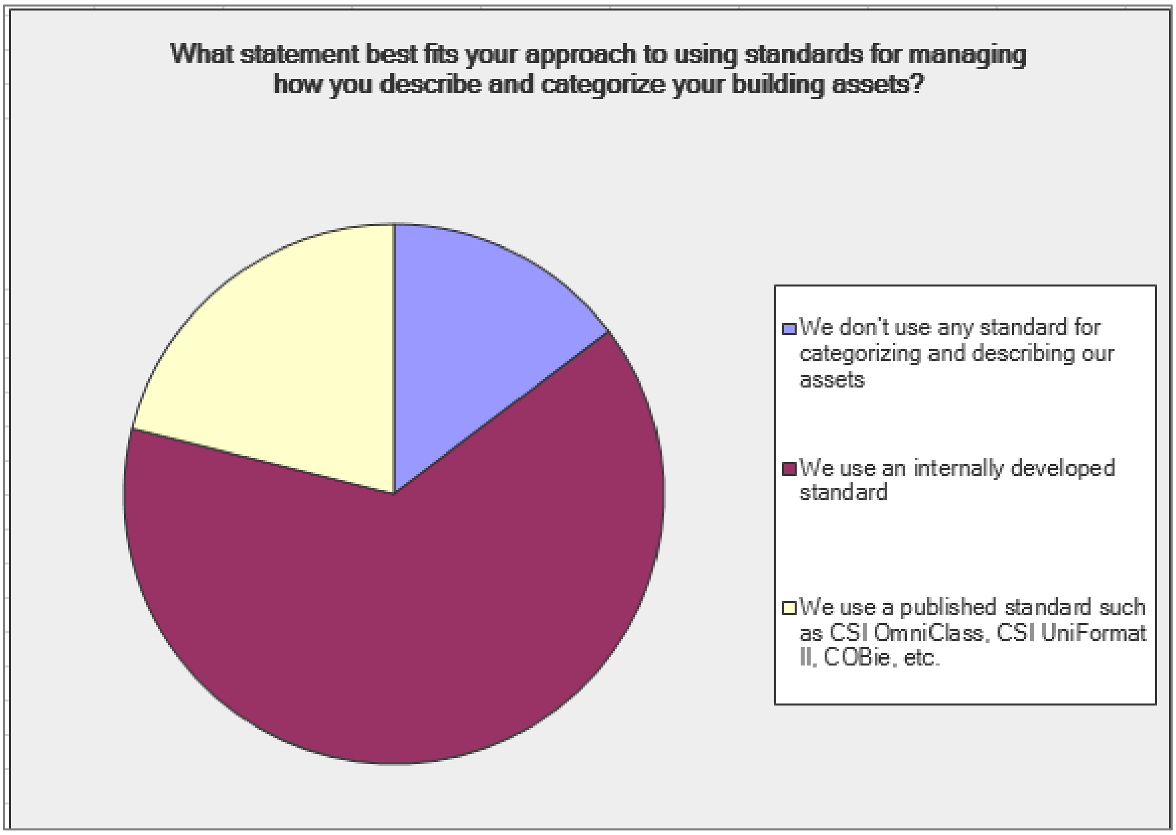

Figure 6 - BIM FM Consortium survey results showing the majority of surveyed building owners utilize internally developed standards

2.5.2 OMNICLASS

The OmniClass Construction Classification System is recognized by the construction industry as the authoritative source for classification of information related to building construction. OmniClass tables 21 and 23 are beneficial to the building owner and using both may need to be required as they each serve a different purpose.

OmniClass Table 21–Elements is recommended as a general framework for BIM information. Elements are systems or major assemblies and as such lend themselves to the migration of information from conceptual design through construction and operations. Table 21 is based on the Uniformat system that was developed in the 1980's for conceptual cost estimating.

OmniClass ™ Table 21 - Elements

OmniClass Number	Level 1 Title	Level 2 Title	Level 3 Title	Level 4 Title	Table 22 Reference
21-04 30 70			**Special Purpose HVAC Systems**		
21-04 30 70 10				Snow Melting	22-23 83 00
21-04 40		**Fire Protection**			
21-04 40 10			**Fire Suppression**		22-21 00 00
21-04 40 10 10				Water-Based Fire-Suppression	22-21 10 00
21-04 40 10 50				Fire-Extinguishing	22-21 20 00
21-04 40 10 90				Fire Suppression Supplementary Components	
21-04 40 30			**Fire Protection Specialties**		22-10 44 00
21-04 40 30 10				Fire Protection Cabinets	22-10 44 13
21-04 40 30 30				Fire Extinguishers	22-10 44 16
21-04 40 30 50				Breathing Air Replenishment Systems	22-10 44 33
21-04 40 30 70				Fire Extinguisher Accessories	22-10 44 43
21-04 50		**Electrical**			22-26 00 00
21-04 50 10			**Facility Power Generation**		
21-04 50 10 10				Packaged Generator Assemblies	22-26 32 00
21-04 50 10 20				Battery Equipment	22-26 33 00
21-04 50 10 30				Photovoltaic Collectors	22-26 31 00
21-04 50 10 40				Fuel Cells	22-48 18 00
21-04 50 10 60				Power Filtering and Conditioning	22-26 35 00
21-04 50 10 70				Transfer Switches	22-26 36 00
21-04 50 10 90				Facility Power Generation Supplementary Components	

Figure 7 – A portion of OmniClass Table 21. Courtesy of OmniClass Development Committee

Table 23–Products is also relevant as a classification for final building equipment items and manufactured products. Manufacturers are beginning to provide downloadable BIM content which is typically referenced by Table 23. These tables are also used in the Construction Operations Building Information Exchange (COBie) standard.

23-25 69 13			**Laboratory And Scientific Equipment**				
23-25 69 13 11				Microscopes			
23-25 69 13 11 11					Acoustic Microscopes		
23-25 69 13 11 13					Binocular Microscopes		
23-25 69 13 11 13 11						Phase Contrast Binocular Microscopes	
23-25 69 13 11 13 13						Binocular Light Compound Microscopes	
23-25 69 13 11 15					Bore scope Inspection Equipment		
23-25 69 13 11 17					Combination Electron And Light Microscopes		
23-25 69 13 11 19					Dark field Microscopes		
23-25 69 13 11 21					Digital Image Varityping Microscopes		

Figure 8 – A portion of OmniClass Table 23. Courtesy of OminiClass Development Committee

Additional information on OmniClass tables is available at www.omniclass.org.

2.6 INFORMATION TRANSFER VERSUS INTEGRATION

Much has been written about the "handover" of information between design, construction and operations phases. There are two basic approaches to transferring information from construction to facility management:

- Direct integration of the BIM and the facility management system.

- Transfer of data using a standard data format, typically the COBie standard.

The advantages of each of these approaches are as follows:

Advantages of direct integration between the BIM model and the facility management system are as follows:

- Better validation of data. With the BIM and facility management systems linked, data is validated upon entry and there is no need for a "data scrubbing" activity on handover.
- Better access to BIM data. Facility management systems that provide floor plan and model viewing functionality open access to the BIM model up to anyone with a Web browser.
- Better ongoing updates to the building. By maintaining a working BIM model throughout building occupancy, the owner has an accurate record of the building as a base for future remodeling and expansion.

Advantages of using a transfer method such as COBie:

- Owners using facility management systems without direct BIM integration have a means to acquire information from the BIM model.
- Design and construction consultants who don't have access to the BIM authoring system or the facility management system can contribute BIM data.

2.6.1 COBie Standard

Where a direct integration between BIM and the facility management system is not available, the COBie standard should be used to transfer information. COBie was developed by US Army Corp of Engineers (USACE) and is currently being further developed and maintained by the Building Smart Alliance and provides a framework for the information attributes required for major building systems. A number of BIM and facility management software developers have developed interfaces for importing and exporting COBie data. Users should be aware however that data will need to be validated after import since the source system is not integrated with a target system.

The COBie standard is also a useful reference for attributes to track various types of building equipment. However, users should use judgment in determining the subset of attributes that can be kept accurate. A "lean" approach to BIM data, tracking the information that is deemed essential for ongoing maintenance, will be more successful than tracking every possible attribute of all equipment items.

Name	CreatedBy	CreatedOn	TypeName	Space	Description	ExtSystem	ExtObject	ExtIdentifier	SerialNumber	InstallationDate	WarrantyStartDate	TagNumber	BarCode	AssetIdentifier
AC Unit Ty	danielle.r.	2011-09-1	AC Unit Type 1	1B21	AC Unit	n/a	IfcEnergyConversionDevice	n/a	n/a	n/a	n/a	n/a	n/a	n/a
AC Unit Ty	danielle.r.	2011-09-1	AC Unit Type 1	1C13	AC Unit	n/a	IfcEnergyConversionDevice	n/a	n/a	n/a	n/a	n/a	n/a	n/a
AC Unit Ty	danielle.r.	2011-09-1	AC Unit Type 1	2B12	AC Unit	n/a	IfcEnergyConversionDevice	n/a	n/a	n/a	n/a	n/a	n/a	n/a
AC Unit Ty	danielle.r.	2011-09-1	AC Unit Type 1	2C15	AC Unit	n/a	IfcEnergyConversionDevice	n/a	n/a	n/a	n/a	n/a	n/a	n/a
AC Unit Ty	danielle.r.	2011-09-1	AC Unit Type 2	2D04	AC Unit	n/a	IfcEnergyConversionDevice	n/a	n/a	n/a	n/a	n/a	n/a	n/a
AHU-1	danielle.r.	2011-09-1	AHU	2D05	M_Air HandLING Unit - Split Sy	Autodesk Revit MEP	IfcFlowMovingDevice	0JGTSjcSn7	n/a	n/a	n/a	n/a	n/a	n/a
AHU-2	danielle.r.	2011-09-1	AHU	2D05	M_Air HandLING Unit - Split Sy	Autodesk Revit MEP	IfcFlowMovingDevice	1gn$K6jVP	n/a	n/a	n/a	n/a	n/a	n/a
Air Compre	mariangeli	2013-01-2	Air Compressor - D	1E15	Duplex Packaged Assembly wi	n/a	IfcMedicalDevice	n/a	n/a	n/a	n/a	n/a	n/a	n/a
ACC-1	danielle.r.	2011-09-1	Air Cooled Chiller	1F01	M_Screw Chiller - Air Cooled -	Autodesk Revit MEP	IfcEnergyConversionDevice	379JtJEeXD	n/a	n/a	n/a	n/a	n/a	n/a
ACCU-5	danielle.r.	2011-09-1	Air Cooled Condens	2R02	Air Cooled Condensing Unit	n/a	IfcEnergyConversionDevice	n/a	n/a	n/a	n/a	n/a	n/a	n/a
ACCU-1	danielle.r.	2011-09-1	Air Cooled Condens	Site	Air Cooled Condensing Unit	n/a	IfcEnergyConversionDevice	n/a	n/a	n/a	n/a	n/a	n/a	n/a
ACCU-2	danielle.r.	2011-09-1	Air Cooled Condens	Site	Air Cooled Condensing Unit	n/a	IfcEnergyConversionDevice	n/a	n/a	n/a	n/a	n/a	n/a	n/a
ACCU-3	danielle.r.	2011-09-1	Air Cooled Condens	Site	Air Cooled Condensing Unit	n/a	IfcEnergyConversionDevice	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Figure 9 – An example of COBie data

2.7 BENEFITS OF CLOUD-BASED BIM AND FACILITY MANAGEMENT SYSTEMS

Organizations implementing facility management systems typically have these choices for installing the software:

- On-Premise, meaning the system is in the organization's private data center and behind the organization's firewall.
- Cloud-Based, meaning the system is in a data center provided by the software vendor and not behind the organization's firewall.

Although many organizations have traditionally preferred the on-premise option, this has changed dramatically in the past three years, with the trend moving strongly to Cloud-based deployment. This is being driven by better security for Cloud-based applications and significant reduction in IT management costs for Cloud-based systems. Without question though, some organizations will choose on-premise deployment due to IT preferences or the need for complete security control.

Cloud-based facility management systems with real-time bi-directional integration to a BIM model enables the subject matter experts, who are closest to the data and have been given an appropriate level of secure access, the ability to update information in the model quickly and easily. Most organizations depend on a number of specialists to plan, manage and operate their buildings. BIM skills in particular are often outsourced by owners and facility managers rather than staffed in-house. Cloud-based systems provide the IT environment that is needed to support essential collaboration.

Figure 10 shows what a basic BIM based lifecycle management solution can look like when coupled with a facility management system.

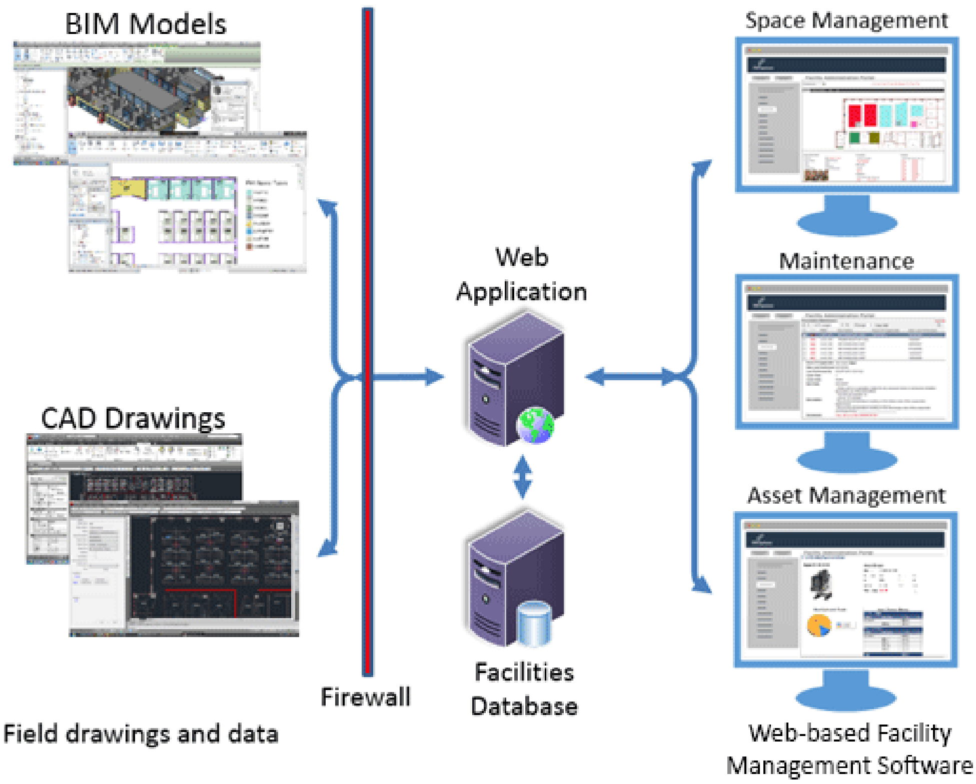

Figure 10 – Lifecycle BIM example

The most basic example is a maintenance technician who spends his or her time in the field completing both preventive and corrective maintenance tasks. Their view of BIM data may be as limited as seeing asset details or maintenance information on a handheld device, such as a smart phone, and may not even interact with a 2D floor plan as they go about their daily maintenance tasks. They could also be performing additional tasks such as barcode scanning assets and logging their conditions through a limited data driven form. This type of very specific access is distributed broadly to staff who interact with facilities data every single day, anytime and anywhere. This allows them to quickly and easily access and update a BIM model, which is the key to high quality lifecycle maintenance of the model. As you can see in this sense there is no actual BIM modeling experience required for the majority of the Lifecycle BIM tasks required to maintain healthy models.

A facility management system that has a live bi-directional connection to the BIM model is the best way to ensure that a model continues to live on and provide value to building owners through the lifecycle of a building. A primary method for achieving this is by providing distributed secure access to AEC and facilities management professionals in a way that allows those specialists to provide the services needed to ensure the continued accuracy and security of the model.

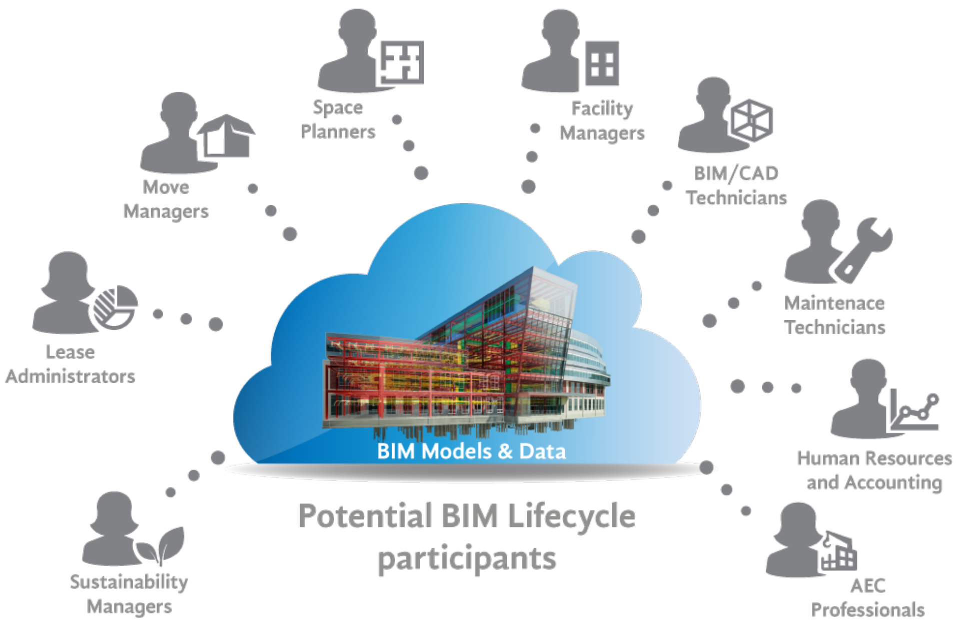

Figure 11 - Collaboration enables Lifecycle BIM

2.8 Space as the Basic Organizer of Facilities Data

To successfully track and report on facilities data a method to reference “places” in the building is needed, particularly with respect to occupants and assets. Systems for tracking space should be established at two levels:

2.8.1 Rooms

Rooms are divisions of a building floor typically enclosed by interior walls and defined as “room” elements within the BIM model. Although there may be some cases of rooms that are defined by space separations rather than walls, rooms should generally be defined by space enclosed by walls.

It is critical that a room numbering system be established that corresponds to building signage and is coordinated with room finish schedules. Establishing this system may require a workflow step to transition between construction room numbers used for the building construction process and occupancy room numbers used for the operations phase of the building's lifecycle.

Room numbers should be unique by building so that the combination of a building ID and a room ID defines a unique location.

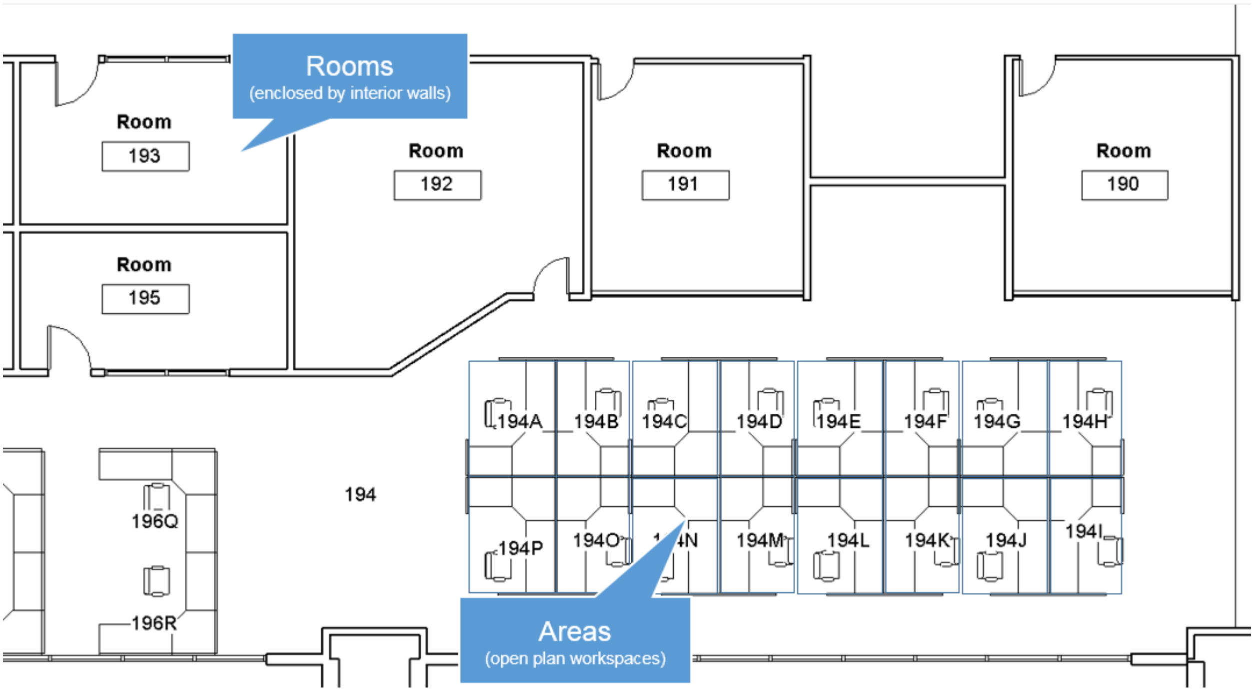

Figure 12 - Example of rooms and spaces

2.8.2 Spaces

In office buildings and buildings where occupancy tracking is important, it is essential to establish a system for tracking workspace areas. Where workspaces are closed offices these will be identical to rooms, but for open plan workspaces multiple areas will exist within a single room. For that reason, a separate system is needed for areas.

All spaces should be identified with space ID numbers that are unique by building, correspond to building signage and are used as the primary reference in the facility management system for occupancy management, move management and facility maintenance.

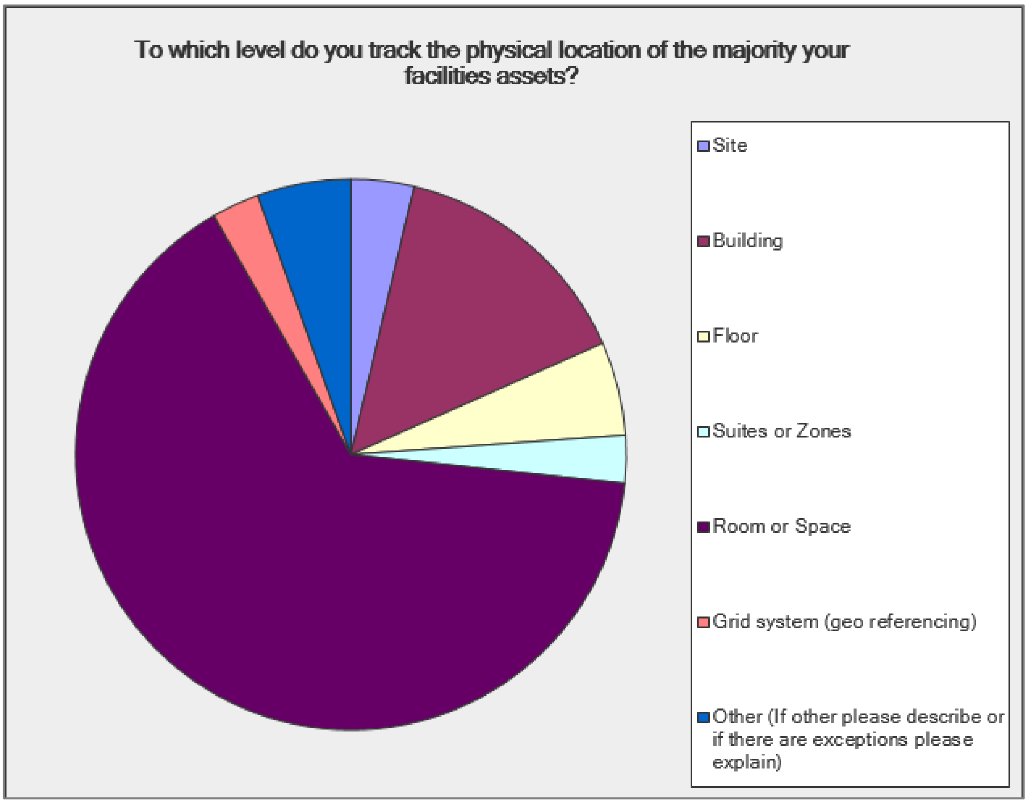

Figure 13 - Survey results showing that the majority of facility owners track asset location to specific spaces

2.8.2.1 Area Standards

Since the area calculations will supply data used for rent calculations and internal space chargebacks, care should be taken in defining the location of area boundaries. For most commercial office buildings area boundaries should be placed consistent with local commercial real estate standards, typically the Building Owners and Managers Association (BOMA) in the United States.

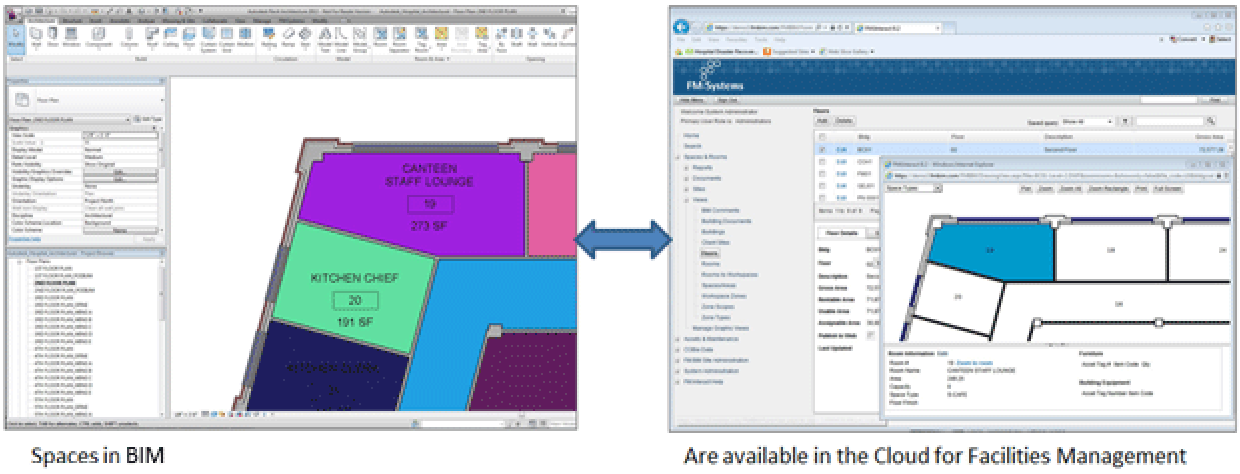

Figure 14 - Space in BIM made available for FM

2.9 Assets as the Second Cornerstone of BIM Model and Facilities Maintenance

Once a building owner's space is organized and optimized they can begin the important task of tracking their building assets. Typically the types of assets that are most important to owners are ones that need to have maintenance performed on them on a routine basis and are required for the functional operation of the building. Examples include the main components of HVAC systems or key components of life safety systems. The assets in these types of systems include air handling units, chillers and pumps that require maintenance technicians to perform both routine preventive maintenance as well as corrective maintenance when components malfunction. As maintenance is performed, several pieces of information begin to be compiled on each asset including its maintenance history, warranty status and possibly asset replacement if it goes beyond its useful life.

2.9.1 Classification of Equipment

Not all equipment has moving parts, or needs regular maintenance, but may still require information beyond location. For example, an electrical disconnect that uses fuses for over-current protection may only require attention when a fuse blows. Immediate access to the fuse type and size for that disconnect, and the equipment that it protects, can not only save time, but may save costs as well. Another example of a static type piece of equipment would be a ball valve that is used to shut off domestic water to a section of a building. That item may never need maintenance, but will definitely need to have a location noted in a BIM for FM model. In order to properly classify the equipment for maintenance and other requirements, the Facility Manager must understand the data needed to populate the BIM for use within an asset and maintenance solution. There are several sources of information for the equipment – manufacturer cut sheets, equipment submittal packages, recommended maintenance schedules and nameplate data, to name a few which are explained in the following paragraphs.

2.9.2 Equipment Nameplates

MEP equipment will most often have a stamped nameplate that is permanently attached to the component. Common information for a nameplate is manufacturer, manufacturer's address, model number, serial number and certification marks. Electrical data will include voltage, amperage, frequency and phase requirements. Motors may include information on horsepower, efficiency and RPMs. Pumps have rated flow, head pressure, maximum flow and pump type – to name a few attributes. The more complex the machinery, the more information necessary to relay the required operating conditions. Including the nameplate data of equipment in the BIM for FM model would be an excellent resource for the Facility Manager. For existing buildings, the nameplate data may be the only available source of information for a piece of equipment.

2.9.3 Submittals

The submittal process is intended to guarantee that the contractor installs the equipment as specified in the contract documents. Like the nameplate, the submittals include manufacturer information, model details and the other relevant data. As part of the submittal process, the design team must approve the documentation submitted by the contractor. If specific attributes are identified ahead of the process, then the designer can include them as part of the data collection process in a standardized way that matches a building owner's data standard. This will, in turn, allow for extraction of data sets that will make it much easier to bring the data into a technology solution such as an IWMS, CAFM or CMMS software. Unlike the nameplate data, the submittals will include the cut sheets for equipment, and can list replacement parts and maintenance schedules. The submittal process occurs relatively early in the construction process, as approval is required before ordering equipment. This approval time period will require the Facility Manager to have input during the preconstruction phase and coordinate the data-input responsibility with the designers. Many large contractors utilize document management software systems that may be able to automatically populate the design model with equipment data that can migrate to the BIM for FM model.

2.9.4 Control Sequences

In some instances, the key piece of data for a component will be the control information in relation to the overall system. As described earlier, a ball valve that is identified as controlling a specific area of a building may need to include that information as an attribute. Likewise, listing the electrical panel that provides power to equipment is not only convenient for workers, but it is also a safety requirement. The Facility Manager will need to fully understand the system as a whole in order to ensure that the correct data is used.

2.9.5 Type versus Instance Properties

Efficiencies in data acquisition can be gained by distinguishing between “type” properties and “instance” properties. Type properties are attributes of a component that are true for all occurrences of that type of item. For example, a building might use the same model of a pump air handling units in ten locations. The model number and basic specifications for the pump would be identical and should therefore be tracked as part of the “type.”

Other properties will be unique to each occurrence. For example, each pump would serve a different zone of the building, so the zone would be an “instance” property. Examples of type and instance properties are shown below in figure 15.

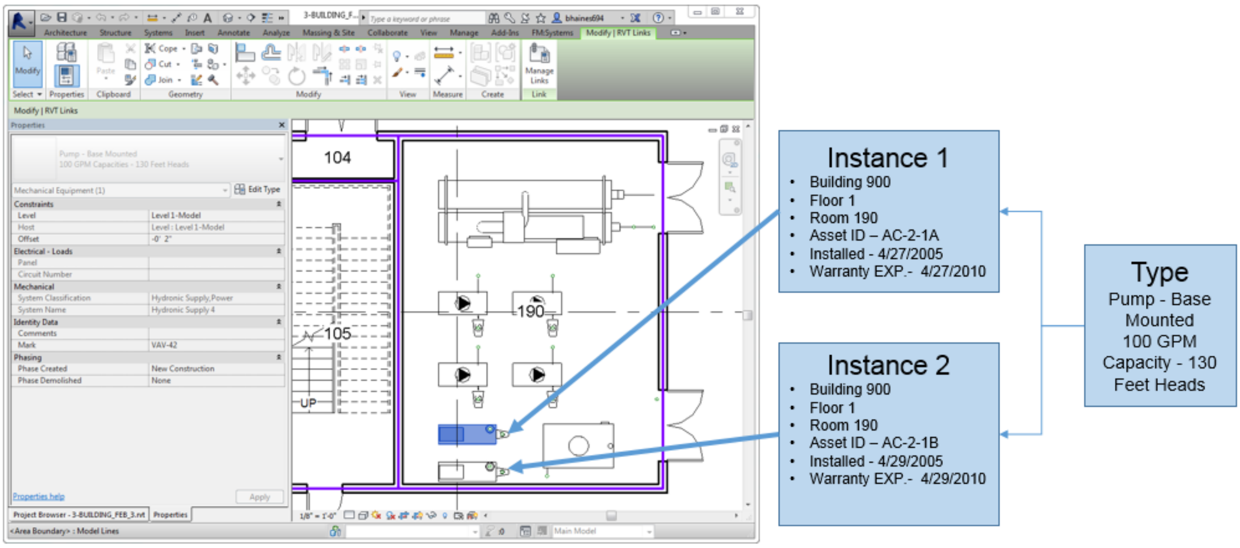

Figure 15 - Type and instance properties for pumps in a building

Finally, information related to ongoing repair, maintenance and operations would be maintained in the facility management system with a reference to the BIM FM Model. An example is shown in figure 16 below.

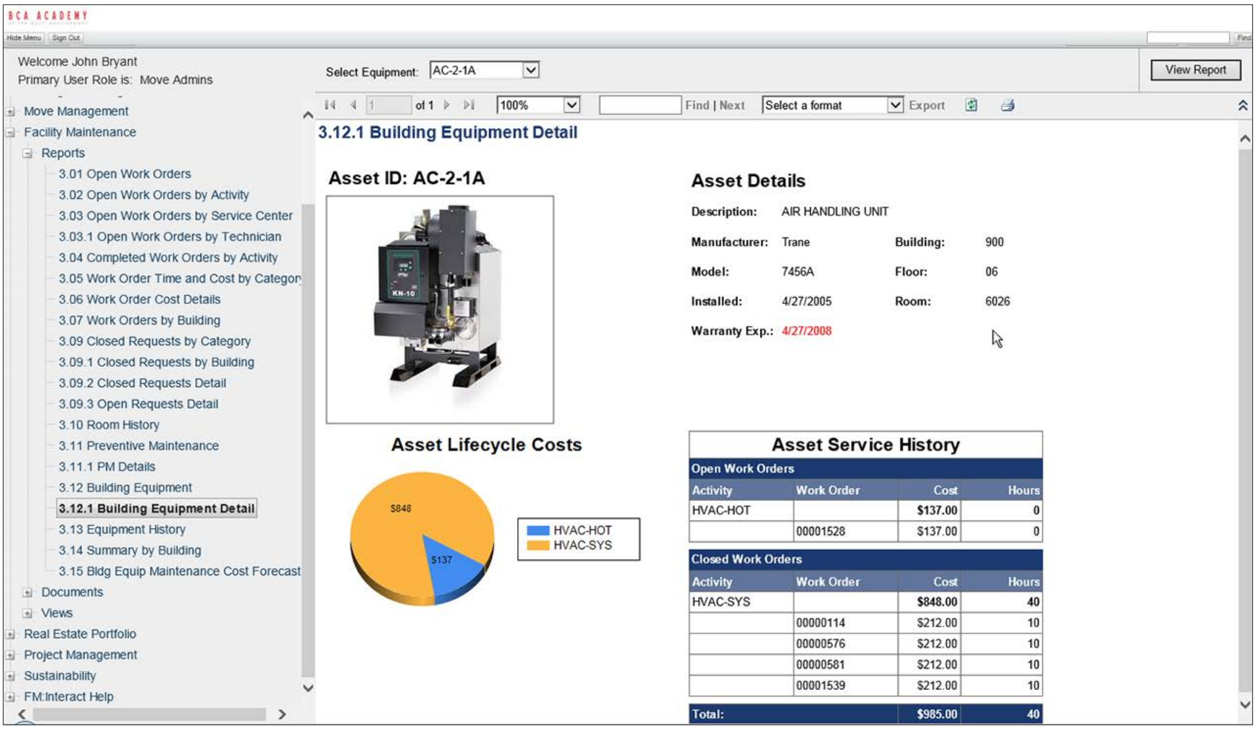

Figure 16 – Information on an equipment item tracked in a facility management system, supplementing BIM information.

3 FM Data Requirements for As-Built BIM Models

3.1 Purposes of the As-Built Model

The As-Built BIM model serves three main purposes:

- It provides the source data from which the BIM FM Model will be built.
- It is the source of record for the building. As such it will serve as a reference throughout the building's life when materials or equipment need to be repaired or replaced.
- Portions of the model may be used as essential reference data for future renovation and expansion projects.

3.2 BIM As-Built Model Requirements

As-built models should be delivered standalone by discipline with discipline models linked unless otherwise specified. The following types of models are an example of what a building owner should expect to receive as part of the "as-built" modeling package:

- Architectural, Structural
- Mechanical, Plumbing and Control Systems
- Electrical Power and Lighting
- Fire Protection
- Special Equipment
- Data

3.3 Data Requirements for Assets

The owner should create a document that specifies the information required for each type of asset. The following principles are recommended:

- Standard naming conventions should exist across all facilities information ranging from file names to object attribution names to ensure consistency, cross software scalability and accurate reporting. File names for models and drawings should follow: Building number – year – discipline designations.
- All assets to have at minimum the properties of manufacturer, description, model and serial number.
- All assets to be accompanied by their appropriate spec sheets, installation manuals and O&M manuals in PDF format.
- All assets to be placed dimensionally accurate; assets not directly bound within a room will be captured via the nearest room's area boundary.

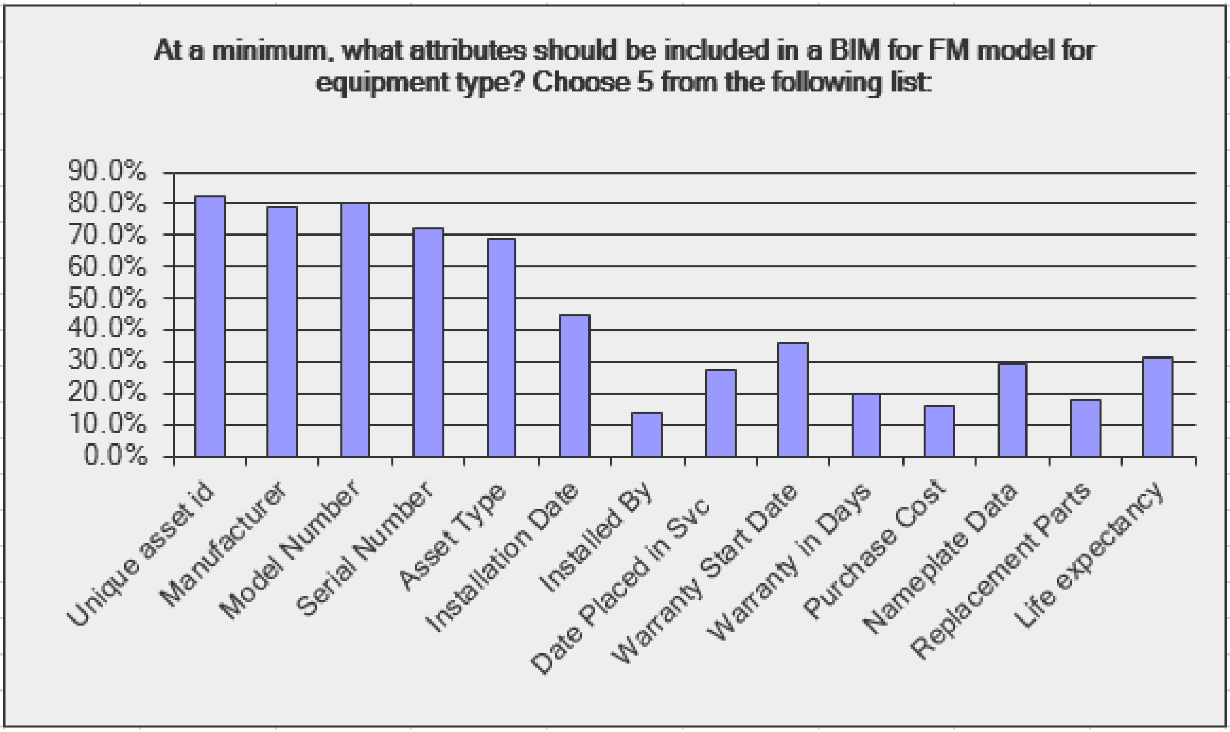

Figure 17 – BIM FM Consortium survey results for data attribution

4 Guidelines for Creating BIM FM Models

The BIM FM Model will serve as the “live” data source used throughout the life of the building. As such it is important that there be enough information to support building maintenance and operations, but not so much as to become burdensome. Attempting to track more data than can be practically updated can result in data of uncertain accuracy, making the entire system untrustworthy. Therefore the temptation to track too much should be resisted and a “lean” approach is recommended.

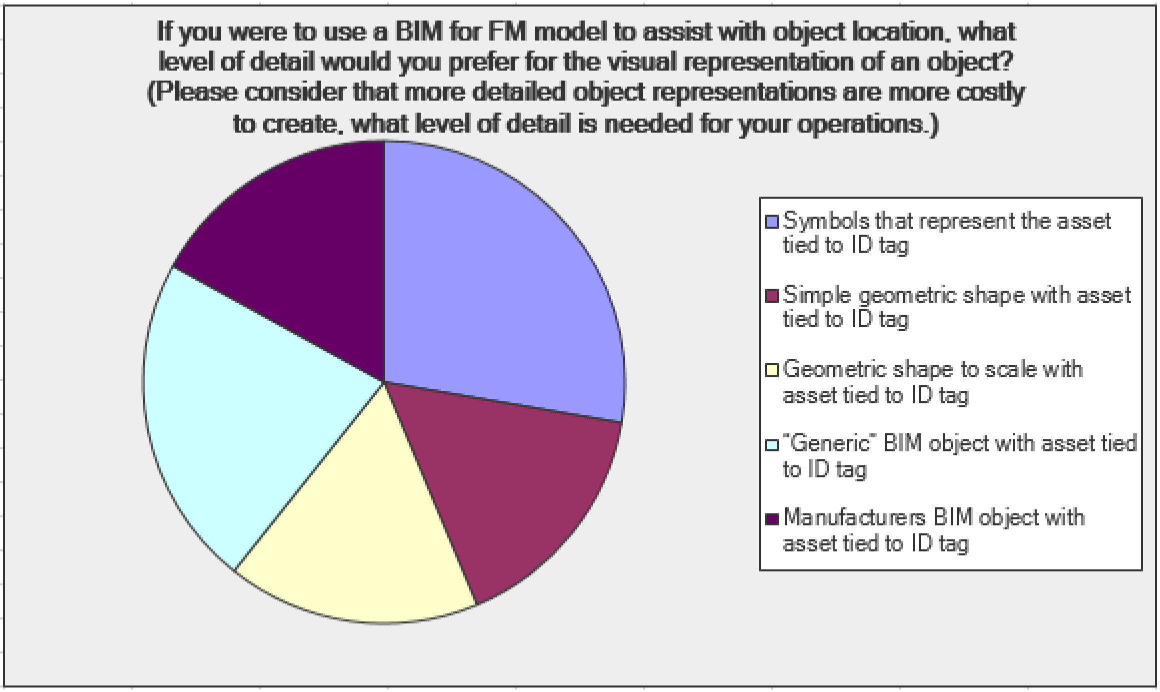

Figure 17 – BIM FM Consortium survey results detailing level of graphical detail preferred by facility management teams in a BIM model.

Attention should also be given to the need many owners have to manage a portfolio of real estate, not just a single building. Modeling guidelines should be followed to ensure the accuracy and consistency of Lifecycle BIM data across the entire facilities portfolio. This information should be compatible with existing CAD based facilities data in a way that ensures all facilities information is available and usable by a building owner’s team, regardless of whether the information was created in a BIM model or generated from traditional facilities data and drawings.

The list of general modeling guidelines below will help to ensure consistency through the lifecycle of all buildings in the portfolio:

- BIM FM Models should be delivered standalone with multiple models combined to the extent practical.
- The following information should be removed to facilitate a more workable model:
    - Details
    - Annotation pertaining to installation or construction
    - Building sections and elevations
    - Working drawing sheets
    - Unnecessary views
    - Unused Families

    - All phases but “existing”
    - Data fields (parameters) that are no longer needed
- Information that should be retained includes the following:
    - Floor and roof plans
    - Reflected ceiling plans
    - Mechanical ductwork and piping plans
    - Lighting plans
    - Electrical power plans
    - Electrical panel diagrams and schedules
    - Fire protection plans
    - Data system plans
- Information from the following disciplines should be included:
    - Architectural
    - Mechanical, Plumbing and Control Systems
    - Electrical Power and Lighting
    - Fire Protection
    - Special Equipment
    - Data
- Standard naming conventions should exist across all facilities information ranging from file names to object attribution names to ensure consistency, cross software scalability and accurate reporting. Specific guidelines are as follows:
    - File names for models and CAD drawings should follow: Building number – discipline designations.
    - All assets should have unique identifiers and should adhere to the following:
        - All assets to have at minimum a detail level of: Manufacturer, model and serial number.
        - All assets to be placed dimensionally accurate; assets not directly bound within a room will be captured via the nearest room’s area boundary.
  - Room numbers, room names and room finishes.
  - Space numbers for office areas with workspace name and space type.

4.1 System

Building systems include components, assemblies and systems which are a part of the overall building. Building owners should create a list of standardized systems that will be used across all of their facilities as this will ensure better reporting results and greater integrity of information. Examples are building HVAC systems, fire protection, electrical power and lighting.

4.2 Object Type

Object type is the name of the components that make up a system. These are typically the components that need to be directly maintained by facility teams either through preventive maintenance programs or by corrective maintenance requests. Object types are also usually at the “catalog item” level when facilities teams need to track inventory and do not represent individual instances (inventory) in a system or on a floor.

4.3 Type Attributes

The specific attributes or properties tracked and maintained in the BIM FM Model vary by system, but in general should include the information required for ongoing building maintenance. For building equipment, essential type attributes are manufacture, description, model number and relevant information on maintenance procedures.

4.4 Instance Attributes

Equipment items should be identified with a unique asset ID. This ID should also be clearly labeled on the item of equipment with a durable label, generally showing the ID number and a barcode.

Equipment items should also have serial number tracked and any performance properties essential to operations.

Judgment should be used to avoid attempting to track more information than can be maintained in an accurate state. Information of uncertain accuracy is worse than the absence of information. It is possible to have dozens of attributes associated with an object but this guide recommends that building owners begin by tracking information that are likely be used for the day-to-day operations and maintenance of the equipment and space within the facility. Additional attributes can be added over time as necessary.

4.5 Required

It is important to understand data priorities in terms of required versus optional information at the object or attribute level. This can help to create a very basic rule that says whether or not the specified piece of information is required or not and can aid in enforcing standardization around which elements will be tracked across a facilities portfolio.

4.6 Data Source

In the context of this guide, data source is used to describe where the authoritative source lies for individual attributes. The two primary locations in Lifecycle BIM are either the relational database in the facility management system or the BIM model. Consideration for data source is important so that an owner knows which data location controls the ability to update or change information associated with individual attributes. An example would be “space type” for an individual space, area or room in a facility. Space type is typically managed in the space management module of the facility management system and is linked to the BIM model for viewing purposes only within the modeling environment. Conversely attribute level information about airflow or power requirements might be more appropriately maintained and updated in the BIM model and linked to the facility management system for viewing and reporting.

4.7 Model Element

Model element simply means whether or not the object or attribute has been physically modeled as either a 3D or 2D element in a BIM modeling platform. In general, each element will be modeled according to its size, shape, location, orientation and quantity. At the early stages of the project, element properties are more generic and approximate, but become more specific and increases in accuracy as building data is gathered.

4.8 Data Only

Similar to model element, "data only" means it is the object or attribute simply being tracked from a data perspective and is not required to be modeled in the modeling platform.

4.9 Source Model

Often a complete BIM model may contain multiple individual models with each model representing a specific trade, system or approach to modeling. Example models that might be included are:

- Architectural
- Mechanical, Plumbing and Control Systems
- Electrical Power and Lighting
- Data

4.10 Responsibility

This column is used to track the party's responsibilities for maintaining the specific systems, object or attribute. This can either be a named member of the facilities management team, BIM partner, or more simply, it could be the name of the role associated with maintaining this information.

Figure 18 below is a spreadsheet which provided a good starting point and example for tracking each of the individual items described above in the Lifecycle BIM data recommendations section of this document.

BIM FM Models									
System	Object Type	Type Attributes	Instance Attributes	Required Yes/No	Authoritative Data Source Model/Data	In Model Yes/No	In Data Yes/No	Source Model Arch/MEP etc.	Responsibility
HVAC									
	Air Handler								
		o Manufacturer							
		o Model							
		o Description							
			o Asset ID						
			o Air Handler Number						
			o Serial Number						
			o Cooling Capacity						
	VAV Boxes								
		o Manufacturer							
		o Model							
		o Description							
			o Asset ID						
			o VAV Box Number						
			o Serial Number						
			o Air Flow Capacity						
	Pumps								
		o Manufacturer							
		o Model							
		o Description							
			o Asset ID						
			o Pump Number						
			o Serial Number						
			o Flow Capacity						

Figure 18 - Example of a requirements document for a BIM FM Model

5 Conclusion

We are still in the early days of utilizing BIM throughout the lifecycle of a building. There is much that the industry still has to learn and it will take some time for best practices to emerge.

Nevertheless, the need to better manage building lifecycles is clear. Poorly managed buildings waste resources and money and fall short of achieving their potential. This harms not only building owners, but also building occupants and society at large. We can do better. BIM is an essential technology for achieving the full potential of our built environment and by working together we can begin realizing the promises of Lifecycle BIM.