Autodesk® Building Information Modeling 2013

BIM for Commissioning, Handover, and Operations

Building Information Modeling (BIM) is an intelligent 3D model-based process used for the design, construction, and operation of buildings and infrastructure projects. The integration of digital building models and operational data is enabling more efficient lifecycle management. This paper offers insight into how BIM can be used for project commissioning, handover, and lifecycle management.

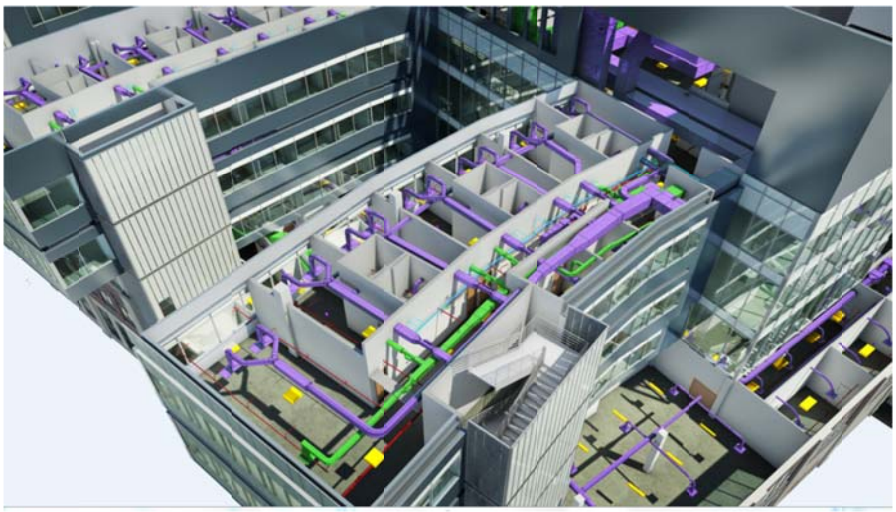

Figure 1. Owners are using BIM for project commissioning, handover, and lifecycle management.

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BIM for Design, Construction, *and* Lifecycle Management

BIM is an intelligent 3D model–based process that provides insight for creating and managing building projects faster, more economically, and with less environmental impact. The benefits of using BIM during design and construction are well publicized. Industry adoption of BIM in North America surged by 75% in the last 5 years, and today almost three-quarters of the North American building industry use BIM to deliver better performing, higher quality buildings[1].

The success of BIM for building delivery is fueling the push towards using BIM for model-based lifecycle management. To capitalize on the value of BIM, building owners are now starting to use the building models and information created during design and construction to improve their building management and operations activities.

The 'i' in BIM—information—is the primary value of BIM for lifecycle management. To successfully cultivate that information, project teams need to adhere to model and data specifications throughout design, construction, and commissioning. And cultivating the *right* information in the model for operations requires a thorough understanding of the end use and users of that building data.

Owners are now starting to mandate the use of BIM during design and construction with the intent to use the building models and data for operations (see sidebar below). They see model-based workflows as an opportunity to minimize their startup time, enhance asset management activities, reduce energy use, and lower operating costs.

Autodesk offers a comprehensive portfolio of BIM solutions that building professionals can use to design, visualize, and simulate their projects. To help extend the value of BIM to building owners, Autodesk works with strategic partners who have industry experience in systems and services for lifecycle management to help capture, manage, and link existing project data to an owner's enterprise systems for facility management, and operations & maintenance (O&M).

Owner Mandate

Increasingly, institutional and federal agencies are mandating the use of BIM and establishing standards for BIM deliverables. For example, in December 2011 the U.S. General Services Administration (GSA) released the first version of its BIM Guide for Facility Management to ensure that its BIM deliverables address facility management needs upon facility occupancy. Similarly, Penn State's Computer Integrated Construction (CIC) Research Program published its BIM Planning Guide for Facility Owners in April 2012, which presents a standard approach for facility owners to more effectively plan the integration of BIM throughout the organization and the lifecycle of a facility. These are just a few examples of owner standards for BIM. See Appendix A for a list of links to the documents referenced above and other BIM standards for owners.

[1] McGraw-Hill Construction, *"SmartMarket Report: The Business Value of BIM in North America"*, November 2012

The Need for Improved Handover

An often-cited 2004 report from the National Institute of Standards and Technology (NIST)[2] calculated that the annual cost of inadequate interoperability in the United States capital facilities industry was $15.8 billion. The report went on to state that owners shouldered approximately two-thirds of those costs during the ongoing operations of their facilities.

The study estimated that operations and maintenance (O&M) personnel spent $4.8 billion annually on information verification and validation. Then they spent another $613 million to transfer that information into a useful format for their systems and processes.

Given these numbers, owners are increasingly requiring that handovers include the more accurate and detailed digital building information that comes from BIM processes—and in a form that can be utilized and consumed by their systems.

Cost of Inadequate Interoperability by Stakeholder Group and Life-Cycle Phase (in US$ Millions)

Stakeholder Group	Planning, Engineering, & Design Phase	Construction Phase	Operations and Maintenance	Total
Architects and Engineers	1,007.2	147.0	15.7	1,169.8
General Contractors	485.9	1,265.3	50.4	1,801.6
Specialty Fabricators and Suppliers	442.4	1,762.2	—	2,204.6
Owners and Operators	722.8	898.0	9,027.2	10,648.0
Total:	2,658.3	4,072.4	9,093.3	15,824.0

Source: Table 6.1, Cost Analysis of Inadequate Interoperability in the U.S. Capital Facilities Industry

Figure 2. Owners shoulder two-thirds of the cost of inadequate interoperability in the United States capital facilities industry.

Capturing Commissioning Data

To capture commissioning data in a form that can be utilized in an owner's processes and systems for facility management and O&M, the owner must establish handover requirements for its capital projects. This requires an understanding of how BIM tools, models, and information will be used for lifecycle management.

Since different owners use different processes and systems for different operations, there is no 'right-way' to use BIM for lifecycle management. Nevertheless, here is a high-level workflow used by owners to help capture and integrate commissioning data:

- Project teams, commissioning personnel, and owners work together—starting as early as possible in the design process—to identify the pertinent handover information (documents and attribute data) needed for an owner's operations.
- BIM software used during the design process by the architect, structural engineer, and MEP engineer automatically incorporates certain project data into the discipline-specific design models. Owners will ultimately use some of this data for facility management and O&M.

[2] Michael P. Gallaher, Alan C. O'Connor, John L. Dettbarn, Jr., and Linda T. Gilday, "Cost Analysis of Inadequate Interoperability in the U.S. Capital Facilities Industry", August 2004

- 3D design and fabrication models are combined in a single 'federated' model for project coordination and construction planning. Attribute data for individual design components (such as doors and associated hardware, light fixtures, finishes, and air-handling units for example) captured during the design process are also transferred to the federated model.
- Teams also use specialized software and service providers to update the federated model with accurate operational information and documents—such as equipment serial numbers, installation and warranty dates, finishes information, and maintenance manuals—to create a digital handover model.

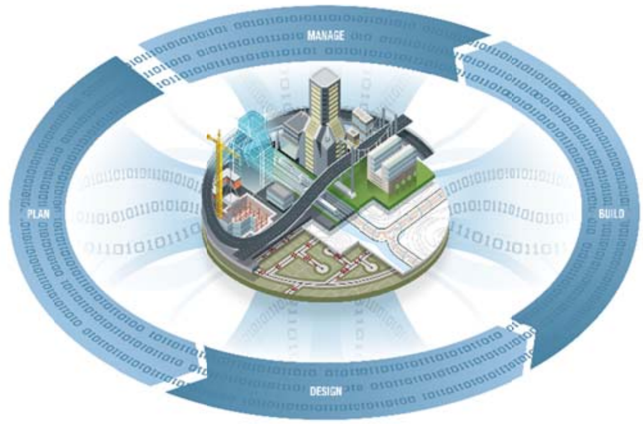

Figure 3. BIM integrates and optimizes project data throughout the project lifecycle.

- Industry standards for collecting building information needed for operations—such as Construction Operations Building Information Exchange (COBie)—also help project teams digitally capture facility information created throughout the planning, design and construction processes and pass the data to the next link in the building lifecycle process, and ultimately to the owner (see sidebar at right).
- A variety of methods are used to capture, extract, and link the handover project data and models to the owners' lifecycle management solutions, such as FM:Systems®, IBM® Maximo®, or IBM® TRIRIGA®.
- Ultimately, owners are seeking an 'as-maintained' model—e.g. a model that stays up-to-date with the building over its lifecycle and is perpetually connected to the owner's lifecycle tools. The as-maintained model would reflect changes to the facility as they occur over time and thus serve as a more accurate basis for renovation/retrofit activity than the 'as-built' models delivered at handover. In addition, the as-maintained model would include performance-based history about the building, providing greater insight to owners and their AEC services firms.

Planning for BIM and Workflow Considerations

What can owners and their project teams do to better prepare for the use of the BIM models and data?

To start with, the handover of digital models needs to be included in the scope of the building project. Owners must be specific about their expectations for the handover model and define what information the model(s) should include (see sidebar below). In addition, when an owner defines its information needs early in the project, the cost of gathering that information tends to decrease based on preset expectations and workflows.

Lifecycle management is generally data-centric, whereas design and construction is more model-centric. Building models used for design and construction are extremely detailed, supporting documentation creation, clash detection, and other geometry-intensive activities. Models needed for O&M are generally used to visualize spaces and navigate to building data—integrating virtual building representations with O&M software platforms to provide a more interactive visual capability. Therefore, models used for design and construction have different requirements for geometric detail (or "level of development") than those used for O&M.

On the other hand, design and construction models created without owners guidelines often lack even the most basic information required for operations and are sometimes turned over to the owner cluttered with unnecessary data. Careful planning and consideration of the owner's end requirements are essential.

Architect and builders tend to assume that owners need as-built models. In fact, what owners usually need are models—and data—that have been right-sized for their operations. For example, if an owner does not need to tag a piece of equipment, that equipment probably does not need to be included in the handover model. To accurately assess information needs, owners must rely on input from their own IT and facilities groups. Owners should 'start at the end' by documenting what data their organization needs to accomplish its day-to-day tasks and putting those needs at the top of their requirements list.

A Win-Win Situation

Facility information created during planning, design and construction—although destined for the owner—is often extremely useful for the other project participants as well. Information exchange formats such as COBie enable the whole project team to benefit from—and make optimal use of—the information while the owner receives the facility information it needs for operations.

Also, what level of integration between operational systems and handover project models/data does the owner require? This should guide the owner's digital requirements for commissioning. Owners should weigh the expense of collecting certain data against the benefit of utilizing that data.

To jumpstart their requirements, many owners draw upon existing standards for defining the building information they need for operations. Sources such as UFGS (see sidebar at right) and COBie, as well as the National Building Information Model Standard (NBIMS), or the AIA's E202–2008 BIM Protocol document are established templates for the exchange of facility and infrastructure data throughout the lifecycle of a building project (see the Appendix for sources).

After defining what they want, owners need to clearly communicate these standards to their architecture and engineering teams. Deliverable standards set clear expectations for consultants to deliver compliant data, and it behooves owners to give clear direction to achieve maximum return during the lifecycle of the building.

UFGS: The Unified Facilities Guide Specifications or UFGS, a joint effort of several US federal government agencies, are construction guide specifications used by the participating agencies for their facility construction projects. The guide includes this list (see Appendix B for a more detailed version) of the types of information required in operations & maintenance data package:

- ✓ Spatial Assets
- ✓ Equipment Assets
- ✓ Parts and Warranty Contacts
- ✓ Warranty Information
- ✓ Replacement Parts
- ✓ Operating Plans
- ✓ Preventive Maintenance
- ✓ Emergency Operations
- ✓ Troubleshooting Instructions
- ✓ Safety Instructions
- ✓ Coordinates

Key Takeaways

High performance teams utilize BIM throughout design, construction, *and* building lifecycle. In the coming years, more and more owners will be requiring the use of BIM for operations.

To optimize the value of BIM handover, owners should begin with the end in mind by understanding the business issues of the people who use the handover data and address their data and workflow needs. At a bare minimum, owners should at least require that their handover deliverables include the source BIM-based as-built models and a package of digital operations manuals for their building assets. In turn, contractors need to understand their clients operational and business issues and be prepared to organize their data and models for their client's consumption.

Lifecycle management is not what Autodesk does—it is what the models and data created by Autodesk software can do. BIM solutions represent powerful technology that, when combined with solid guidelines, help to streamline operations and maintenance.

Owners are in a unique position to demand high performance and drive the building and infrastructure industry toward more efficient lifecycle management. Autodesk strives to help owners and their project stakeholders do that.

Future Predictions

The 2012 SmartMarket report cited these predictions by representatives from large facility owners on the impact of BIM in the coming years.

"Over the next ten years, building owners will demand ever-increasing usage of BIM as a precondition, ushering in a new era of accuracy, quality and sophistication for the building industry."

—Patrick MacLeamy, CEO of HOK, chairman of buildingSMART International

"Effectively employing BIM in the lifecycle management of a facility and Real Property Portfolio will transform the industry in ways not seen since the introduction of elevators multiplied the number of floors in buildings."

- Charles Matta, FAIA, deputy CIO of GSA Public Buildings Services

Source: McGraw-Hill Construction, "SmartMarket Report: The Business Value of BIM in North America", November 2012

Glossary

As-built model: A model representing the as-built conditions of a facility.

Building Information Management or BIM: An intelligent model-based process that helps owners and service providers achieve business results by enabling more accurate, accessible, and actionable insight throughout project execution and lifecycle.

Fabrication model: A building model with an adequate level of detail and accuracy for use in prefabrication.

Federated model: A building model that is the combination of discipline-specific models (ex. Architecture, plumbing, electrical, HVAC, etc), which is often used for 3D coordination.

Level of development or LOD: The level of completeness to which a model element is developed.

Lifecycle management: The practice of coordinating the physical facility with the people and work of the organization throughout the total lifecycle of the facility—from concept to design to construction to operations to reuse and eventual demolition.

Model-based: The use of 3D digital data and modeling software to provide specifications for individual components and assemblies.

Appendix A: BIM Standards for Owners

- U.S. General Services Administration (GSA) BIM Guide Series 08 - Facility Management v1 (www.gsa.gov/portal/content/122555)
- The Pennsylvania State University, Computer Integrated Construction Research Program. (2012). "BIM Planning Guide for Facility Owners". Version 1.0, April, (bim.psu.edu/Owner/default.aspx)
- Indiana University BIM Deliverable Standards (www.indiana.edu/~uao/iubim.html)
- U.S. Veterans Affairs (VA) BIM Guide (www.cfm.va.gov/til/bim/BIMGuide/lifecycle.htm)
- AIA E202 – BIM Protocol Exhibit (www.aiacontractdocuments.org/e202_faq.cfm)
- AGC ConsensusDOCS 301: BIM Addendum (www.agc.org/cs/contracts)
- COBie (Whole Building Design Guide) (www.wbdg.org/resources/cobie.php)
- National BIM Standard™ (www.wbdg.org/bim/nbims.php)
- Penn State BIM Project Execution Planning Guide (www.engr.psu.edu/ae/cic/bimex)
- Autodesk BIM Deployment Plan (www.autodesk.com/bimdeploymentplan)

Appendix B: UFGS

The Unified Facilities Guide Specifications (UFGS) are a joint effort of the U.S. Army Corps of Engineers (USACE), the Naval Facilities Engineering Command (NAVFAC), the Air Force Civil Engineer Support Agency (HQ AFCESA), the Air Force Center for Engineering and the Environment (HQ AFCEE) and the National Aeronautics and Space Administration (NASA).

UFGS consist of a master set of construction specifications contributed and maintained by the participating agencies as standard construction guide specifications used in facility construction projects. The guide includes this list of the types of information required in operations & maintenance data package:

BENEFICIAL OCCUPANCY PHASE

a. Spatial Assets.
    (i) Gross Area
    (ii) Net Area
    (iii) Floor Covering Type
    (iv) Wall Covering Type
    (v) Ceiling Type

b. Equipment Assets.

c. Parts and Warranty Contacts.

d. Warranty Information.

e. Replacement Parts.

f. Operating Plans.
    (i) Operator Prestart. Include procedures required to install, set up, and prepare each system for use.
    (ii) Startup, Shutdown, and Post-Shutdown Procedures. Provide narrative description for Startup, Shutdown and Post-shutdown operating procedures including the control sequence for each procedure.
    (iii) Normal Operations. Provide narrative description of Normal Operating Procedures. Include Control Diagrams with data to explain operation and control of systems and specific equipment.
    (iv) Operator Service Requirements. Include instructions for services to be performed by the operator such as lubrication, adjustment, calibrations, inspection, and recording gage readings.
    (v) Operating Instructions. Includes specific instructions, procedures, and illustrations for operation of the installed Components and features of each Type and System.

g. Preventive Maintenance.

h. Emergency Operations.

i. Troubleshooting Instructions.

j. Safety Instructions.

k. Coordinates.

l. Products and Equipment Attributes.