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BIM USES GUIDE

YOU ARE HERE

The *BIM Uses Guide* defines the way BIM can be used on projects.

GETTING STARTED

Getting Started with Building Information Modeling (BIM) on a project can be overwhelming – there seem to be an endless amount of technical terms, acronyms, and software programs. The UCMC BIM Subcommittee created the following set of resources to support Harvard stakeholders, whether the language of BIM populates your everyday conversations or this is your first time learning about BIM.

Beginners may find it helpful to start with the *Introduction to BIM* and progress sequentially to the *BIM Uses Guide*. Others may start with the *BIM Procurement Guide*, flip back to the *BIM Uses Guide*, and then jump to the *BIM Execution Plan Template*.

"What is BIM?"	**"How can I use BIM on my project?"**	**"Should I use BIM on my project?"**	**"How can I select a BIM-enabled team?"**	**"How do I implement BIM on my project"?**
1	2	3	4	5
INTRODUCTION TO BIM	**BIM USES GUIDE**	**BIM DECISION MATRIX**	**BIM PROCUREMENT GUIDE**	**BIM EXECUTION PLAN TEMPLATE**
Addresses questions including: ▪ What is BIM? ▪ Why should I use BIM? ▪ Does BIM cost more? ▪ Take longer?	Explains the different ways project stakeholders can use BIM. Future documents reference the *BIM Uses Guide.*	Helps Harvard stakeholders determine if a project can benefit from BIM, and if so, what specific BIM Uses are best suited for that project. * Includes *BIM Decision Matrix* instructions	Includes: ▪ Sample RFP language ▪ BIM-capability evaluation methods ▪ Procurement Best Practices	A standardized framework for teams to plan, document, and implement BIM on a project. * Includes *Guide to BIM Execution Planning*

1. EXISTING CONDITIONS

1.01 Surrounding Area

Laser scanning accurately records the surface geometry of the surrounding environment. This data can be converted to a BIM, providing documentation of the surrounding project area. The results provide improved modeling and site-related analysis (i.e. sun path, wind, etc.) as well as contextual understanding for design and construction logistics planning. Another (less accurate) method of documenting surrounding areas is photogrammetric surveying, which provides measurements from photographs.

Figure 1 Surrounding area model

1.02 Existing Buildings

Laser scanning, combined with conventional surveying methods, produces an accurate virtual model of the existing building. The resulting documentation looks like a photograph, but is actually made up of millions of points—each with its own coordinate. These points, referred to as a 'point cloud' can be converted to a BIM, providing an accurate baseline for documentation and coordination. Costly field issues associated with inaccurate as-built documentation can be eliminated with the precise nature of a laser scan.

Laser scanning should be considered for:

- **1.02.1 Building Exterior**
- **1.02.2 Building Interior**
- **1.02.3 Building Systems**

1.03 Geo-Tech

Information from borings and geotechnical reports can be extrapolated into a BIM to plan soil removal and subsurface work. BIMs include:

- **1.03.1 Environmental Pre-Characterization**
- **1.03.2 Subsurface**

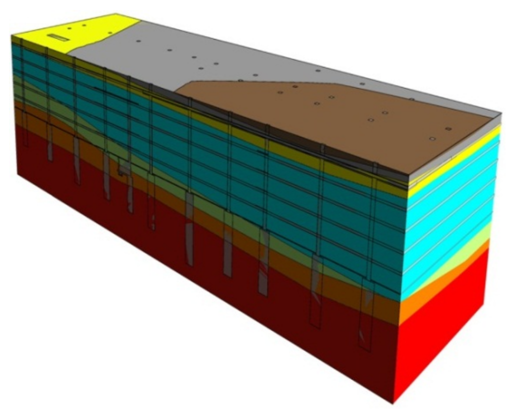

Figure 2 Environmental pre-characterization model

1.04 Site and Topography

Site surveys or laser scanning can document surface conditions. Benefits of this can include an improved contextual understanding for design and construction logistics planning, allowing the team to design and fabricate around topographical obstacles, avoiding costly changes.

The following elements can be included in the BIM for document planning and coordination:

- **1.04.1 Surface Materials**
- **1.04.2 Site Utilities**
- **1.04.3 Major Plantings**

2. Program and Space Validation

Area and program information is extracted from the BIM in order to track developments in space allocation as the design develops. This allows the tracking of design decisions on rentable area, gross area, and usable area. BOMA calculations and diagrams can be generated directly from the BIM. Different applications can include:

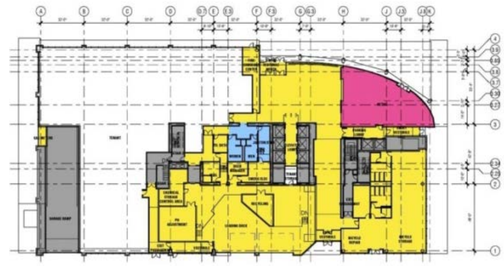

Figure 3 BOMA plan created from model

2.01 Program

2.02 BOMA (Building Owners and Managers Assoc.)

3. Design Authoring

The BIM is the environment for developing the design for:

Figure 4 Architecture design model

3.01 Architecture

3.02 Interiors

3.03 HVAC

3.04 Structure

3.05 Telephone/Data

3.06 Plumbing

3.07 Lighting

3.08 Fire Protection

3.09 Electrical/Fire Alarm

4. Digital Mock-Up

Detailed modeling of specific areas and assemblies can improve understanding of and coordination between design details. This can facilitate discussion with consultants, contractors, and subcontractors resulting in optimized and constructible details. The following systems should be considered:

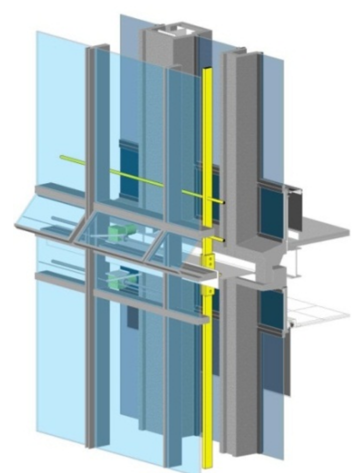

Figure 5 Curtain wall digital mock-up

4.01 Foundations

4.02 Façade

- **4.02.1 Curtain wall Assembly**
- **4.02.2 Parapet**
- **4.02.3 Mechanical Spaces**
- **4.02.4 Material Interfaces**

4.03 Mechanical

- **4.03.1 Mechanical Spaces**
- **4.03.2 Material Interfaces**
- **4.03.3 Shafts**

4.03.4 **Plenum**

4.04 Quantity Comparison

4.05 Finishes

4.06 FFE

4.07 Elevator

5. Design Options

Figure 6 Design options created in Revit

5.01 Visualization

Multiple versions of a design can be modeled for comparison through renderings, drawings, and other imagery. Visualizations of each option allow for more informed decision-making by owners, users, or potential tenants.

5.02 Quantity Comparison

Separate quantity takeoffs can be extracted for cost comparisons between design options, providing accurate cost breakdowns to support decision-making.

6. Design Communication

6.01 Still Images

Images can be exported from the BIM to provide visualization of the design intent. Accurate materials and lighting can create photo-realistic imagery to preview the visual impact of the finishes. Still images come in several of the following forms:

6.01.1 **Renderings**

6.01.2 **Rendered Drawings**

6.01.3 **Imagery**

Figure 7 High resolution interior rendering

6.02 Animations

The BIM can be used to create various animations: walk-throughs, fly-throughs, and step-by-step sequences of detailed assemblies and processes.

6.03 3D Print

A 3D printer constructs a scale physical model from a digital model, such as a BIM. The model can be created from materials such as acrylic, epoxy, starch, and powder. 3D printing is an efficient process for generating a physical representation from a digital design, providing a tactile way to experience the design.

6.04 Promotional Materials

Images, animations, and other assets can be created within the BIM to support promotional materials, including signage, slides, tear sheets, and videos.

6.05 Tenant Guidelines

7. Design Documents

7.01 OPR/BOD

7.02 Documents

2D design documents are created within the BIM and can improve coordination between the various disciplines, leading to reductions in cost. Types of documents include: plans, exterior elevations, interior elevations, building sections, schedules, and legends.

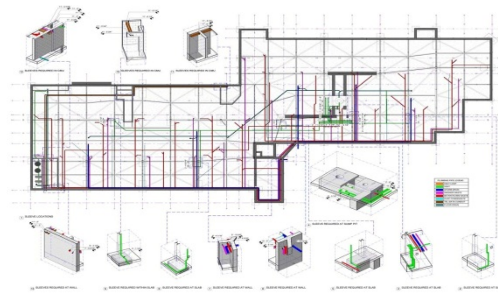

Figure 8 Color-coded plan showing pipe embed locations

7.02.1 SD

7.02.2 DD

7.02.3 CD

7.03 Details

Details can be created within the BIM using combinations of 2D and 3D documentation. At minimum, details should be comprised of 2D drafting over 3D model geometry. 2D drafting over live views of 3D geometry assures more accurate coordination than importing 2D details into the BIM. Details fully modeled in 3D allow for the most accurate coordination and quantity extraction.

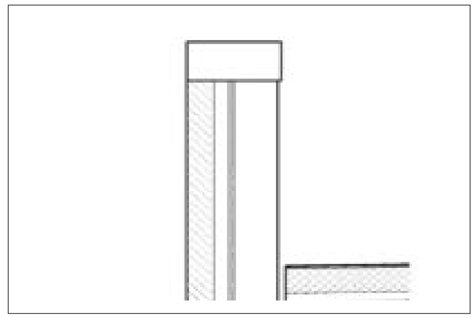

Figure 9 Unmodified detail section in Revit
Image Credit: HKS Architects

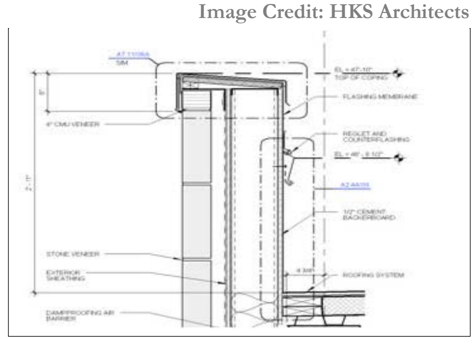

Figure 10 Detail section with annotation and detail elements
Image Credit: HKS Architects

7.03.1 Details - SD

7.03.2 Details - DD

7.03.3 Details – CD

7.04 Specifications

Specifications can be linked to the BIM, enabling an update to the specifications manual each time a change is made in the BIM. If components are synced, designing and altering will not cause errors. Integration between specifications and the BIM can create a unified project with consistent information.

8. Design Analysis

8.01 Architectural

The following analyses can be performed by leveraging geometry or data from the BIM, enabling iterative review of design:

8.01.1 Materials

8.01.2 Day lighting

8.01.3 Code Validation

8.01.4 Acoustical

8.01.5 ADA

8.01.6 Egress

8.02 Sustainability/Evaluation

8.02.1 LEED Documentation

8.02.2 Daylighting

8.02.3 Documentation for LEED credits can be developed using views from the BIM.

8.02.4 Utility Int. Analysis

8.03 Energy Model

Due to timing of analysis and potential model clean-up, energy analysis is often performed separate from the BIM. There are opportunities to leverage some architectural geometry and data, preventing the engineer from developing a separate model.

9. ENGINEERING ANALYSIS

9.01 Structural Analysis

Structural design options, overall building structure, and individual detailed connections can be analyzed and tested, which can result in a structure optimized for cost and performance.

9.02 Energy Analysis

The following loads can be calculated using spatial and envelope data from the BIM:

9.03 Mechanical Analysis

9.04 Lighting Analysis

9.05 Envelope

Using geometry and data from the BIM, the envelope can be analyzed at the levels of system, assembly, and material interfaces. Since the enclosure is a high-risk element, the envelope analysis is a critical component of a project. Envelope analyses include:

9.05.1 Thermal

9.05.2 Thermal-Air Infiltration

9.05.3 Hydrothermal (Condensation)

9.05.4 Structural

9.05.5 Fire

9.05.6 Water-Proofing

9.06 Wind

Wind studies can leverage geometry from the BIM, resulting in quicker turnaround of and more opportunities for analysis.

10. DESIGN COORDINATION

10.01 Clash Detection

Software analyzes the BIM for physical interferences (clashes) between building systems and components, then, clashes are manually sorted and reported. Clash detection during design can result in increased coordination of design intent, setting the stage for construction coordination.

10.02 Clearance Checking

Clearance checking is a type of clash detection that analyzes code or access clearance conflicts. This can be accomplished by modeling clearance zones or by changing clash settings to clearance.

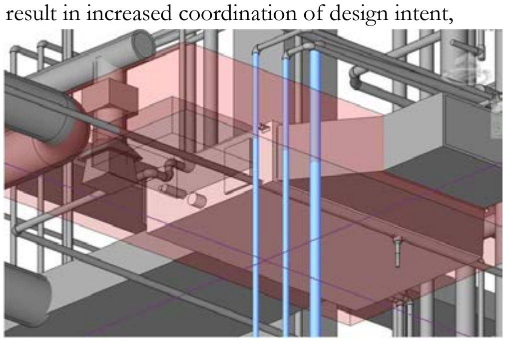

Figure 11. Transparent red volume indicates clearance zone required for mechanical maintenance

10.03 Clash Resolution

Conflicts found during clash detection need to be resolved within the design BIM authoring platform. Virtually solving the issue ahead of time can avoid costly errors and revisions in the field.

11. Construction Coordination

11.01 Clash Detection

Software analyzes the BIM for physical interferences (clashes) between building systems and components, then, clashes are manually sorted and reported. Construction-level clash detection can result in a reduction of: field conflicts, RFIs, and change orders. Coordination with off-site prefabricated components can be improved.

11.02 Clearance Checking

Clearance checking is a type of clash detection that analyzes code or access clearance conflicts. This can be accomplished by modeling clearance zones or by changing clash settings to clearance.

11.03 Clash Resolution

Conflicts found during clash detection need to be resolved within the fabrication BIM authoring platform in order to be incorporated into shop drawings. Virtually solving the issue ahead of time can avoid costly errors and revisions as well as schedule and occupancy delays.

11.04 Coordination Sign-Off

After construction coordination is complete, a set of 2D and 3D coordination drawings can be created within the BIM for construction team sign-off and design team submittal review.

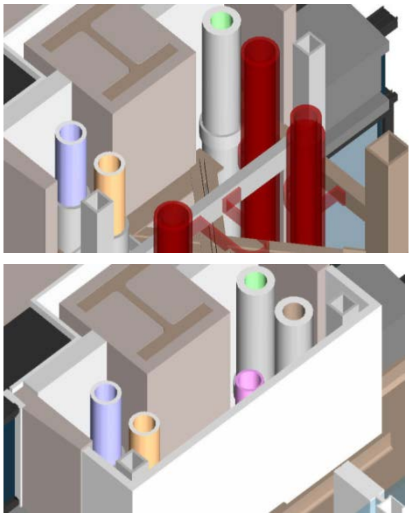

Figure 12 Detailed demolition and installation phasing of facade elements

12. Scheduling

12.01 Phasing

12.01.1 Project Phasing

Representative masses in the BIM are linked to the summary project schedule for visualization and preliminary planning. This improves understanding of phasing and can allow for comparison of different strategies.

12.01.2 Detailed Phasing

Detailed phasing focuses on a specific detail, process, or period of time, such as curtainwall assembly or slurry walls/ foundations. Components in digital mock-ups are linked to a construction sequence in order to visualize multi-trade installation. This identifies critical phases of the installation sequence of complex details.

12.02 Schedule

12.02.1 Project Schedule

Individual objects in the BIM are linked to the master schedule for visualization and schedule simulation. Visualizations can include milestone snapshots and animations.

12.02.2 3-Week Look-Ahead

Snapshots can be extracted from the schedule-linked BIM in weekly intervals. This can reduce deviations from the original schedule, create visual milestones for the field staff, and verify that the project is on schedule.

12.02.3 Sequenced Logistics

Modeled logistics objects are organized by the construction schedule to produce visualizations of site planning.

13. Quantity Extraction

Quantity extractions from the BIM can be used to support cost engineering and procurement activities. Quantities can be provided in spreadsheet format as well as in Advanced Bill of Materials. Consider extracting the following quantities:

Figure 13 Advanced Bill of Materials sheet

13.01 Foundations

13.02 Structure

13.03 Exterior Enclosure

13.04 Roof

13.05 Interior Construction

13.06 Finishes

13.07 Stairs/Elevators

13.08 Mechanical

13.09 Electrical/Fire Alarm

13.10 Fire Protection

13.11 Site

13.12 Plumbing

14. Logistics Planning

Detailed logistics objects are modeled in the BIM and organized by the construction schedule. The model can provide fast, accurate quantities for logistics objects; simulation of construction phasing; and a single, coordinated source for logistics documentation. This can provide more accurate planning and study of logistics as well as clearer, more detailed planning presentations.

14.01 Traffic

The model can be used to design, simulate, and present traffic planning. Turning radius and wheel paths can be accurately calculated and documented allowing for a more detailed understanding of space allocation and vehicle access on the site.

14.01.1 Truck Routes/Queue

14.01.2 Lane Closures

14.01.3 Deliveries

14.02 Parking

The model can be used to analyze temporary parking options for the site and the public. Including parking spaces in the model allows for fast and accurate space counts, simulation of multiple design options, and a single file location for multiple parking allocations during different phases of design.

14.03 Site Planning

Staging and storage zones can be modeled and located in relation to equipment zones (e.g. crane radius) and other logistics objects (e.g. turning radius, truck routes). This can enable more detailed understanding and planning of the site.

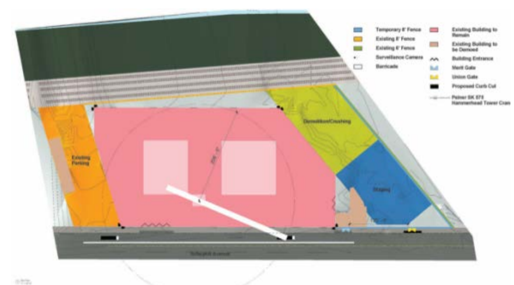

Figure 14 Site plan with crane radius

14.03.1 Staging and Storage

14.03.2 Equipment Zones

14.03.3 Environmental Controls

The following environmental control plans can be analyzed and developed in the model:

14.03.4 ICRA

14.03.5 Erosion Control

15. Safety

15.01 Internal Safety Measures

A complete safety plan can be developed in the BIM, which can result in better communication of requirements and a safer site. Components of a safety plan include:

15.01.1 Controlled Access Zones

15.01.2 Floor Penetration Protection

15.01.3 Guard Rail/Perimeter Protection

15.02 Public Safety Measures

Visuals can be extracted from the BIM to inform the public, communicate upcoming work, and allow stakeholders to interact with the job site. The public safety measures can include:

15.02.1 Pedestrian Protection and Routes

15.02.2 Emergency Routes

16. Construction Layout

Geometry from the BIM is exported to total station for an accurate, coordinated construction layout. This can increase efficiency in the layout of systems, and reduce overall margin of error. Systems to layout can include:

16.01 Partitions

16.02 Mechanical

- **16.02.1 Hangers**
- **16.02.2 Curbs**

16.03 Structure

- **16.03.1 Foundations**
- **16.03.2 Slabs and Slab Edge**
- **16.03.3 Structural Steel**
- **16.03.4 Verification**

Figure 15 Robotic Total Station in the field

17. SHOP DRAWINGS & SUBMITTALS

Geometry and data from the BIM can be exported to fabrication software. Required geometry is detailed for shop drawings and can be sent to computer numerical control (CNC) equipment for prefabrication, and erected efficiently on site. This can result in time and cost savings and a reduced margin of error. Potential systems to consider:

17.01 Formwork/Foundations

17.02 Steel

17.03 Façade

- **17.03.1 Curtain wall**
- **17.03.2 Metal Panel**

17.04 Mechanical

17.05 Plumbing

17.06 Fire Protection

17.07 Electrical/Fire Alarm

17.08 Casework/Millwork

17.09 Elevator

17.10 Design Features

17.11 Wood Framing

Figure 16. Fabrication model, CNC steel fabrication and erected steel

18. FIELD SUPPLEMENTS

18.01 3D Print

A 3D printer constructs a scale physical model from a digital model such as a BIM. The model can be created from acrylic, epoxy, starch, powder, and other materials. 3D printing is an efficient process for generating a physical representation of a complex detail, providing a tactile way to understand the assembly.

18.02 Drawings

Drawings are extracted from the BIM depicting additional details, dimensions, and other information needed for construction (supplementing the CDs). On-site efficiency can be maximized by quickly supplying the information to subcontractors.

18.03 Renderings

Photo-realistic imagery of special conditions, finished details, and spaces are printed large scale from the BIM and displayed on site. This can reduce rework by increasing understanding of design intent by subcontractors.

Figure 17 Interior rendering on site to guide construction

19. Turnover/Record BIM

The finished BIM is considered the Record BIM for turnover to the owner. See Appendix regarding the standard turnover. BIM elements can contain information for facilities management, including:

19.01 Warranty Data

19.02 Maintenance Data

19.03 Asset Data

19.04 Performance Data

20. Facilities Management

The Turnover/Record BIM can integrate with automated building controls, property management training, maintenance records, and work orders. The following features should be discussed:

20.01 CMMS Integration

20.02 BAS Integration

20.03 Controls Integration

20.04 Work Orders Integration

20.05 Mobile Solutions

20.06 Asset Tracking

20.07 Asset Management

20.08 Disaster Planning

20.09 Space Mgmt. & Tracking

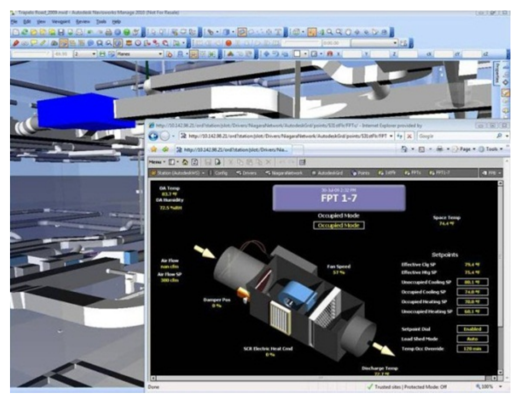

Figure 18. BAS integration platform

BIM Use Timeframes

Although teams should determine the appropriate timeframe for a BIM Use on a specific project, there are some general rules of thumb for BIM Use timeframes:

	Design	Preconstruction	Construction	Operations
Existing Conditions	●	●	●	
Program & Space Validation	●			
Design Authoring	●			
Digital Mock-Up	●	●	●	
Design Options	●			
Design Communication	●			
Design Documents	●			
Design Analysis	●			
Engineering Analysis	●			
Design Coordination	●			
Construction Coordination		●	●	
Scheduling		●	●	
Quantity Extraction		●	●	
Logistics Planning		●	●	
Safety		●	●	
Construction Layout			●	
Shop Drawings & Submittals			●	
Field Supplements			●	
Turnover/Record BIM			●	
Facilities Management Implementation				●

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