The Uses of BIM

THE USES OF BIM

Classifying and Selecting BIM Uses

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PREFACE

When developing the Building Information Modeling (BIM) Project Execution Planning Guide[1], the research team documented approximately twenty-five (24 to 26 depending on the version) BIM Uses, primarily identified through industry interviews. These BIM Uses were, in general, organized by project phase (plan, design, construct, and operate). Many implementers commented on the value of having defined BIM Uses, but the organization of these uses within the Guide, while simple to understand, had several drawbacks. First, each Use of BIM does not reside within one single project phase. In fact, most can occur in multiple project phases. It can be debated that every use of BIM could be applied during any phase of the lifecycle of a facility. Secondly, the current structure has few levels, categories, or classes of BIM Uses. Furthermore, this structure is not very adaptable to change, such as adding new Uses as they are developed. While the BIM Project Execution Planning Guide made progress towards standardizing a list of terms and definitions, the names have not been accepted uniformly and as teams adapt the materials of the Guide

for their own purposes, they frequently customize the BIM Uses to suit their individual needs.

In addition to the BIM Project Execution Planning Guide, there are other guides and documents that provide listings of BIM Uses. Of those publications that list the Uses of BIM, the lists vary greatly from one publication to the next and few publications categorize the Uses into classes and class hierarchies. Therefore, the structure presented in this document aims to provide a standard list and definition of the Uses of BIM and organizes the Uses in classes and a class hierarchy.

The purpose of this document is to define a common language for the Uses of BIM. By developing this common language, teams can more clearly communicate the purposes for implementing BIM on a project or within their organization. This document provides the fundamental terminology and organizational structure for the purposes for which BIM is implemented throughout the lifecycle of a facility. The Uses can be utilized during the development of the BIM Plan or to better allow for the establishment of requirements. They can also be used to standardize process and information exchanges terminology. This standardization is critical to future developments within the National BIM Standard – US. Overall, the BIM Uses allow for better communication of the purposes for implementing BIM throughout the life of a facility.

This BIM Use classification was established through a comprehensive ontology development methodology. The methods used to classify the BIM Uses included: 1) defining domain and scope, 2) acquiring domain knowledge, 3) identifying domain terms, 4) integrating

the terms, 5) evaluating (refinement and validation) the classification system, and 6) documenting classification system. To develop the classification system, over 550 Terms were documented using content analysis, software analysis, brainstorming, and industry practice analysis. These 550 Use terms were then grouped by common attributes into approximately 30 groups. During this process, only the purpose of the BIM Use term was considered. Therefore items such a project phase, facility element, discipline, and level of development were not considered when developing the classes. These groups were then organized into larger categories of BIM Uses and organized into a hierarchical structure. This structure was then internally evaluated through competency questions, mapping the original terms to the structure, and comparing it to other structure such as the BIM tetralogy[2]. Based on the internal evaluation, the ontology was updated and validated externally. The external validation included one-on-one interviews with over 30 industry experts and 4 separate industry focus group meetings. Based on the external feedback, the structure was updated and documented.

This document is designed to communicate the BIM Uses classification system and BIM Use Purposes. The first portion of the document introduces the BIM Use classification systems. This is followed by a detailed discussion of the components of the classification system including the BIM Use Purposes and BIM Use **Characteristics**. The BIM Use Purpose Section includes a description of the objective of each of the BIM Uses. The BIM Use **Characteristics** section includes a description of the facility element, facility phase, **discipline**, and level

of development. These sections are followed by a method for implementing the BIM Use Classification System. This method can be used as an alternative method for defining the Uses of BIM currently defined in Chapter 2 of the BIM Project Execution Planning Guide (BIM PxP Guide).[3]

[1]Computer Integrated Construction Research Program, *BIM Project Execution Planning Guide – Version 2.1*(University Park, PA, USA: The Pennsylvania State University, 2011), http://bim.psu.edu.

[2]buildingSMART alliance, "Tetralogy of BIM," National BIM Standard – United States, 2013, http://www.nationalbimstandard.org/project_structure.php.

[3]Computer Integrated Construction Research Program, BIM Project Execution Planning Guide – Version 2.1.

EXECUTIVE SUMMARY

This document presents a system for the classification of the Uses of BIM. This classification system provides a common language for the Uses of Building Information Modeling (or BIM Uses) that can be leveraged to communicate the precise purpose and context of implementing BIM on a capital facility project. A BIM Use is defined as *a method of applying Building Information Modeling during a facility's lifecycle to achieve one or more specific objectives.*

The BIM Project Execution Planning Guide provides a structured method to plan the implementation of Building Information Modeling on a project. The procedure includes the following four steps:

1. Identify high-value BIM uses during the project planning, design, construction, and operational phases
2. Design the BIM execution process by creating process maps
3. Define the BIM deliverables in the form of information exchanges

4. Develop the infrastructure in the form of contracts, communication procedures, technology, and quality control to support the implementation

The classification system can be implemented as an alternative approach to the first step of the procedure defined in Chapter 2 of the BIM Project Execution Planning Guide. Rather than classifying the BIM Uses by facility phase (as was done in the BIM Project Execution Planning Guide), this system classifies BIM Uses based on the purpose of implementing BIM. It is critical to understand that BIM does not change the purpose – only the means by which the purpose is achieved.

BIM Uses are categorized into five primary purposes: 1) Gathering, 2) Generating, 3) Analyzing, 4) Communicating, and 5) Realizing. These purposes can be decomposed further into 18 sub-purposes for implementing BIM. Using the purpose definitions, one can accurately communicate 'why' they are implementing BIM. After the purpose is determined, the BIM Use is more precisely identified by elaborating on detailed BIM Uses Characteristics such as facility element, facility phase, author discipline, or level of development.

This BIM Use classification systems and procedure provide the fundamental terminology and structure for communicating the purposes for which BIM is implemented. It can be used within the procurement language and BIM planning to define the precise requirements of various parties. It can also be used to standardize terminology related to process and information exchanges. Overall, the classification of BIM

Uses allows for better communication of the purposes and methods for implementing BIM throughout the lifecycle of a facility.

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Beatty), Charles Miller (MBP), Mairav Mintz (MBP), and Rachel Riopel Wiley (HDR).

CHAPTER 1.

BIM USE CLASSIFICATION SYSTEM AND STRUCTURE

Building Information Modeling (BIM) has been defined as *"the act of creating an electronic model of a facility for the purpose of visualization, engineering analysis, conflict analysis, code criteria checking, cost engineering, as-built product, budgeting, and many other purposes."*[1] To foster better communication within the industry, it is important to define a consistent language to describe the focused use of BIM on a capital facility project. A **BIM Use** can be defined as *"a method of applying Building Information Modeling during a facility's lifecycle to achieve one or more specific objectives."*

BIM Uses can be classified primarily based on the **purpose** for implementing BIM throughout the life of a facility. In addition to the purpose alone, several other characteristics can be defined to properly identify and communicate a BIM Use. These purposes and **characteristics** (see Figure 1-1) can be defined at varying levels depending upon the level of specificity required for different applications of the Uses.

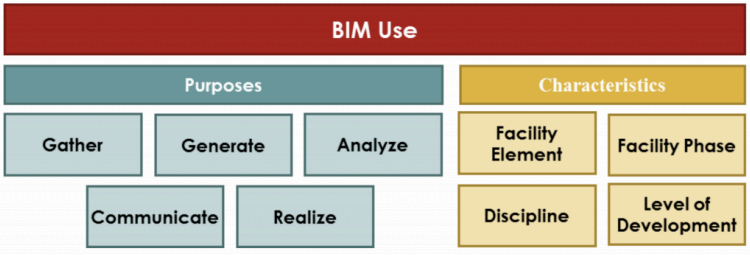

Figure 1-1: The Components of a BIM Use

The BIM Use Purpose communicates the primary objective of implementing the BIM Use. The BIM Use Purposes, shown in Figure1-2, fall into five primary categories: gather, generate, analyze, communicate, and realize. Of these primary categories, there are numerous subcategories that further specify the purpose of the BIM Use.

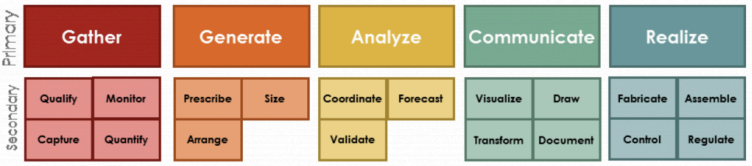

Figure 1-1: The BIM Use Purposes

The BIM Use Characteristics allow a user to further define the BIM Use based on common facility and project attributes: **facility element**, **facility phase**, discipline, and **Level of Development**. By determining these factors, as shown in Table 1-1, a particular BIM Use can then move to a specific approach.

Table 1-1: BIM Use Characteristics

Characteristics	Description
Facility Element	The system of the facility on which the BIM Use will be implemented.
Facility Phase	The point in the facility's lifecycle at which the BIM Use will be implemented.
Discipline	The party by whom the BIM Use will be implemented.
Level of Development	The degree of granularity to which the BIM Use will be implemented.

[1]buildingSMART alliance, National Building Information Modeling Standard Version 1 – Part 1: Overview, Principles, and Methodologies (National Institute of Building Sciences, 2007).

CHAPTER 2.

THE PURPOSE AND OBJECTIVES OF BIM

The BIM Use Classification System categorizes the BIM Uses primarily by the purpose and objective of the BIM Use. A BIM Use Purpose is *the specific objective to be achieved when applying Building Information Modeling during a facility's life*. The purposes and **objectives** for implementing a BIM Use, as shown in Table 2-1, are divided into five major categories and 18 subcategories.

Table 2-1: BIM Uses Purposes and Objectives

BIM Use Purpose			BIM Use Objective	Synonyms
01	**Gather**		**to collect or organize facility information**	administer, collect, manage, acquire
	01	Capture	to represent or preserve the current status of the facility and facility elements	collect
	02	Quantify	to express or measure the amount of a facility element	quantity takeoff
	03	Monitor	to collect information regarding the performance of facility elements and systems	observe, measure
	04	Qualify	to characterize or identify facility elements' status	follow, track, identify
02	**Generate**		**to create or author information about the facility**	create, author, model
	01	Prescribe	to determine the need for and select specific facility elements	program, specify
	02	Arrange	to determine location and placement of facility elements	configure, lay out, locate, place
	03	Size	to determine the magnitude and scale of facility elements	scale, engineer
03	**Analyze**		**to examine elements of the facility to gain a better understanding of it**	examine, evaluate
	01	Coordinate	to ensure the efficiency and harmony of the relationship of facility elements	detect, avoid
	02	Forecast	to predict the future performance of the facility and facility elements	simulate, predict
	03	Validate	to check or prove accuracy of facility information and that is logical and reasonable	check, confirm
04	**Communicate**		**to present information about a facility in a method in which it can be shared or exchanged**	exchange
	01	Visualize	to form a realistic representation of a facility or facility elements	review
	02	Transform	to modify information and translate it to be received by another process	translate
	03	Draw	to make a symbolic representation of the facility and facility elements	draft, annotate, detail
	04	Document	to create a record of facility information including the information necessary to precisely specify facility elements	specify, submit, schedule, report.
05	**Realize**		**to make or control a physical element using facility information**	implement, perform, execute,
	01	Fabricate	to use facility information to manufacture the elements of a facility	manufacture
	02	Assemble	to use facility information to bring together the separate elements of a facility	prefabricate
	03	Control	to use facility information to physically manipulate the operation of executing equipment	manipulate
	04	Regulate	to use facility information to inform the operation of a facility element	direct

These Purposes were developed through an extensive review of available resources. The Purposes were then grouped and the most comprehensive and applicable Purposes were selected. Those terms were then validated through a detailed **process** of industry review.

Each purpose is defined using the purpose term, an objective, synonyms, and a description (see Table 2-2).

Table 2-2: BIM Use Defining Attributes

Attribute	Description
Term	A word or phrase used to describe a thing or to express a concept
Objective	The goal, aim or purpose for implementing a BIM Use
Description	An account of the BIM Use including all the relevant aspects, qualities, and properties
Synonyms	A word or phrase that means nearly the same as standardized BIM Use Term. It may have had the same meaning but has since been superseded.

2.1 GATHER

Objective: to collect or cull facility information.

Synonyms: administer, collect, manage, and acquire.

Description: BIM is often used to gather information about a facility at various phases during a facility's life. Whether that is to count the specific amount of an element or determine the current status of a facility element in order to properly manage that asset, the use of BIM can greatly assist in this effort. This sub-purposes of BIM Uses include: Qualifying, Monitoring, Capturing, and Quantify. In this primary purpose of BIM Uses, the author is collecting, gathering and organizing information about the facility. This purpose of BIM Uses does not determine the meaning or make inferences about the meaning of the information gathered, rather it is solely focused on the collection and organization of the information. This is often the first step of a comprehensive series of BIM processes.

2.1.1 CAPTURE

Objective: to represent, or preserve the current status of the facility and facility elements.

Synonyms: collect.

Description: BIM is often used to capture geometric and attribute data about a facility. This can be done using a number of methods and at a number of points during the life of a facility: the elements of the site prior to the development of a new facility or the conditions of an existing facility prior to renovation. Data could be captured using a laser scanner or recorded manually by inputting model and serial numbers into a spreadsheet. The common factor within this purposes of BIM Uses is that data is captured where no data existed prior. However, it is not newly generated information, rather creating a record of the facility elements that exists.

2.1.2 QUANTIFY

Objective: to express or measure the amount of a facility element.

Synonyms: takeoff, count.

Description: In this purpose of BIM Uses, BIM is used for counting or collecting the number of specific facility elements. This purpose is often used as part of the estimating and cost forecasting process. During the design phase of a facility, quantities may be defined broadly, represented by a range and subject to change. In the construction phase, quantities become more certain and in the operations phase, quantities of elements can be readily calculated, say for instance. For example, the area of carpet to be replaced or the vacant space which

is available and rentable, the exact area and dimensions should be known.

2.1.3 MONITOR

Objective: to observe the performance of facility elements and systems.

Synonyms: observe, measure.

Description: BIM can be used to monitor real-time performance data of facility elements and facility activities. This purpose of BIM Uses includes those domain uses in which BIM is implemented to understand the performance of particular facility elements or processes. For example, during the operations phase of a facility, BIM can be used to monitor the temperature of a space. It is in this purpose of BIM Uses where Building Automation System data is integrated with the BIM data. Or in construction, BIM could be used to monitor the productivity of a construction process. It is in this purpose of BIM Uses that dynamic real-time data is collected to support decision making.

2.1.4 QUALIFY

Objective: to characterize, or identify facility elements status.

Synonyms: follow, track, identify.

Description: For this BIM Use Purpose, the status of a facility element is tracked. This includes information such as: does this element exist within the facility? How is it working? This BIM Use Purpose tracks facility elements over time. For example, in design, what is the element's level of development? In construction, has the

element been fabricated? Is it installed? Is it damaged? During operations, this BIM Use Purpose can collect warranty information on the element and whether or not the element is reaching the end of its useful life.

2.2 GENERATE

Objective: to create or author information about the facility.

Synonyms: create, author, model.

Description: Within the lifecycle of a facility almost every discipline that interacts with the facility will generate information about the facility. This purpose of BIM Uses includes those where BIM is used to create or author information about the facility. It includes prescribing, arranging, and sizing facility elements to various levels of development. Within the design phase, the design team will be the primary generators of information, while in the construction phase, the subcontractors will generate most of the information. Additionally, in the operations phase, that information could be generated by those maintaining the facility when they update or change that facility. Anytime new information is authored, modeled, or created, it is generated.

2.2.1 PRESCRIBE

Objective: to determine the need for and select specific facility elements.

Synonyms: program, specify, select.

Description: The prescribing purpose of BIM Uses is

used when a generator determines there is a need for a specific facility element. The programmer or architect of the facility may prescribe the need for certain rooms or spaces in the facility. While the mechanical engineer may prescribe the need for a specific HVAC system. The contractor could determine the need for a temporary construction element such as a tower crane, and the operator of the facility may prescribe a specific replacement part for the facility. The element prescribed depends on a number of factors such as phase, discipline, and level of development.

2.2.2 ARRANGE

Objective: to determine location and placement of facility elements.

Synonyms: configure, layout, locate, place.

Description: The arranging purpose of BIM Uses includes those Uses in which a location or configuration of a facility element is determined. During the planning phase of a facility's life, this could be the arrangement or adjacency of specific spaces within a proposed facility. During the design phase, it could be the general location of fire protection piping. While in the construction phase, it could include the placement of the hangers that support that piping. This could also be used during the operations phase to determine the placement of furniture systems. In general terms, any time a geometric location of the element is determined, it is being arranged.

2.2.3 SIZE

Objective: to determine the magnitude and scale of facility elements.

Synonyms: scale, engineer.

Description: The sizing purpose of BIM Uses is in use when the magnitude of a facility element is determined. Some of those elements during design could include the dimensions of spaces, the shape of a steel beam, or the size of ductwork. During construction, it could include the size of a crane or the thickness of duct insulation. Additionally, during operations, facility managers record the size of replacement parts or modifications to the facility.

2.3 ANALYZE

Objective: to examine elements of the facility to gain a better understanding of it.

Synonyms: examine, evaluate.

Description: Elements of the facility often require further analysis to determine their viability for the facility. The analyzing purpose of BIM Uses includes those uses in which a methodical examination of the facility elements is needed. The Uses of this purpose include coordinating, forecasting, and validating. It is in these BIM Uses data is often taken from what was gathered or generated and put into the format into which it can be used for decision making.

2.3.1 COORDINATE

Objective: to ensure the efficiency and harmony of the relationship of facility elements.

Synonyms: detect, avoid.

Description: The coordinating purpose of BIM Uses include those uses where facility elements are analyzed to ensure their relationship to other elements is effective and in harmony. This purpose of BIM Uses is often called clash detection, collision avoidance, design coordination, and interference management, among others. Ultimately, all of the facility elements should work in conjunction with one another. This can include coordinating design intent of various systems during design, coordinating fabrication and installation during construction or coordinating existing operations while renovations are underway. Overall this purpose of BIM uses ensures that the facility will fit together as it is planned and that all the various systems have been considered.

2.3.2 FORECAST

Objective: to predict the future performance of the facility and facility elements.

Synonyms: simulate, predict.

Description: This purpose of BIM Uses is one of the largest and has the most variance in its application from element to element. Within this purpose of BIM Uses, detail analysis is conducted to predict future performance of the facility and facility elements. Some of the primary performance factors that should be considered include financial, energy, flow, scenario, and temporal. Financial forecasting includes cost estimation of first cost of

construction as well as the life cycle cost of a facility. Energy forecasting predicts how future energy consumption and flow forecasting predicts performance such as air flow or occupant/crowd circulation. Scenario forecasting predicts performance of the facility during emergencies, such as fire, flood, evacuation, and others. Temporal forecasting predicts the performance of the facility over time to include building degradation and the timing for element replacement. Together this purpose of BIM Uses examines multiple facility variables predicts facility performance.

2.3.3 VALIDATE

Objective: to check or prove accuracy of facility information and that is logical and reasonable.

Synonyms: check, confirm.

Description: This purpose of BIM Uses is implemented to validate facility information. This includes purpose checking facility information for accuracy to ensure that it is logical and reasonable. The validating BIM Uses fall into three primary areas: prescription, functionality, and compliance validation. Prescription validation ensures that the facility has the elements that were specified and programmed within the facility including the primary element of facility spaces or rooms. The purpose of functionality validation is to ensure that the facility is constructible, maintainable, and usable. Will the facility perform the purpose for which it has been designed? Compliance validation confirms a facility's compliance with codes and standards to include building codes, ADA standards, sustainability standards

and others. Anytime facility information that was developed in another process is checked for accuracy, it falls into the category of validating.

2.4 COMMUNICATE

Objective: to present information about a facility in a method in which it can be shared or exchanged.

Synonyms: exchange.

Description: One of the primary Uses of BIM is to communicate facility information. The communication purpose of BIM is intended to present information about a facility in a method which can be shared or exchanged. This is often the last step of many other processes when a visualization, transformation, drawing, or document is developed to communicate information from that process to the next user of that information. This is one of the most valuable uses of BIM. It promotes and enhances communication and often reduces the time it takes to communicate. Additionally, communication of the data is often a byproduct of the processes to accomplish other BIM Uses.

2.4.1 VISUALIZE

Objective: to form a realistic representation of a facility or facility elements.

Synonyms: review.

Description: As part of the communication purpose of BIM Uses, using BIM to better visualize a facility is very powerful. It is especially powerful for those who have not been trained within the design and construction industry

but are critical stakeholders and decision makers. The visualization purpose of BIM Uses include those BIM Uses which are implemented to form a representation of the facility or facility elements. Often this visualization can be very realistic and detailed in nature. Visualization is often used to support decision making about the facility's design or construction as well as support marketing efforts. It can include walkthroughs, renderings, and schedule visualizations. The fact that the visualization is a byproduct of other BIM processes improves the ability of individuals to share facility information in a more effective manner with much additional effort.

2.4.2 TRANSFORM

Objective: to modify information and translate it to be received by another process.

Synonyms: translate.

Description: Often within the BIM process, facility information needs to be taken from one form to another so that it can be received and used by another process. This translation or transformation of data allows for interoperability between different systems. It also allows legacy data to be used by current infrastructure. Some examples include developing spooling information, developing layout data, and developing industry standard formats. Often this translated data is in manner in which it is not human interoperable, but readable by machine.

2.4.3 DRAW

Objective: to make a symbolic representation of the facility and facility elements.

Synonyms: draft, annotate, detail.

Description: While it might be possible to one day rid the industry of drawings and paper, this is not the case today. With that said, BIM improves the ability to develop drawings including detailing and annotating them. These are developed in a parametric method rather static methods. For example, when the BIM model is updated, the corresponding drawings and sheets are also updated. Anytime a symbolic representation is developed from an intelligent model, it is considered a drawing. This includes isometric, one line diagrams, figures and all other symbolic representations.

2.4.3 DOCUMENT

Objective: to create a record of facility information including the information necessary to precisely specify facility elements.

Synonyms: specify, submit, schedule, report.

Description: Often times it is necessary to record facility data in a written narrative or tabular format. The document purpose of BIM Uses includes uses in which a record of facility data is created. This includes those Uses necessary to precisely specify facility elements. The output of this BIM Use often includes specifications, submittals, design schedules, and other reporting of facility data.

2.5 REALIZE

Objective: to make or control a physical element using facility information

Synonyms: implement, perform, execute.

Description: BIM is beginning to allow the industry to remove the direct input of human interaction to develop specific elements of the facility. The realize purpose of BIM Uses includes those Use in which facility data (BIM data) is used to make or control a physical element of the facility. This BIM Use purpose gives the industry the ability to fabricate, assemble, control, and regulate elements of the facility. It is this ability that could eventually lead to the improved productivity of both construction and operations of facilities.

2.5.1 FABRICATE

Objective: to use facility information to manufacture the elements of a facility.

Synonyms: manufacture.

Description: BIM is allowing the industry to develop facility elements that were not possible prior to detail product modeling. The fabricate purpose of BIM Uses include those Uses in which facility information is directly used to manufacture elements of the facility. For example, facility information can be used to directly fabricate structural steel shapes from a CNC Machine or directly fabricate ductwork or cut piping. Within the design phase, BIM can be used to quickly generate prototypes of future facility elements, while in operations it could be used to quickly fabricate replacement parts.

2.5.2 ASSEMBLE

Objective: to use facility information to bring together the separate elements of a facility.

Synonyms: prefabricate.

Description: The assembling purpose of BIM Uses include those uses where facility information is made available to bring together the separate elements of a facility. While still somewhat of a manual process, the precision that BIM allows, ensures that different systems can be prefabricated. It even gives the ability to fit together systems that were traditionally very separate. Some common example include curtain wall systems, energy/MEP cores, and restrooms.

2.5.3 CONTROL

Objective: to use facility information to physically manipulate the operation of executing equipment.

Synonyms: manipulate.

Description: BIM affords the ability to use facility information to control equipment operations. The controlling purpose of BIM Uses include those Uses in which facility information is used to physically manipulate the operation of executing equipment. Some common examples include using facility information to lay-out future work within a facility such as the location of walls or the future placement of imbeds in composite decks. Another example is using facility information to control executing equipment: determining stakeout area using GPS systems which is tied to excavating equipment.

It is the ability to control executing equipment that could one day lead to the automated construction site.

2.5.4 REGULATE

Objective: to use facility information to inform the operation of a facility element.

Synonyms: direct.

Description: The use of BIM to regulate facility elements potentially allows facility operators to optimize their operations. The regulating purpose of BIM uses include those in which facility information is used to inform the operation of a facility element. A common example of this is when information gathered from a temperature monitor (or thermostat) is used to alter the output of the HVAC system. A critical component of the process is that the data is tied to intelligent monitoring systems and the building information model. This allows the systems to make informed decisions based on the entire system. It is this purpose of BIM Uses which could eventually lead to fully automated operations of a facility.

CHAPTER 3.

ELABORATION ON THE BIM USE CHARACTERISTICS

BIM Use Characteristics are used to more precisely define the BIM Use beyond the purpose and objective alone. The characteristics to be defined, as shown in Table 3-1, include the facility element(s), facility phase(s), discipline(s), and level of development.

Table 3-1: BIM Use Characteristics

Characteristics	Description
Facility Element	The system of the facility on which the BIM Use will be implemented.
Facility Phase	The point in the facility's lifecycle at which the BIM Use will be implemented.
Discipline	The party by whom the BIM Use will be implemented.
Level of Development	The degree of granularity to which the BIM Use will be implemented.

Adding these characteristics move the BIM Use beyond answering "why" to a more distinct description which could be used in procurement efforts. Additionally, when BIM planning, a team can communicate to all the stake

holders who, what, when, and to what degree the BIM Use will be implemented. Depending on the facility's BIM utilization, it is possible to have multiple disciplines implement multiple BIM Use purposes during multiple phases on multiple facility elements to multiple levels of development. For example, Coordination Analysis can be implemented during design and construction by the designer and contractor to a level of development 300 and 400. Therefore creating two separate instances of a BIM Use.

3.1 FACILITY ELEMENT

It is necessary to determine on which facility elements the BIM Use(s) will be executed. Based on OmniClass Table 21: Elements [5] or other applicable element breakdown structures, the team can determine which facility elements are part of the BIM use. For example, the team may determine that it only necessary to develop a schedule visualization of the substructure and superstructure and not the systems of the facility. The top level of this table include: 01) Substructure, 02) Shell, 03) Interiors, 04) Services, 05) Equipment and Furnishings, 06) Special Construction and Demolition, and 07) Sitework.

3.2 FACILITY PHASE

After determining the discipline, the planning team should determine during which facility phase they will be implementing the BIM Use. Facility phase designation

often results in multiple BIM uses and multiple disciplines. For example, the design team may be responsible for coordination analysis during the design phase and the construction team may be responsible for the coordination analysis during the construction phase. If **project team** does not have phase predetermined, it is suggest that the team use OmniClass Table 31: Phases [6] to designate phases: These current phases within this table include: 10) Inception Phase, 20) Conceptualization Phase, 30) Criteria Definition Phase, 40) Design Phase, 50) Coordination Phase, 60) Implementation Phase, 70) Handover Phase, 80) Operations Phase, 90) Closure Phase.

3.3 DISCIPLINE

The discipline is also synonymous with the responsible party for the BIM Use. OmniClass Table 33: Disciplines [7] presents standard disciplines. These disciplines could also correspond with the various project roles. At a top level, the disciplines currently in this table include planning, design, investigation, project management, construction, facility use, and support. While the primary discipline may be identified, this does not preclude other disciplines from being responsible for part of the BIM Use. Additionally it is possible to have multiple disciplines responsible for the BIM Use. This would then make for separate BIM Uses.

3.4 LEVEL OF DEVELOPMENT

For each of the BIM Uses, the level of development should be identified in order to maximize the benefit from the BIM Use. The Level of Development describes the level of detail / granularity to which a Model Element is developed. AIA / BIMForum has recently released a major revision to the level of development specification. This revision further specifies level of development for specific elements of the facility. Table 3-2 shows a description of the Level of Development definitions.

Table 3-2: Fundamental LOD Definitions [8]

Level of Development	Description
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 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 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 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 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 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.

[5] OCCS Development Committee Secretariat, "OmniClass Table 21 – Elements," May 16, 2012, http://www.omniclass.org/.

[6] OCCS Development Committee Secretariat, "OmniClass Table 31 – Phases," October 31, 2012, http://www.omniclass.org/.

[7] OCCS Development Committee Secretariat,

"OmniClass: Table 33 – Disciplines" (OmniClass Secretariat, October 30, 2012), http://www.omniclass.org/pdf.asp?id=11&table=Table%2033.

[8] BIMForum, "2013 Level of Development Specification" (AIA / AGC, August 22, 2013), http://bimforum.org/wpcontent/uploads/2013/08/2013-LOD-Specification.pdf.

CHAPTER 4.

SELECTION OF BIM USES

Based on the overall BIM strategy including the Mission, **Vision**, **Goals** and Objectives for a project or organization, the planning team should identify the appropriate BIM Uses. A challenge and opportunity faced by the early project planning team is identifying the most appropriate uses for BIM on a project given the project characteristics. There are many different traditional tasks that can benefit by being replaced by the implementation of BIM. The goal of this section is to provide a method for

BIM STRATEGY:
Mission: Defines the purpose of the project.
Vision: The picture of the project after it has integrated BIM.
Goals: Specific aims which the project wishes to accomplish.
Objectives: Specific results

that when accomplished move the goals

identifying appropriate BIM Uses for project implementation. These steps, as shown in Figure 4-1, include defining the purpose and additional characteristics for each BIM Use.

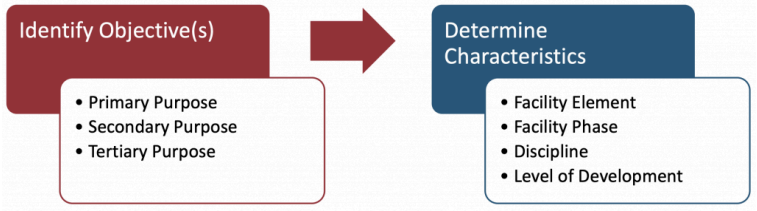

Figure 4-1: BIM Use Selection Procedure

4.1 DETERMINE THE PURPOSE FOR IMPLEMENTING BIM

BEGIN WITH THE END IN MIND [9]

When planning for the implementation

Based on the overall strategy, the planning team should begin to determine how they will be implementing BIM on the project. The planning team should consider how they will be using information during the course of the

project including how they will:

- Gathering
- Generating
- Analyzing
- Communicating, and
- Realizing

Often, these tasks or purposes have been implemented using "traditional" processes. It is up to the project team to determine if they will be implementing these using BIM. (More detailed descriptions can be found in the next section of this guide.) It is important that the team consider each of potential uses (as shown in Table 4-1 and consider their relationship with the project goals.

of BIM it is critical to consider the entire life of the facility. The planning team should strive to understand how all facility stakeholders will be implementing BIM. The planning team should consider how the facility owners are going to be using BIM first and then work their way back through construction, through design and into planning.

Table 4-1: BIM Use Purposes and Objectives

BIM Use Purpose			BIM Use Objective	Synonyms
01	**Gather**		**to collect or organize facility information**	administer, collect, manage, acquire
	01	Capture	to represent or preserve the current status of the facility and facility elements	collect
	02	Quantify	to express or measure the amount of a facility element	quantity takeoff
	03	Monitor	to collect information regarding the performance of facility elements and systems	observe, measure
	04	Qualify	to characterize or identify facility elements' status	follow, track, identify
02	**Generate**		**to create or author information about the facility**	create, author, model
	01	Prescribe	to determine the need for and select specific facility elements	program, specify
	02	Arrange	to determine location and placement of facility elements	configure, lay out, locate, place
	03	Size	to determine the magnitude and scale of facility elements	scale, engineer
03	**Analyze**		**to examine elements of the facility to gain a better understanding of it**	examine, evaluate
	01	Coordinate	to ensure the efficiency and harmony of the relationship of facility elements	detect, avoid
	02	Forecast	to predict the future performance of the facility and facility elements	simulate, predict
	03	Validate	to check or prove accuracy of facility information and that is logical and reasonable	check, confirm
04	**Communicate**		**to present information about a facility in a method in which it can be shared or exchanged**	exchange
	01	Visualize	to form a realistic representation of a facility or facility elements	review
	02	Transform	to modify information and translate it to be received by another process	translate
	03	Draw	to make a symbolic representation of the facility and facility elements	draft, annotate, detail
	04	Document	to create a record of facility information including the information necessary to precisely specify facility elements	specify, submit, schedule, report.
05	**Realize**		**to make or control a physical element using facility information**	implement, perform, execute,
	01	Fabricate	to use facility information to manufacture the elements of a facility	manufacture
	02	Assemble	to use facility information to bring together the separate elements of a facility	prefabricate
	03	Control	to use facility information to physically manipulate the operation of executing equipment	manipulate
	04	Regulate	to use facility information to inform the operation of a facility element	direct

When determining whether or not they will be implementing BIM for these BIM Use purposes, the project team needs to consider the BIM resources, competency, and experience of the team. The resources include software, hardware, and IT support. When determine competency and experience, the planning team should consider past performance and overall ability. It is important to understand that if the team does not have the necessary skills to successfully implement BIM it may actually hinder the adoption of BIM. At the

end of this effort the team should be able to make a "go / no go" decision on each of the BIM Use purposes prior to more elaboration on each BIM Use.

4.2 ELABORATE ON WHO, WHAT, WHEN, AND TO WHAT LEVEL

After the planning teams determines for which purposes the project will be implementing BIM, they need to determine, as shown in Table 4-2, which discipline, which phase, which facility elements, and to what level of development these BIM Use purposes will be implemented.

Table 4-2: BIM Use Elaboration Characteristics

Characteristic	Description
Facility Element	The system of the facility on which the BIM Use will be implemented.
Facility Phase	The point in the facility's life at which the BIM Use will be implemented.
Discipline	The party by whom the BIM Use will be implemented.
Level of Development	The degree of granularity to which a model element is developed.

Adding this detail, elaborates on the BIM Uses above only a purpose. It is possible to have multiples of each characteristic for each BIM Use purpose. For example, multiple disciplines can implement multiple BIM Use purposes during multiple phases on multiple facility elements. Therefore it is possible at the conclusion of the effort, that the project team may have as few as five elaborated BIM Uses or as many as 50 or more elaborated BIM Uses depending on the level of implementation of the project. At the conclusion of the effort, the team will

now be able to describe all the Uses in terms of discipline, phase, elements, level of development and purpose. Often after elaborating on the characteristics of the BIM use, a planning team often determines that they have more BIM Uses.

[9] Stephen R. Covey, The 7 Habits of Highly Effective People: Restoring the Character Ethic, Rev. ed. (New York: Free Press, 2004).

APPENDIX A: CITATIONS

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APPENDIX B: GLOSSARY

Building Information Modeling (BIM) (CIC Research Program): A process focused on the development, use, and transfer of a digital information model of a building project to improve the design, construction and operations of a project or portfolio of facilities.

Building Information Modeling (BIM) (NBIMS): "the act of creating an electronic model of a facility for the purpose of visualization, engineering analysis, conflict analysis, code criteria checking, cost engineering, as-built product, budgeting and many other purposes."[10]

Building Information Model (BIM) (NBIMS): A digital representation of physical and functional characteristics of a facility. A BIM is a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle; defined as existing from earliest conception to demolition. A basic premise of BIM is collaboration by different stakeholders at different phases of the life cycle of a facility to insert, extract, update or modify information in the BIM to support and reflect the roles of that stakeholder.

BIM Project Execution Plan (BIM PxP or BIM Plan): A planning the results from the BIM Project Execution

Planning Process. This document lays out how BIM will be implemented on the project as a result of the decision of the group.

BIM Project Execution Planning Procedure: A process for planning the execution of BIM on a project. It consists of four primary steps: 1) identify BIM Goals and BIM Uses, 2) design BIM Project Execution Process, 3) develop Information Exchanges, 4) define supporting infrastructure for BIM Implementation.

BIM Use: A method or strategy of applying Building Information Modeling during a facility's lifecycle to achieve one or more specific objectives.

Characteristics (BIM Use): An element used to define the Use of BIM including its purpose and objective, facility element, facility phase, discipline and level of development.

Discipline: Disciplines are the practice areas and specialties of the actors (participants) that carry out the processes and procedures that occur during the life cycle of a construction entity.[11]

Elaboration Characteristics (BIM Use): the second level or tier of BIM Use definition including facility element, discipline, facility phase, and level of development.

Facility Phase: A phase is a period of time in the duration of a construction project identified by the overall character of the construction processes which occur within it.[12]

Facility Element: An Element is a major component, assembly, or "construction entity part which, in itself or in combination with other parts, fulfills a predominating function of the construction entity" (ISO 12006-2).[13]

Goals (BIM): Objectives used to define the potential value of BIM for a project and for project team members. BIM Goals help to define how and why BIM will be used on a project or in an organization.

Level of Development (LoD) (The Uses of BIM): The degree of granularity to which a model element is developed. Level of Development (LoD) (BIMForum): The degree to which the element's geometry and attached information has been thought through – the degree to which the project team members may rely on the information when using the model.

Objective (BIM): Specific results that when accomplished move the organization toward their BIM goals.

Process (BIM): A generic name for the practice of performing BIM. This process can be planned or unplanned. The BIM Process may also be referred to as the BIM Execution Process or the BIM Project Execution Process. The BIM Project Execution Planning Process suggests diagramming the BIM process using process maps.

Process Maps (BIM): A diagram of how BIM will be applied on a project. The BIM Project Execution Plan proposes two levels of Process Maps: BIM Overview Map and Detailed BIM Use Process Maps.

Project Team: Every participant contracted to work on a project. This may include the owner, designer, contractor, and subcontractor.

Purpose (BIM Use): The specific objective to be achieved when applying Building Information Modeling during a facility's life. See section 2 for a description of each BIM Use Purpose

Vision (BIM): A picture of what the BIM Implementation is striving to become.

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[10] buildingSMART alliance, National Building Information Modeling Standard Version 1 – Part 1: Overview, Principles, and Methodologies

[11] OCCS Development Committee Secretariat, "OmniClass: Table 33 – Disciplines."

[12] OCCS Development Committee Secretariat, "OmniClass Table 31 – Phases." 13 OCCS Development Committee Secretariat, "OmniClass Table 21 – Elements."

[13] OCCS Development Committee Secretariat, "OmniClass Table 21 – Elements."

APPENDIX C: VERSION HISTORY

Revisions from Version 0.9 to Version 1.0:

GLOSSARY

BIM Use

A method of applying Building Information Modeling during a facility's lifecycle to achieve one or more specific objectives.

Building Information Modeling (BIM)

The act of creating an electronic model of a facility for the purpose of visualization, engineering analysis, conflict analysis, code criteria checking, cost engineering, as-built product, budgeting, and many other purposes."[1]

Characteristics

An element used to define the Use of BIM including its purpose and objective,
facility element, facility phase, discipline and level of development.

Elaboration Characteristics

The second level or tier of BIM Use definition including facility element, discipline, facility phase, and level of development.

Goals

Objectives used to define the potential value of BIM for a project and for project team
members. BIM Goals help to define how and why BIM will be used on a project or in an organization.

Level of Development (LoD) (The Use of BIM)

The degree of granularity to which a model element is developed.

Vision

A picture of what the BIM Implementation is striving to become.

discipline

Disciplines are the practice areas and specialties of the actors (participants) that carry out the processes and procedures that occur during the life cycle of a construction entity.

Source: OCCS Development Committee Secretariat, "OmniClass: Table 33 - Disciplines."

facility element

An Element is a major component, Assembly, or "construction entity part which, in
itself or in combination with other parts, fulfills a predominating function of the construction entity" (ISO 12006-2).[13]

[13] OCCS Development Committee Secretariat, "OmniClass Table 21 - Elements."

facility phase

A phase is a period of time in the duration of a

construction project identified by the
overall character of the construction processes which occur within it. [12]

[12] OCCS Development Committee Secretariat, "OmniClass Table 31 - Phases."

objectives

Specific results that when accomplished move the organization toward their BIM goals.

process

A generic name for the practice of performing BIM. This process can be planned or unplanned. The BIM Process may also be referred to as the BIM Execution Process or the BIM Project Execution Process. The BIM Project Execution Planning Process suggests diagramming the BIM process using process maps.

project team

Every participant contracted to work on a project. This may include the owner, designer,
contractor, and subcontractor.

purpose

The specific objective to be achieved when applying Building Information Modeling
during a facility's life. See section 2 for a description of each BIM Use Purpose