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University Construction Management Council

G U I D E   T O

BIM EXECUTION PLANNING

5

YOU ARE HERE

The *BIM Execution Plan Template* and accompanying *Guide to BIM Execution Planning* are the last elements in Harvard's *Getting Started with Building Information Modeling* set of resources.

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*

TABLE OF CONTENTS

INTRODUCTION

HARVARD AND BIM

Harvard will enhance the planning, design, construction, and facility management process at the University through the use of BIM to improve efficiency, quality, and reduce the cost of capital projects. Harvard will utilize BIM to promote a collaborative and efficient approach to project delivery and post construction efforts, where information is shared and University resources are effectively managed during the life cycle of a facility.
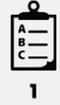
See Harvard's *Introduction to BIM* for more information.

WHAT IS A BIM EXECUTION PLAN?

A BIM Execution Plan ("BEP") is a BIM-driven project execution plan. It is a framework for strategically implementing BIM using consensus-built best practices, standards, and protocols. As the team coauthors the BEP, the project reaps secondary benefits. The process maximizes the benefits of BIM by improving communication and collaboration across the project team.

WHEN DO I START?

The team can start a BEP during virtually any project phase. However, the earlier the team starts developing the BEP, the sooner they can implement, and the better the outcome. Establishing standards early gives the team more time to adjust and improve.

HARVARD'S BEP TEMPLATE

The intent of the Harvard University BEP Template ("BEP Template") is to standardize how project teams document their BIM approach, *not* to standardize or mandate how they deliver BIM on projects. Standardized documentation of BIM approach will allow Harvard University to compare processes, deliverables, and results from a variety of BIM-enabled projects – which ultimately will allow Harvard University to identify best practices, streamline project BIM approach, and deliver consistent results.

Throughout this document, this icon indicates information that Harvard Project Managers "need to know."

BEP PROCESS

A BEP fits into Edward Deming's standard PDCA (plan-do-check-act) process improvement method.
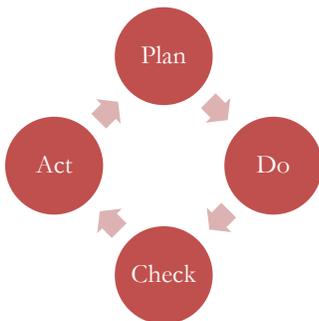
Plan	The initial authorship of the BEP, covered in great detail throughout this document.
Do	Implementation of the BEP throughout the course of day-to-day project work.
Check	At specific checkpoints, study the actual use of BIM on the project as compared to the BEP. Identify successes and deviations.
Act	Define and document the steps required to put BIM Implementation back on track. These can include modifying the BEP to reflect actual implementation or altering project process to comply with the BEP.

This document details the first step, Plan, of the cycle. See Conclusions at the end of this document for more information on the subsequent steps.

ROLES AND RESPONSIBILITIES

Leadership

According to the 2008 McGraw Hill Smart Market Report, 66% of architects and contractors identify "owner demand" as a key factor in influencing their BIM adoption. Owner buy-in and leadership enables greater team BIM performance; therefore, the Harvard PM

needs to help author the BEP and open the first meeting (see below). The Harvard PM's presence sets the tone for the BEP and the BIM implementation.

Facilitation

One participant will facilitate the authoring of the BEP. Responsibilities include setting up meetings, managing meetings, documenting decisions in the BEP, and documenting updates to the BEP. After each meeting, the facilitator should distribute minutes and updates to the BEP to all team members. For assignment of Facilitation, see Delivery Method section below.

Participants

BIM adoption requires buy-in at all levels; therefore, it is important to include each firm's Project Manager and BIM Lead in the authorship of the BEP. Criteria for a BIM Lead are defined in the Team section below. Depending on the size of the firm and the size of the project, the BIM Lead and the Project Manager may be the same person.

MEETINGS

BIM Execution Planning requires a careful mix of decision makers and technical users directly involved in production. The team will meet multiple times to discuss and document the BEP components. The table below outlines a recommended meeting sequence, including approximate durations, topics, and participants.

	Suggested Duration	Agenda Items	Participants	Owner	Architect	Engineer (S)	Engineer (MEP?F)	CM
Meeting 1	2 hours	Kick-off[1] Team Milestones	PM	●	●	●	●	○
			BIM Leads	●	●	●	●	○
Meeting 2	2 – 3 hours	BIM Uses Software	PM	●	●	●	●	○
			BIM Leads	●	●	●	●	○
Meeting 3	1 hour	Standards Model Management	PM					
			BIM Leads	●	●	●	●	○
Meeting 4	3 hours[2]	Level of Development	PMs					
			BIM Leads	●	●	●	●	○
Meeting 5	30 minutes	Sign-Off[3] Next Steps[4]	PM	●	●	●	●	○
			BIM Leads	●	●	●	●	○

● Indicates required attendee   ○ Indicates optional attendee, depending on delivery method.

[1] Introduction to BEP. Opportunity for Harvard PM to reiterate importance of BIM on project.

[2] Not all participants need to attend all disciplines. See Level of Development section below.

[3] Final BEP issued and reviewed.

[4] See Conclusions at the end of this document for more information on the subsequent steps.

DELIVERY METHODS

The BEP Template was created with all of Harvard's project types and delivery methods in mind. As a result, the BEP Template

The *BIM Procurement Guide* includes how to include the BEP into contract forms.

4

is flexible enough for teams to use it on any project, regardless of contract form.

Design-Bid-Build

On a Design-Bid-Build ("D/B/B") project, the architect will facilitate the BEP, unless otherwise directed by Harvard. The team may need to approach the BEP in two steps:

1. Initiate the BEP at the beginning of design, focusing on design team requirements and protocols. For construction-related content, teams can either (a) leave blank or (b) fill in to indicate construction team requirements. Harvard may opt to define overarching construction team requirements without drilling into excessive detail. For example, Harvard may identify BIM Use requirements for the construction team without developing the associated Level of Development and Workflow.

2. Once Harvard selects a CM, the full team can complete the BEP.

Design-Build

Given the structure of a Design-Build ("D/B") project, the D/B entity will facilitate the BEP, unless otherwise directed by Harvard. The team can complete the BEP at the beginning of the project. However, Harvard and the CM may opt to complete a preliminary BEP, to identify requirements for design team selection.

Construction Management at Risk

Similar to D/B/B, on a Construction Management at Risk ("CM At-Risk") project, the team may need to approach the BEP in two steps:

1. Initiate the BEP at the beginning of design, focusing on design team requirements and protocols. The architect will facilitate the BEP at this stage, unless otherwise directed by Harvard. Since Harvard will likely select a CM earlier in CM-At-Risk than D/B/B, the team can leave the construction-related content blank or define minimal construction-related requirements.

2. Once Harvard selects a CM, the full team can complete the BEP. Unlike D/B/B, BEP facilitation will transition from architect to CM, unless otherwise directed by Harvard.

USING HARVARD'S BEP TEMPLATE

The BEP Template is an Excel 2010 file. Users can edit, copy, delete, and otherwise modify all tables in the template to fit the specific needs of a project. Users should not resize columns as it will affect the print scale. Some sections of the template are minimized to save space. To expand these sections click, the + icon (shown at right) located to the left of the row numbers.

For clarity and brevity, delete all text, rows, and sections that are irrelevant to the final document (unless section directions indicate otherwise).

The BEP prints to a portrait 8.5 x 11" sheet. All pages will print with a header containing the section title, page number, date, and Harvard logo.

BEP COMPONENTS

The Harvard BEP Template is comprised of eight sections, introduced below. Each topic corresponds with a Tab in the BEP Template. Users should refer to this guide before you start BIM Execution Planning, as they work through each section of the BEP Template, and as a refresher during the project.

TEAM

BIM Leads

A BIM Lead is each discipline's BIM point person for the project. Choosing the appropriate BIM Leads is critical to successful BIM implementation.

The BIM Lead should be a permanent part of the project team. Ideally, the BIM Lead possesses the authority to make key decisions about process and scope and has some proficiency with BIM software. For example, deciding Model Access often requires modifications to an office's typical information sharing practices; weekly model uploads can seem like a major shift from milestone drawing exchanges. This requires a BIM Lead that can speak to that decision, and contribute technological expertise to the discussion.

If an office is short on BIM-enabled decision makers, a firm may suggest their office CAD Manager or "BIM Expert" as the BIM Lead. This person might have the requisite technical skills, but without being permanently committed to the project they cannot provide lasting support for the process. As a rule of thumb, consistent commitment to the project and authority are more important in a BIM Lead than technological prowess.

After identifying BIM Leads, use the BEP template to record their discipline and contact information.

IT Resources

BIM is technology intensive; therefore, it is helpful to have the IT Managers for each participating firm included in the BEP.

MILESTONES

BIM implementation is time-sensitive; processes, analysis, and deliverables can only add value to the project if information is available when needed. Defining milestones early provides a shared understanding of timing and a working vocabulary that will inform subsequent sections of the BEP. The team will use Milestones to define the start and end point of specific BIM Uses, model Level of Development ("LOD"), and Workflow.

Identify design deadlines, approvals, construction stages, procurement dates, key submittals, turnover deadlines, and other milestones that will impact project delivery. Sample milestones shown in image at right.

The inclusion of Milestones in the BEP doesn't suggest that the BIM Leads drive the schedule; rather, it is a way for Project Managers to ensure that the BIM Leads understand how milestones impact delivery.

Document milestones in the BEP template. When possible, include start and end dates for each milestone. If dates change as the project progresses, update the BEP accordingly.

Milestones Table

Project 1 (e.g. Base Building)

Fill in chart below to indicate major project phases and milestones. Provide start and end dates based on the best available information. Update this chart as new information becomes available.
Create additional rows as needed. Delete sample text. A second section is available for multi-phase projects – delete if not used.

Acronym	Milestones	Start (DD/MM /YYYY)	End (DD/MM /YYYY)	Notes
PD	ex: Program Design			
PD-OK	ex: Owner Approval of Program			
SD	ex: Schematic Design			
SD-OK	ex: Owner Approval of SD			
DD	ex: Design Development			DD set will serve as Permit Set. Procure key trade partners off of DD set.
DD-$	ex: DD Budget			
DD-OK	ex: Owner Approval of DD & Budget			
CD	ex: Construction Documents			CD will serve as GMP Set.
GMP	ex: GMP Set			
STL	ex: Steel Mill Order			
FND	ex: Foundations			
STL	ex: Steel Mill Order			
COM	ex: Commissioning			
CO	ex: Certificate of Occupancy			

BIM Uses

A BIM Use is a unique task or procedure on a project which can benefit from the integration of BIM into that process (Source: Penn State). They are the foundation of BIM implementation, and therefore, of the BEP.

See Harvard's *BIM Uses Guide* for BIM Use definitions.

Individual team members need to understand the value of their modeling efforts throughout the life of the project. If the team doesn't identify a BIM Use early enough, they likely won't create the model appropriately for that use. For instance, if properly modeled, a wall modeled during Schematic Design ("SD") can support quantity takeoff in Design Development ("DD") and coordination during the Construction Documents ("CD") phase. It is far easier to prepare for downstream use than it is to retrofit objects after the fact.

Considering BIM Uses

As a team, determine whether to proceed with each BIM Use.

Review and discuss the BIM Decision Matrix recommendations, as shown in the image to the right. To make the best use of the team's time, discuss the recommended "Proceed" Uses first, then the "Investigate" BIM Uses.

The team should only proceed with BIM Uses where the impact outweighs the effort.

Refer to the project's *BIM Decision Matrix* report for BIM Use recommendations.

Consider and discuss the potential impact and effort for each BIM Use. To assess impact, ask:

- What are the risks associated with the project? Can this BIM Use reduce risk?
- Does this BIM Use align with a specific project goal?

To assess effort, ask:

- Does the team have the resources for this BIM Use? Some BIM Uses require specialized modeling skills that the team might not have. Others require discipline-specific software and training to implement.
- How much time will it require? If a BIM Uses takes too much time, it may not be complete or available in a timely manner.
- Is the team committed to this BIM Use?
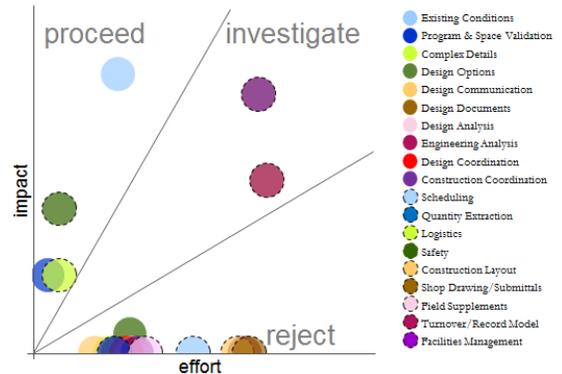
Documenting BIM Uses

Document status [Reject, Pending, Proceed] for each BIM Use in the BEP template. Identify roles, responsibilities, and phasing for "Proceed" BIM Uses. See BEP Template for specific instructions. The example in the BEP Template (shown below) indicates:

- Architect is responsible for documenting the existing conditions of Surrounding Area in the BIM, during Conceptual Design.
- Architect is responsible for documenting the existing Building Exterior, between Concept and SD. The CM will support the effort.
- Team will not document existing building interior or systems.
- CM is responsible for documenting the existing Geo-Tech conditions in the BIM, from Concept to CDs.
- CM is responsible for further investigation of Site & Topography documentation, with support from the Architect.

| Example													
BIM Use	Phasing		Owner	Design			Builder		Subcontractors				
	Start	End	HARV	ARCH	MEP	STRU	CM	Mech	Sh.Mtl	Plum	Elec	FP	Steel
Existing Conditions													
Surrounding Area	CO	CO		●									
Existing Buildings													
Building Exterior	CO	SD		●			○						
Building Interior													
Building Systems													
Geo-Tech	CO	CD		○			●						
Site & Topography				○			●						

SOFTWARE

We often say BIM is "10% technology, 90% sociology." However, technology is a key component of the BEP. Each project needs to consider software requirements.

Types of BIM Software

There are three basic types of software, divided into categories according to primary use:

- Teams use **Authoring Software** to generate model geometry and data. Most software platforms are better suited for either **Design Authoring** or **Fabrication Authoring** – although, some platforms can be used for both.

- Teams use **Reviewing Software** to review the model, extract information, and leverage data. Within the Reviewing Software, users cannot typically author, modify, or delete geometry or data. Various Authoring file formats aggregate in the Reviewing Software, creating the Composite Model (also referred to as the Composite BIM or the Federated Model).

- **Analysis Software** leverages authored geometry and data to perform specialized analysis, typically design analysis (e.g. energy, acoustical, structural, or day-lighting). The quality of the analysis is highly dependent on the quality of the model created in the Authoring Software. The team will include geometry and data requirements for analysis in the Level of Development discussion.
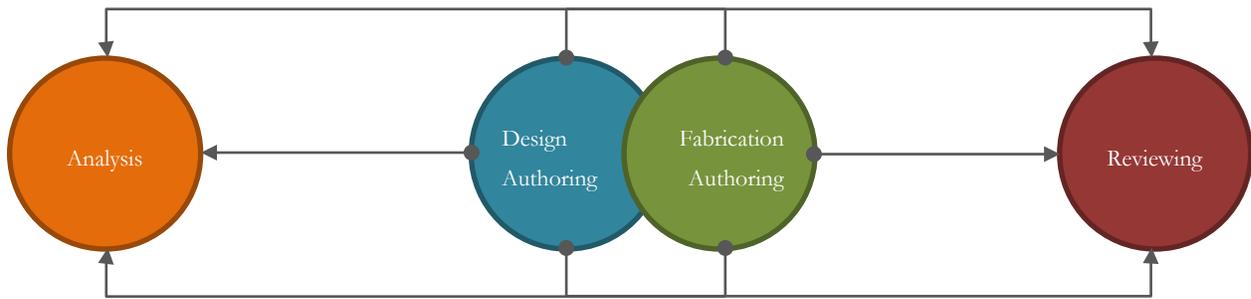
Software Products

There are many BIM software platforms available for any combination of Authoring, Reviewing, and Analysis. Harvard's software platform *preferences* are:

- Design Authoring .... Autodesk Revit or similar
- Fabrication Authoring .... Autodesk AutoCAD or similar
- Reviewing .... Autodesk Navisworks or similar
- Analysis .... No preference

The above preference is not a requirement or mandate; however, Harvard *requires* the following file formats for Turnover.

- Native file format
- Autodesk Revit (*.RVT) or Autodesk AutoCAD (*.DWG)
- Autodesk Navisworks (*.NWC; *.NWF; *.NWD)

Selecting Software

For each selected BIM Use, discuss potential software platforms. Consider the following guidelines when selecting software platforms:

- Harvard's *preference* is for Autodesk and Autodesk-compatible software.
- The team's proficiency with specific software platforms. Typically, specific Authoring software is fundamental to a firm's process, but they are more flexible with the Reviewing platform.
- Consider how compatible software platforms are. Consider the import and export formats of each software program.
- **To minimize complexity, select platforms which have functionality for multiple BIM Uses.**

Documenting Software

Once the team determines the appropriate software platform for each BIM Use, document it in the BEP Template. Include Software Platform, Notes, and Primary Users. See BEP Template for specific instructions. The example in the BEP Template (shown below) indicates:

- For all software selected: team will use most current version of software and won't upgrade until all team members agree to.
- Architect will use a combination of ImageModeler and SketchUp 8 to document the surrounding buildings.
- Architect and CM will document building exterior in Revit 2013, using the Scan-to-BIM Plugin.
- Architect and CM will use SketchUp 8 and Revit 2013 to document Geo-Tech reports; however, final deliverable will be in Revit.
- CM is investigating Civil 3D and Revit for Site & Topography modeling.

Example

BIM Use	Software Platform	Notes	Primary Users
Existing Conditions			
Surrounding Area	ImageModeler, SketchUp 8	1, 2	Architect
Existing Buildings			
Building Exterior	Revit 2013	1, 2, 5	Architect, CM
Geo-Tech	SketchUp 8, Revit 2013	1, 2, 6	Architect, CM
Site & Topography	Civil 3D? Revit?		CM

Notes

1 Projects will use most current version of software, unless otherwise indicated.

2 Projects will upgrade to new version of software after all team members have thoroughly tested and are comfortable with

3 Indicates a required file format, unless explicit permission to deviate is granted from Harvard.

4 Subcontractors must identify appropriate add-on, plug-in, or object enabler needed to properly view the file.

5 Architect will use Scan-to-BIM Revit Plugin

6 Modeling starts in SketchUp and then is transitioned to Revit for final deliverable.

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STANDARDS

In order to achieve BIM Uses, the team must follow certain Model Standards. Standards organize and format model files with clear protocols, so that they are suitable for the selected BIM Uses. Harvard prescribes certain Standards to ensure properly formatted turnover models which serve data management needs. The chart below indicates which Standards Harvard prescribes and which Standards teams need to develop. Regardless, teams need to discuss how each Standard applies to the project, determine how they will implement it on the project, and document decisions in the BEP Template.

Document each of the project standards in the BEP Template.

Standard	Harvard Prescribed	Team Determined
File Structure		
Organization		●
Nomenclature	●	
Worksets		●
Phasing		●
View Management		
Project Browser		●
Nomenclature	●	
Element Management		
Nomenclature	●	
Parameters	●	
Tolerance	●	●
Coordinate System		
Internal	●	
Shared	●	
Drawing Standards		
File Format & Setup	●	
Layering	●	

File Structure

File Structure is comprised of File Organization and File Nomenclature.

File Organization refers to the quantity and arrangement of individual model files. Typically, disciplines are isolated in an individual Authoring File; although, M/E/P/FP are often combined into a single Design Authoring File. File Structure is important because consistent file organization facilitates downstream BIM Uses, determines workflows, and maintains manageable file sizes.

File Nomenclature is a standardized naming convention for Authoring and Composite model files. Maintaining consistent file naming is critical for referenced (linked) files to function properly across project teams.

Worksets

Worksets are a Revit-specific standard. A Workset is a collection of model elements which subdivide a Revit file when worksharing is enabled. Worksharing is a design method that allows multiple team members to work on the same project model at the same time. This standard provides consistent nomenclature, methodology, and visibility for all worksets. Standardized worksets enables users to work efficiently when modeling, as well as when referencing (linking) files. Since most team members "Enable Worksharing", the standard sets expectations for the entire team.

Phasing

Phasing is another Revit-specific standard. In Revit, each Phase indicates a distinct period of time in the life of a project. Each element is placed in a specific phase (referred to as "Created In") and can be "Demolished In," if appropriate. This standard provides consistent nomenclature and methodology for all Revit files. Phasing controls the flow of building model data into views and schedules. Maintaining consistent phases is critical for referenced (linked) files to function properly across project teams.

View Management

View Management is comprised of Project Browser organization and Nomenclature. View Management impacts both Views and Sheets.

Project Browser is typically a Revit-specific standard, but the approach applies to other platforms. Revit's Project Browser shows a logical hierarchy for all views, schedules, sheets, families, groups, and other parts of the current project. Teams can use specific attributes to sort (e.g. by Team Member or Use). An organized Project Browser distinguishes the author of each view and view use. Sorting enables efficient access to content and assures that sheet views remain unaltered.

View and Sheet Nomenclature are a standardized naming convention for views, sheets, and schedules. Standardized naming allows users to quickly identify views and reinforces view use and team member. Review Harvard's View and Sheet Nomenclature Standard and discuss how the team will implement it on the project.

Element Management

Element Management is comprised of Nomenclature and Parameters. Since Element Management is critical for facilities management, Harvard prescribes a detailed standard.

Element Nomenclature is a standardized naming convention for model objects, which allows users to quickly identify what an object is. Review Harvard's Nomenclature Standard. The example in the BEP Template (shown to the right) is E-_NPDS_LPNP_PANEL30x30, which indicates:

Equipment						
Discipline	Equipment System	Equipment Type	Descriptor	Examples		Example Description
AA	AAAA	AAAA	A..AA	E-_NPDS_LPNL_PANEL30x20		30 x 20 Lighting Panel in Normal Power Distribution System
Discipline		Consists of one alphabetical character and a hyphen or two alphabetical characters. Refer to discipline codes list in File Organization. For more specific genres, creators can use the second letter to indicate the subset of that genre.				
Equipment System		Four character System Code. See Appendix A for more detail.				
Equipment Type		Four character Equipment Code. See Appendix A for more detail.				
Descriptor		Additional text describing the object; determined by user. May include function, material, size.				

- Discipline: The object is an electrical element
- System: The object is in a Normal Power Distribution System
- Type: The object is a Lighting Panel
- Descriptor: The object is a 30x20 Panel

Parameters are fields which hold data for component types or instances. Parameters can include location data, manufacturer information, and other characteristics. This standard provides consistent nomenclature for custom parameters and options for their values. Standardized implementation of data fields and values enables the team to more easily leverage the model for quantity takeoff, scheduling, and facilities management.

Discuss how the team will implement and maintain Element Management on the project. The team should detail specific protocols and include them as an Appendix to the BEP.

Tolerance

Tolerance indicates precision settings for authoring files for Length, Angle, Area, Volume, and Slope. Precisions settings for Composite Models include Clashing and Measuring. Determine the capabilities for most downstream uses of the model, including construction drawings, details, coordination, direct-from-model fabrication, and direct-from-model layout. Setting tolerance requirements assures a consistent level of precision across the project.

Harvard requires a specific tolerance for authoring and review, as indicated in the BEP Template. Depending on the selected BIM Uses, teams may need to implement a more stringent tolerance.

Coordinate System

Coordinate System addresses both internal and shared (or external) coordinates. Internal Coordinates include Levels, which align models in the "Z" axis, and Grids, which align models in the "X" and "Y" axis. External Coordinates aligns models with their coordinate position in the "real world." While Internal Coordinates align building disciplines with each other, External Coordinates will align the building with the rest of the campus.

Review Harvard's Coordinate System Standard in the BEP; determine how the team will implement the standard. Refer to the Harvard University Survey Standards & Specifications or the HPPM Planning Resources Group for more information or assistance.

Drawing Standards

Drawing Standards provide graphic consistency for each discipline's information as it is transferred to the required documentation of the drawing set. Harvard's Drawing Standards are included in the Harvard CAD and Image Standards. The BEP Template includes Revit-specific guidelines. Review both the Harvard CAD and Image Standards and the Harvard's Revit specific guidelines and discuss how the team will implement.

LEVEL OF DEVELOPMENT

Level of Development ("LOD") is an important planning tool for setting goals and managing the team's expectations. LOD is the maximum amount of information and geometry authorized for use by others. LOD addresses the information, geometry, and organization needed to complete specific BIM Uses in the given timeframe.

Basics of LOD

Industry-wide, LOD is an evolving topic, with many perspectives, complexities, and nuances. Harvard is tracking the discussion, especially that of the AIA/AGC BIMForum LOD Working Group, which will publish an LOD Catalog by Q2 2013. The LOD Catalog builds on the LOD originally defined in the 2008 AIA E202, which enables the team to assign LOD 100, 200, 300, 400, 500 to individual object types at each stage. Although there are contractual definitions, it is simpler to understand the intent of LOD.

It is important, albeit sometimes confusing, to distinguish level of *development* from level of *detail*. Level of detail is the amount of information and geometry provided by the modeler. Simply put, level of detail is input; LOD indicates reliability. For example, a structural engineer may *input* placeholder gusset plates during DD. Since the geometry is inaccurate, the team cannot *rely* on the gusset plate for coordination.

LOD is based on individual objects or assemblies rather than models. Therefore, there is no such thing as a LOD300 model. Although it is possible to have a model that contains objects at LOD300, it is highly unlikely. Different objects progress at different paces. As a result, Harvard's BEP Template provides a separate table for each object category (e.g. Doors, Duct, and Lights) and is organized by major modeling phase.

LOD Intent	
100	Estimate It
200	Specify It
300	Purchase It
400	Build/Install It
500	Operate It

Until the AIA/AGC Working Group publishes the LOD Catalog, Harvard requires teams to document LOD in detailed narrative format. Teams are welcome to use the LOD field to indicate general intent (See LOD Intent table above), but are not required to. Harvard will revise its BEP Template when the LOD Catalog is published. Some components need to be referenced in multiple models; however, it is best practice for the team to place object types in one model. As a result, it is useful to have all disciplines attend all LOD discussions to learn each other's modeling processes. For example, rather than place lighting fixtures in both the electrical model and architectural model, the electrical engineer and architect should determine requirements for lights that includes calculations, aesthetics, and geometry – and place lights in only one of those models. See table above for more examples. Throughout the BEP Template, LOD Rules of Thumb are provided, based on industry best practices for specific object types.

Cross Discipline LOD								
Component Type	Owner	Architect	Engineer (S)	Engineer (M)	Engineer (E)	Engineer (P)	Engineer (FP)	CM
Slabs	●	●	●					○
Lighting Fixtures	●	●			●			○
Plumbing Fixtures	●							○
Diffusers	●			●				○
Devices	●	●					●	○
Sprinkler Heads	●				●			○

Determining LOD

As a team, discuss and determine the LOD for each object type at each phase. Consider the following:

- The BIM Uses relevant to each object type, at each phase.
- What geometry does that BIM Use require?
- What data does that BIM Use require?
- How should the geometry and data be organized?

For example, assume a project team is discussing structural framing. The team is proceeding with some of the following BIM Uses:

- Structural Analysis during SD
- Construction Documents during SD and CD

▪ Coordination during CD and Construction
▪ Shop Drawing Review during Construction

The team will discuss the geometry and attribute requirements of each BIM Use. For example, Coordination likely requires accurately sized framing, accurately located. From a data standpoint, Coordination may require parameters that document each dimension of the member, as well as which level (elevation) the member is associated with. Furthermore, coordination may require beams on a separate workset from columns.

Documenting LOD

Once the team determines the LOD for a specific object type for each phase, document it in the BEP Template. Include Geometry (Location, Host), Data (Parameters), and Organization (Model, Worksets, and Category). See BEP Template for specific instructions. The example in the BEP Template (shown below) indicates:

▪ The structural engineer models framing through CDs and hands off model to steel detailer during Construction.

▪ During SD, the workset is the default for Grid Lines, Shared Levels & Grids. In DD the workset changes to Superstructure. After the engineer hands off, worksets aren't relevant because the detailing software does not use worksets or layers.

▪ During SD, the structural engineer represents column locations with gridlines, while completing analysis. By DD, the structural engineer has completed basic load calculations and is placing members.

Object Category (Structural Framing)					
	SD	**DD**	**CD**	**Construction**	**Turnover**
Model	STRUC	STRUC	STRUC	STEEL	
Worksets	Shared Levels & Grids	SuperStructure	SuperStructure	N/A	
Category	Grids (until RAM analysis complete)	Structural Framing	Structural Framing	Beam (IFCPROPER TYSET: Member_Type)	
LOD		L100	L300	L400	
Parameters			Left out (y/n)		
Location/Host	TOS, Level-hosted	TOS, Level-hosted	TOS, Level-hosted	TOS	
Notes	Place grids in design option to insure no accidental movement.	Accurate size and location.	Extend members to actual connection point (e.g. back of beam pocket) Include gusset plates.	Include all details except welds. Exclude connection openings from coordination exports.	Exclude nuts and bolts.

▪ The intent for framing is "Estimate It" in DD, "Puchase It" in CD, and "Build It" in Construction. There is no intent during SD and Turnover.

▪ Steel members in Revit include basic steel parameters by default. The only additional parameter requested by the team was a "Left Out" parameter during CD to indicate which beams to leave out for equipment installation.

▪ Revit beams are level-hosted by default. In this case, top-of-steel ("TOS") will be hosted to the bottom of the level above, which can clear up potential misalignments of links.

MODEL MANAGEMENT

Implementing and maintaining BIM on a project can be a complicated process with many moving parts. Model management is a generic term for the support of that process, which includes model quality assurance/quality control; file conversion, and model transfer protocols.

Quality Assurance/Quality Control

The purpose of Model Quality Assurance/Quality Control ("QA/QC") is to confirm that a model, or set of models, complies with the BEP, and therefore is appropriate for specific BIM Uses. Document QA/QC milestones and protocols in the BEP Template. The team can document QA/QC protocols, methods, or tips in the Additional Protocols section.

Model Transfer Protocols

Documenting Model Transfer Protocols clarifies model file requirements and expectations.

At minimum, the team should discuss the following iterative handoff points:

- Design Coordination
- Transfer to Construction
- Construction Coordination
- Shop Drawing Review
- Turnover

For each handoff point, the team should determine and document:

- Involved Team Members (Model Authors and Recipients)
- File Transfer Platform
- Timeframe/Schedule
- Protocols

WORKFLOW

Although workflow maps are not the end product, they are a step towards gaining team efficiency - enabling the team to perform at a higher level. Much like the overall BEP, the benefits come from both the act of mapping workflows and the finished documentation of the workflow.

Process mapping requires the team to think and rethink about each step needed to implement a particular BIM Use, while identifying synergistic activities between BIM Uses. It ensures that the team hasn't missed any steps. It is also an effective tool for ensuring that the team identifies and addresses all potential questions and issues of a project from the beginning of a project to completion.

It also provides an effective way to brainstorm, take notes, gather and view information and even summarize data. It reminds the team of its assumptions, the actions that followed, and the latest status of the project. As the team develops process maps, they can systemically ask probing questions that lead to process improvement. Developing a process map can reveal the following:

- non-value added activities
- complicated work flows
- redundant activities
- bottlenecks
- excessive process dependencies

The more efficient and well-defined each workflow is, the more successful each BIM Use will be.

Additionally, the discussion and final workflows provide transparency for all team members.

Since the workflows offer a window into the reality of BIM implementation, it will serve as additional BIM education for Harvard. The process will clarify the details of the team's scope and key data connection points. The various members of the design team will gain a shared view of each process that they support. It is an effective way for the team to communicate and consolidate information.

Finally, the finish process map provides a visual map that tracks the development of ideas and issues, as well as the extent of investigation. Like all maps, it shows where the team or individual has been, where they are at, and where they need to go in pursuit of resolution to particular issues.

Mapping Process

1. Mapping Environment

It's important to establish a team environment for working on process maps - one in which the group works together to uncover information in a participatory, non-threatening approach. Each team member needs to ask questions and generate discussion. Discussions often unearth varying viewpoints and perceptions. Teams often use whiteboards, post-its, and markers to work on process maps.
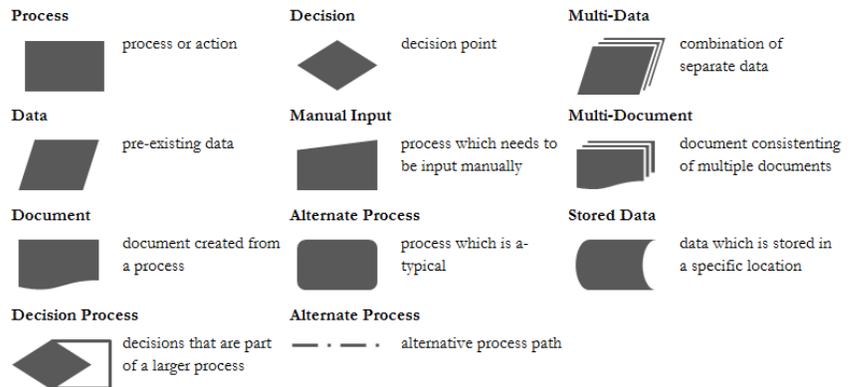
2. Big Picture

First, create an Overview Map to visualize the timing for each selected BIM Use, relationships between BIM Uses, and relationships between BIM Uses and other activities.

3.   Detail BIM Use Process Map

After creating the Overview Map, detail each selected BIM Use to clearly define the sequence of its various sub processes. These BIM Use workflows tend to be unique per project because of the various stakeholders, tools and project constraints. BIM Use workflows include detail processes, steps, inputs and outputs.

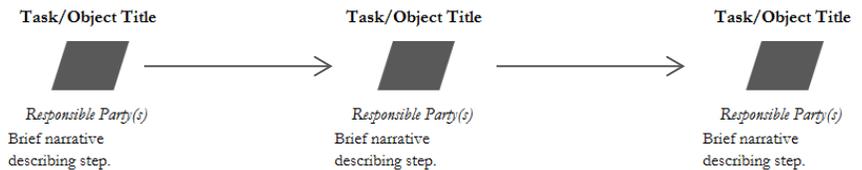| Process | process or action | Decision | decision point | Multi-Data | combination of separate data |
Data	pre-existing data	Manual Input	process which needs to be input manually	Multi-Document	document consisting of multiple documents
Document	document created from a process	Alternate Process	process which is a-typical	Stored Data	data which is stored in a specific location
Decision Process	decisions that are part of a larger process	Alternate Process	alternative process path		

The team identifies all individual tasks, even small steps. For the final process map, small steps may be included in Protocol documents, as shown in the BEP Template. Even small steps may create inefficiencies or opportunities for error.

The team should indicate the responsible party for each task. This process clarifies how much or little supporting team members need to participate in a specific BIM Use. Everyone may have different ideas as to their responsibilities within the process. The mapping process will identify tasks that need role clarification. The team identifies dependencies between tasks, including all predecessors and successors.

Documenting Workflow Maps

After the team maps the workflows, they need to document them in the BEP. The BEP Template includes standard process map shapes to identify task types, a standard process map object, and a sample workflow and protocol.

Task/Object Title	Task/Object Title	Task/Object Title
Responsible Party(s)	*Responsible Party(s)*	*Responsible Party(s)*
Brief narrative describing step.	Brief narrative describing step.	Brief narrative describing step.

For each process, document individual objects using the appropriate shape, title, responsible party, and a brief description. Include references to protocols or other sections of the BEP when relevant.

Revisiting Workflow Maps

The team should review each process map throughout the BIM Implementation process, both for clarification of process and reflection of actual workflow. The team should update process maps periodically to reflect the actual workflows implemented on the project. After the project is completed, the team should review the process maps to compare the actual process used versus the planned process.

APPENDICES

As the team goes through BIM Execution Planning, some topics may require additional exploration, protocols, and project-specific documentation within the BEP. Teams can include these items as Appendices to the BEP. Examples of Appendices include Quick Reference Guides, Subcontractor BIM Contract Exhibit, Element Management Protocols, or Co-location Work Plan.

Teams can prepare Appendices as appropriate. Within the BEP Template, type the name of each Appendix to create a cover sheet. Copy rows and page-breaks as needed; delete the examples given.

CONCLUSIONS

After the team completes the initial authorship of the BEP, it's time for the next step in the PDCA process improvement method: Do, the implementation of the BEP throughout the course of day-to-day project work. Next steps likely include:

- Reference BEP in the contract form
- Create project Revit template
- Test technology and workflows
- Start modeling

The team may want to use QA/QC milestones as process checkpoints, to study the use of BIM on the project, as compared to the BEP. Define and document the steps required to put BIM Implementation back on track. These can include modifying the BEP to reflect actual implementation or altering project process to comply with the BEP.

As the team continues through the PDCA process improvement cycle, share successes, and deviations with HPPM, so that future Harvard projects can benefit from the team's process.