Operating in a BIM Environment
Operating in a BIM Environment

“The only constant is change.”

Heraclitus 500 BCE
"Build it before you build it."

Mark Swanson  - Today
BIM is just a tool: for coordinating construction projects
BIM is just a tool: There is no one size fits all
Contractors in nine of the world's top construction markets using BIM report that building information modeling (BIM) helps them to improve productivity, efficiency, quality and safety on their projects, as well as their own competitiveness.


2014
82% of U.S. contractors using BIM
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**Why do Contractors use it?**

### Percentage of Contractors Citing the Top Three Activities for Which Their Organization Leverages BIM During Design/Pre-Construction Phase

- **Multi-Trade Coordination**: 60%
- **Visualization of the Design Intent**: 52%
- **Modeling for Constructability Evaluation**: 34%
- **Determining Quantities From a Model**: 30%
- **Integration of Model**:


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**BIM Implementation Levels**

*Percentage of Contractors at High/Very High BIM Implementation Levels (By Country)*


- **Japan**: 27% (2013), 43% (2015)
- **New Zealand**: 23% (2013), 50% (2015)
- **South Korea**: 23% (2013), 52% (2015)
- **Canada**: 29% (2013), 54% (2015)
- **UK**: 28% (2013), 66% (2015)
- **France**: 39% (2013), 71% (2015)
- **Australia**: 33% (2013), 71% (2015)
- **Germany**: 37% (2013), 72% (2015)
- **Brazil**: 24% (2013), 73% (2015)
- **US**: 55% (2013), 79% (2015)

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**BIM Required for Team Formation**

Contractors’ Approach to Requiring BIM Expertise as a Factor in Team Formation (By Country/Region)


- We require companies be experienced in BIM: Japan 30%, South Korea 31%, Brazil 37%, Aus/NZ 28%, UK 21%, US 30%, Canada 33%, Germany 39%, France 37%
- We encourage BIM expertise, but do not require it: Japan 63%, South Korea 57%, Brazil 50%, Aus/NZ 56%, UK 64%, US 52%, Canada 48%, Germany 35%, France 37%
- BIM expertise does not affect our decisions: Japan 7%, South Korea 11%, Brazil 13%, Aus/NZ 16%, UK 15%, US 18%, Canada 19%, Germany 26%, France 27%

Operating in a BIM Environment

- Design / Preconstruction Modeling:
  - Level of Development (LOD)
  - Clash Detection
  - Quantity take offs- exporting data
  - Site Logistics
  - Schedule Loading – 4D
  - Virtual Mockups for Masonry
  - Reviewing a BIM Collaboration model
Contractors in nine of the world's top construction markets using BIM report that building information modeling (BIM) helps them improve productivity, efficiency, quality and safety on their projects, as well as their own competitiveness.

Basic types of BIM models

- Architectural
- Structural
- Mechanical
- Electrical
- Plumbing
- Energy
- Trades

Images from Autodesk, IMI
Contractors in nine of the world's top construction markets using BIM report that building information modeling (BIM) helps them improve productivity, efficiency, quality and safety on their projects, as well as their own competitiveness.


Process map / BIM Execution Plan

Who puts what in the model?
What goes in the model?
When does it go there?
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**Work Flow Process**

1. **WAY FINDING (SUBWAY PROGRAM)**

2. **MILESTONES**

   - **PD** 100 - 300
   - **SD** 350 - 500
   - **PDP** 350 - 500
   - **CD** 500
   - **CA**
   - **AB**

3. **350**

4. **BIM FORUM**
BIM: Software

AutoDesk:
- REVIT
- Navisworks
- Recap
- 360 Glue
- 360 Field

- Tradesmen’s (3D)
- CAD BLOX
- Timberline
- Primavera
- Innovaya
- SketchUp
- Rhino
- Bentley
- Tekla
Reviewing a BIM Collaboration Model: FREE Software

Enhance communication

Measure

Mark up and annotate

http://usa.autodesk.com/design-review
Reviewing a BIM Collaboration Model: FREE Software

Bluebook
VU 360
PDF reader
Area take offs
Mark up and annotate

Reviewing a BIM Collaboration Model: FREE Software

Autodesk Navisworks Freedom
Download free Navisworks 3D viewer

Features
Free* viewer for easy opening of .NWD and 3D DWF files

Enables viewing of model hierarchy, object properties, and embedded review data, including viewpoints, animations, redlines, and comments
Supports real-time display of materials and lighting

http://usa.autodesk.com/support/viewers/
Reviewing a BIM Collaboration Model: FREE Software

Autodesk
Navisworks Freedom

http://usa.autodesk.com/support/viewers/
Reviewing a BIM Collaboration Model: Design Team Collaborate

A360
Autodesk® A360 enables design, engineering & project teams to efficiently work together in one central workspace.

- 2D and 3D model view.
- Deep file search.
- Supports over 100 file formats.

http://usa.autodesk.com/support/viewers/
Reviewing a BIM Collaboration Model: Construction Team Collaborate

BIM 360™ Glue®
BIM 360 Field

Features & benefits
BIM coordination and collaboration is a cloud-based BIM coordination service that provides virtually anytime, anywhere access to connected project information.
From the Office to the Field
BIM is going Mobile
A360

**SHARE**
Keep project teams informed, involved and on track

**VIEW**
View and work with 100+ 2D and 3D formats from any device, wherever you are

**SEARCH**
Find critical project and design information with powerful search
Reviewing a BIM Model

Communicating with the design team with PDFs
Contractors in nine of the world's top construction markets using BIM report that building information modeling (BIM) helps them to improve productivity, efficiency, quality and safety on their projects, as well as their own competitiveness.

Expectations – Questions to ask

- Owner Goals
- Project Team Goals
- BIM Execution Plan
- Defined Levels of Development
AIA G202 (2013) Building Information Modeling Protocol Form

### 3.3 Model Element Table

Identify (1) the LOD required for each Model Element at each Project milestone, (2) the Model Element Author, and (3) references to any applicable notes found in Section 3.4.

Insert abbreviations for each MEA identified in the table below, such as “A – Architect,” or “C – Contractor.”

NOTE: LODs must be adapted for the unique characteristics of each Project.

<table>
<thead>
<tr>
<th>Model Elements Utilizing CSI UniFormat™</th>
<th>Project Milestone 1</th>
<th>Project Milestone 2</th>
<th>Project Milestone 3</th>
<th>Project Milestone 4</th>
<th>Project Milestone 5</th>
<th>Project Milestone 6</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LOD</td>
<td>MEA</td>
<td>Notes</td>
<td>LOD</td>
<td>MEA</td>
<td>Notes</td>
<td>LOD</td>
</tr>
<tr>
<td>A SUBSTRUCTURE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Added LOD 350 to accommodate trade coordination.
Level of Development - LOD for Masonry

Current REVIT Software
LOD 100-200
BIM-M – raising the bar

Figure 2: Virtual mock-up of load-bearing masonry construction with structural elements highlighted. Courtesy of Lena Klein and Russell Gentry, Georgia Tech Digital Building Laboratory.

Current REVIT wall section
Courtesy IMI
<table>
<thead>
<tr>
<th>Level of Development</th>
<th>LOD 300</th>
<th>LOD 350</th>
<th>LOD 400</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary Use of Model</strong></td>
<td><strong>COLLABORATION</strong></td>
<td><strong>COLLABORATION AND ANALYTICAL PROGRAM INTERACTION</strong></td>
<td><strong>DOWNSTREAM USE</strong></td>
</tr>
<tr>
<td>1. Wythes should be modeled independently to allow back up wythe to adjust to structure. Include rigid insulation in cavity layer if applicable.</td>
<td>1. Show bond beam locations and heights. Bond beams should ‘flag’ differently for clash detection purposes and should show differently in model.</td>
<td>1. Air space information; flashings, weeps, mortar net, vapor barriers</td>
<td></td>
</tr>
<tr>
<td>2. Veneer and backup ‘wallpaper’ should be smart enough to show coursing and bond patterns. A default running bond with 3/8” joints could be programmed with options for alternatives. The starting elevation for coursing should be established for each wythe. No need to show individual masonry units, but the selection of the material should ‘inform’ the wallpaper on unit lengths and heights.</td>
<td>2. Show vertical bar/grout locations. Grouted cells should ‘flag’ differently for clash detection purposes and should show differently in model.</td>
<td>2. Joint reinforcing</td>
<td></td>
</tr>
<tr>
<td>3. The coursing feature should allow designers to place walls, doorways, windows, with an indicator that informs them whether they are in coursing or not.</td>
<td>3. Control joint and expansion joint locations shown (CJs). Program should break wall panels where CJs are placed so this carries into the analytical model as separate walls. There should be an indicator that defaults to placing CJs in coursing (headjoints). Should have ability to place these in elevation or plan views.</td>
<td>3. Anchor, ties</td>
<td></td>
</tr>
<tr>
<td>4. The coursing feature should automatically start coursing at floor lines unless the designer overrides this feature.</td>
<td></td>
<td>4. Bar laps</td>
<td></td>
</tr>
<tr>
<td>5. Structural Usage Tags.</td>
<td></td>
<td>5. Grouting sequence</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6. Lintels</td>
<td></td>
</tr>
</tbody>
</table>
BIM-M
LOD 300: Coursing, Insulation, Wythes modeled independently
Level of Development - LOD for Masonry

BIM-M
LOD 350: Bond Beams, vertical bar-grouted cells, control joints
BIM-M
LOD 400: Flashing, weeps, control joint material, horiz. reinforce
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Project Delivery Methods - Which of these is best for BIM?

1. Design-Bid-Build
2. Construction Manager at Risk
3. Design/Build
4. Integrated Project Delivery (IPD)
Early detection of conflicts and constructability issues before they materialize in the field.
BIM: Clash Detection

CMU wall conflict with joist

MOVE PIPE IN DRIVE
BIM: Quantification & Estimating

- Quantify materials and estimate the work based on the conditions the project is built.
BIM: 4D Schedule Visualization

- Scheduling sequence that everyone can see.
What's in a BIM Model?  REVIT
What's in a BIM Model?  REVIT
Design Process starts with an idea. A sketch that moves towards a BIM model and finally construction.
BIM: Design 3D Visualization
BIM: Design 3D Visualization
BIM: Site Logistics & Staging
BIM: Site Logistics & Staging
BIM: Design 3D Visualization
BIM: Design 3D Visualization
BIM: Design 4D Visualization

3D - the dimension of depth as well as width and height.

4D – adds the element of time. Linking 3D BIM model components with time related schedule.
Construction Schedule: Steel

Project schedules provided by Foti Construction Co.
Construction Schedule: CMU

14 months

Project schedules provided by Foti Construction Co.
Area of 4D Construction Sequence

KEY PLAN

A B C D E
4D BIM scheduling

- Scheduling sequence that everyone can see.

Tuesday 9:00:00 AM 10/1/2013 Day=1 Week=1

CMU LOAD BEARING WALLS
STEEL ROOF JOISTS

STEEL FRAME
STEEL STUD BACKUP WALLS
Urban Outfitters Building 3
Philadelphia, PA
56,000 sq ft

Image by Advanced Structural Technologies | WWW.ASTMN.COM
Client/AST Objectives

• Provide conceptual visualization of complete building

• Integrate the work of multiple design disciplines

• Analyze building for interferences and obstructions
Sample Collisions

CASE STUDY
AST Tilt Wall Panel Books

BENEFITS/OBJECTIVES REALIZED

• Schedule
• Time saved to schedule: 4 weeks
• Accuracy/Quality of Drawings
• Speed and accuracy of changes
GENERAL CONTRACTOR BIM PROCESS

BIM turns into VDC

VDC = VIRTUAL DESIGN AND CONSTRUCTION

BIM was an efficient, time-saving tool that was a vital part in the construction of the Harley-Davidson Museum campus.
GENERAL CONTRACTOR BIM PROCESS

Coordination Model
Navisworks
GENERAL CONTRACTOR BIM / VDC PROCESS: MORTENSON CONSTRUCTION
General Contractor BIM Process

- Virtual Mockups – Trades input and coordination
- Leverage the Design Model
- Put separate design models together in Navisworks
- Run a Clash Detection on Collaboration Model
- On going Virtual Coordination meetings with team to identify and clear design clashes.
- Glue 360 – push back up to cloud and distribute.
MASONRY VDC USES:

1. Site Logistic Planning (site utilization)
2. Phase Planning (visual sequencing)
3. Virtual Mockups (constructability)
5. Digital Fabrication (prefab)
Masonry Trades serve as advisory until project landed.

- Estimated by extracting quantities from REVIT.
- Coordination model vs Design Model.
- Trades modeling work.
VDC PROCESS:
VIRTUAL MOCKUPS
VDC PROCESS: VIRTUAL MOCKUPS

NOTE:
This set of documents are for reference only to aid in construction sequences. This document does not replace the contract documents. Contract documents must be adhered to and any changes must be approved by the project architects. All details must be verified by responsible subcontractor trades.
VDC PROCESS: VIRTUAL MOCKUPS

- Communication Device
- Constructability
- Who has what and when?
- Sequencing
- How are all systems working together?
VDC PROCESS:
INTEGRATED WORK PLAN (IWP)

- Go through each step of the wall construction.
- Field use drawings.
- Tailor the drawings to the crew.
- Right of Reliance – dimensioning from models.
VDC PROCESS: INTEGRATED WORK PLAN (IWP)

FIELD NOTES / COMMENTS:

MASONRY UP TO STUHL BRICK LEDGE PER ARCHITECTURAL DETAILS

AT NEW FRAMING BUMP OUT; INSTALL 5/8" M OVer TOP PARAPET; OvelAPPLING MOISTURE BARRIER

PROVIDE FIBERTITE WEEP CHANNEL; MODIFY FRAMING TO ACCOMODATE WEEP CHANNEL

INSTALL FIBERTITE OVER TOP OF PARAPET AND OVERLAY PERMA MASONRY BARRIER BY A MIN. OF 2". FIBERTITE STOPS 12" BELOW TOP OF PARAPET FRAMING

FIBERTITE WRAPS UP FROM ROOF ONTO BLOCKING
VDC-USE THE RIGHT MEDIUM FOR THE CREW
VDC PROCESS:
INTEGRATED WORK PLAN (IWP)

• IDENTIFYING MASONRY WALLS.
4D planning for Safety - Enclosure Systems
Sub-Contractor BIM Applications
Many Projects whether via the owner or General Contractors are requiring BIM from the trades
MASONRY SUB CONTRACTOR
PROCESS
BIM Standards & Specification

**Required Model Elements**

1. The trade contractor shall provide the model scopes defined in the next portion which represents the minimum requirements in the model. Greater requirements or level of detail shall be incorporated if typically drawn on 2D plans, or as required to properly represent or coordinate the modeled system.

2. Any definition of LOD (Level Of Development) should consider referencing the BIMForum 2013 Level Of Development Specification For Building Information Models in conjunction with the definitions for those LODs produced by the AIA in their BIM protocol document G202-2013.
Updated As-Built Models

Design Models are provided 'as is' and are not developed for Cost Estimating, Construction, Scheduling, Fabrication or Facility Management. When the Design Models are shared with the Trade Contractors, the Trade Contractors take on the responsibility to either convert or recreate these for their use in Coordination, Fabrication, and satisfying the As-Built requirements for the project. The Design Teams completion of the trade coordination process. Any revisions or updated as-built models shall be submitted to Gilbane / CG Schmidt within 10 days of changes made to the sign-off model. **There is a Revit Model As-Built requirement for all trades** and many contain data requirements to be built in to them, further described in the following section. Achieving the client’s expectations is a means and methods approach that needs to be individually tailored to ensure that solutions are not only fit for purpose, but are achieved through strong collaboration and active communication.
B. All subcontractors will be required to execute file agreements provide by the respective members of the design team.

3. **System Model:** Each Subcontractor is to create a system model as depicted in the “Modeling Matrix” located within this exhibit in Autodesk Revit 2010, AutoCAD 3D 2010 (or higher) and Navisworks 2010. Each Subcontractor shall also provide a system model in their native software(s). All system models are to be created using the metric system consistent design documents. All system models should be developed in accordance to the project schedule and in succession to complete all virtual construction preceding physical construction.
MASSONRY SUB CONTRACTOR PROCESS
Hardware needed to REVIEW BIM models in the field
Trimble Sketchup (FREE)
Trimble Sketchup Pro ($590)
IMI Masonry Details are Sketchup details
Sketchup 3D Warehouse loaded with free IMI Masonry detail content.
MASONRY SUB CONTRACTOR
BIM Software

REVIT Building Suite Premium ($6,825)
REVIT Building Suite Ultimate ($12,075)
CASE STUDY - MASONRY SUB CONTRACTOR PROCESS

Seedorff Masonry – Des Moines Process

1. Obtain REVIT Architectural Design model from General Contractor.
2. Cleaned out everything but the block walls from model.
3. Re-build masonry walls to modular dimensioning with REVIT using in-house staff.
4. Create bond beam and rebar families.
5. Place bond beams and rebar in design masonry walls.
7. Coordination with Mechanical Sub Contractor.
BIM Software: Augmented Reality
BIM Software: Augmented Reality
BIM Software: Augmented Reality
BIM Software: Augmented Reality
REALITY CAPTURE: LASER SCANNING

STATIONARY – TOTAL STATION / LIECA

AERIAL DRONES

MOBILE MAPPING
REALITY CAPTURE: LASER SCANNING
Autodesk: RECAP

STATIONARY – TOTAL STATION / LIECA
MASONRY APPLICATIONS: LASER SCANNING
LASER SCANNING: MASONRY RENOVATION / RESTORATION:
Santa Maria del Fiore
Florence, Italy
(cupola) 1418-1436
NEW FABRICATION APPLICATIONS:
3D PRINTING
FABRICATION APPLICATIONS
3D PRINTING: QUAKE COLUMN

http://www.wired.com/2014/10/architects-create-3-d-printed-column-survives-earthquakes/
FABRICATION APPLICATIONS
3D PRINTING: QUAKE COLUMN

http://www.wired.com/2014/10/architects-create-3-d-printed-column-survives-earthquakes/
NEW FABRICATION APPLICATIONS: 3D PRINTING

Architect Brian Peters adapted a desktop 3D printer to produce ceramic bricks.
NEW DESIGN APPLICATIONS: COMPUTATIONAL DESIGN
NEW DESIGN APPLICATIONS: COMPUTATIONAL DESIGN
BIM Summary - BIM allows the contractor to:

- Communicate earlier with design team.
- Quantity extraction.
- Clash Detection.
- 4D Schedule the work.
- Build Virtual Mockups.
- Collaborate with project team.
Operating in a BIM Environment

• Build it before you build it.