CONSTRUCTABILITY REVIEW AND VIRTUAL MOCKUPS

BIM for Constructability Review of Building Envelopes: Examples and Best Practices

Dace A. Campbell, AIA, LEED AP // BNBuilders
BIM for Constructability Review of Building Envelopes

- WHY BIM?
- CONSTRUCTABILITY REVIEW
- BEST PRACTICES
- WHAT’S NEXT
• Founded in 2000
• Headquartered in Seattle
  - San Francisco, San Diego, Portland, Montana
• $300+ million in annual volume
• 250+ employees
• $10K-$70M projects

**National Recognition**
- 2010 - ENR *Top 400 Contractor*
- 2008 - Winner of AGC’s Grand Award for Safety Excellence for Mid-Size Companies
- 2008 ENR *Best of the Best Award* for Project Management
- 2008 AIA BIM Award

**Significant work in collaborative, integrated delivery**
- Integrated Project Delivery
- Design-Build
- GC/CM
- Negotiated work

**Key markets**
- Life Science and Research
- Healthcare / Medical Facilities
- Public / Civic Spaces
- Offices and Corporate Headquarters
- Education (K-12 and Higher Education)
- Mixed-Use Facilities
- Hospitality
- Commercial / Retail

**BIM**
- In use since 2006
- Applied to $500M and 2M s.f. in new construction
- Focus on PE’s and Supts as BIM users
- Recognized as national and local leader
BIM for Constructability Review of Building Envelopes

WHY BIM?
Why BIM?

- We’re inefficient
  - 30-60% waste

- We’re unproductive
  - 40-year decrease
  - Manufacturing sectors have doubled

- We’re wasteful
  - Consume 40% of global raw materials

- We’re deadly
  - 4 deaths in construction daily
Why BIM?

- BIM as *simulation*
  - Unlike manufacturing, there is only one chance to “get it right” in construction
  - Mockups are expensive and time-consuming

- BIM is a “virtual prototype”
  - Build it virtually to perfect the product and process

- Simulate the building to:
  - Increase
    - Confidence
    - Understanding
    - Communication
  - Reduce
    - Delivery time
    - Project cost
    - Waste
    - Injuries
    - Conflicts & RFIs
Why BIM?

Don’t do rework.

Do prework.
“Top 10” Uses of BIM in Construction

0. Design Visualization
1. Surveying
2. Design Assistance & Constructability Review
3. Site Planning & Site Utilization
4. “4D” Scheduling and Sequencing
5. “5D” Model-Based Estimating
6. Subcontractor/Supplier Communications
7. Systems Coordination
8. Fabrication and Installation
9. Prefabrication
10. Operations and Maintenance
“Top 10” Uses of BIM in Construction

0. Design Visualization
1. Surveying
2. Design Assistance & Constructability Review
3. Site Planning & Site Utilization
4. “4D” Scheduling and Sequencing
5. “5D” Model-Based Estimating
6. Subcontractor/Supplier Communications
7. Systems Coordination
8. Fabrication and Installation
9. Prefabrication
10. Operations and Maintenance

- Analyze and test “means and methods” while preserving design intent
- Quality control of design documents
  - BIM exposes potential errors and omissions in design documentation
- Design assistance and detailing
  - Ensure design can be built to meet targeted schedule, cost, and quality
- Virtual Mockups
  - Prototype complex details and interdisciplinary assemblies for quality control
BIM for Constructability Review of Building Envelopes

CONSTRUCTABILITY REVIEW
Neighborhood Center Renovation
Laboratory Expansion and T.I.

- West Elevation
- Design Coordination Model
- Curtainwall Section
- L2 Structural Framing Plan
- L2 Enlarged West Stair Plan
- Curtainwall Sill Detail
Laboratory Expansion and T.I.
Laboratory Expansion and T.I.
Community Youth Center

- Built detailed model of corner condition based on architect’s 2D section details
- Analyzed condition as designed: complicated formwork vs. trades out of sequence
- Developed alternative detail and submitted to design team for review and approval
Library and City Hall
Five Community Libraries
Five Community Libraries
Laboratory Core and Shell
Laboratory Core and Shell

Construction Sequencing
Campus Outpatient Clinic Expansion
Campus Outpatient Clinic Expansion

EXIST 1936 BUILDING

NEW 2010 ADDITION

EXIST 1936 BUILDING
Campus Outpatient Clinic Expansion

- Roofing Membrane
- Roof Sheathing
- Rigid Insulation
- Vapor Barrier
- Metal Deck W/ Concrete Topping
- Aluminum Screen Frame
- Aluminum Panel System
- Rigid Insulation
- Exterior Sheathing
- Metal Stud Frame
- Structural Steel
- Windows
- ACT
Tribal Early Childhood Education Center
Community College Science Building

Curtain wall embed. Location needs confirmation from shop drawing.

Slab edge
Community College Science Building

- Concrete elevated deck
- Curtain wall embeds
- Plumbing deck penetrations
- Post-tensioned cables
- Shear stud rails
- Mild steel reinforcement
Tribal K-12 School Campus

- Structural steel vs. hollow metal door and window frames
- (4) unique conditions repeated throughout campus
- Finding these issues saved up to 6 weeks of delay
Enabled BNB to discover and resolve discrepancies between design intent and means/methods.

Not catching this would have meant certain failure of the building enclosure.

To fix this in the field would have cost $25,000 in rework, weeks of delay.

Eliminate conflicts, reduce rework, lower costs = happy subs and higher quality work.
Brewery/Winery/Food Facility

- Supporting design dialogue in detailing
- Asking and answering RFI’s
Brewery/Winery/Food Facility

- Model used to study interface between plaster, roofing, and parapet cap
- Roofing/Plaster/Flashings details being worked out by team using Revit design model & SketchUp
- Collaborative problem-solving “means and methods” together
- Solution developed, printed, and signed-off in meeting
Tribal Behavioral Health Clinic

- Inconsistent design docs
  - Uncoordinated footing depths
  - Complicated brick ledgers
  - Complex pourback conditions at exterior column locations

- Details Revised
Tribal Behavioral Health Clinic

- Isolate and analyze a single scope of work
- Create task-specific views of the model
- Illustrate and clarify design docs
  - Support RFIs
  - Preserve design intent

- Generate Field Drawings
  - Plans, Sections, & 3D
  - Reference complete details in construction docs
  - Complete dimensions – no math in the field!
  - 11” x 17” for easy duplication and lamination
  - Approval/sign-off for QC

- Make installation clear and obvious
  - Color-coded
  - Easy to understand “IKEA” instructions
BIM for Constructability Review of Building Envelopes

BEST PRACTICES
BIM “Rules of Engagement” for Building Enclosures

- BNB’s suggested best practices for using BIM in design and construction
  - Apply “Lean” principles
  - Assume interdisciplinary collaboration, even IPD
  - Prepare models anticipating “downstream” use by future parties

- Best practices based on real-world experience
  - By applying BIM to $500M of construction
  - 30+ projects with several A/E’s and owners
  - Across wide range of building types and delivery types

- For your consideration on future projects
  - Not a “manifesto,” just a work-in-progress
  - Published regionally and nationally
  - Targeted towards designers and owners
  - Will inform our next generation of contracts
  - BNB wants your feedback!
1. Model First

Build the model first, then draft over 2D extractions

- Draft only to format graphics or to add, *but not change*, information

- In this workflow, there should be *no* discrepancies between models & drawings in terms of:
  - scope
  - size
  - location
  - number of objects/components

- Any discrepancies between the model and drawings should be limited to level-of-detail

- For BNB, we are responsible for noting discrepancies discovered between models/drawings, design team is responsible for reconciling them

* Discipline is required to for newbies not to stray from “new” workflow
2. Share the Model

Share the source model data with others

- Publish it at moments “frozen” in time consistent with document delivery milestones (50% DD, etc)

- Ask for the model from others, upstream and downstream

- All model data to be compatible with industry standards
  - For BNB, acceptable file formats include RVT, DWG, NWC, IFC

- PDF’s and screenshots helpful for visual reference, but not much more

* A/E’s have concern about ability to “lock down” proprietary information like custom families
3. Assign Responsibility

Determine early who is responsible for modeling which project scope (and when)

- **Ideal: Do It Yourself**
  - If you would traditionally draw/design something, then you should be the one to model it
  - Example: architect would model plumbing or electrical fixtures, engineer would model pipes/conduits connecting to them)

- **Model it only once**
  - No duplicate elements between disciplines
  - For BNB, we can check accurate quantities and generate estimates

* Most BIM software doesn’t inherently support this way of working, we need creative workarounds to borrow/copy data between disciplines
4. Level of Detail

Accuracy is more important than detail

- Minimum suggested detail in the model is consistent with what would traditionally be shown in drawing sets
  - 1/8” scale plans, sections, elevations
  - 1-1/2” scale detail plans/sections

- Abstractions for some shapes are okay as long as everything is in the right place
  - Example: extrusion cross-section of window mullion not as important as external profile

- Do not use dimension overrides
  - For BNB, we can transfer XYZ coordinates from the model to northing, easting, elevation points for survey/layout

* Some BIM software is good with LOD control, and warns against dimension overrides
5. Model Standards & Digital Hygiene

Coordinates

- Determine, publish, and promote a single project origin
  - *Do NOT rely on Revit “shared coordinates”* which are not exportable downstream to other applications
- Publish the relationship between the building/grid and a site datum (like the state plane coordinate system or local survey datum)
  - For BNB, sea-level for Z=0 is preferred for construction layout, but not critical if the design team picks another vertical datum

Naming

- Keep active file names consistent and update/overwrite them
- Do not include dates within the file name
- Instead archive backups in folders with dates/descriptions

* These practices are fundamental to file sharing and collaboration, and shouldn’t be new to most teams with good CAD standards.
6. Phasing

Manage “phases” to distinguish work conditions:

- Existing to-remain
- Demolition
- Proposed work

* Consistent with traditional A/E scope of work, and important for downstream filtering of model data
7. Support Bid Packages

Organize and structure the model in a way that reflects anticipated bid packages

- For BNB, we can include colored, highlighted views of the model to supplement traditional bid packages
- Other work can be shown halftone or transparent for reference
- Beyond geometry, leverage the “I” in BIM

* Exceeds traditional A/E deliverables, but easily accomplished with thoughtful use of BIM tools
8. Reflect Means and Methods

- Build the model anticipating typical construction means & methods

- Avoid using “cheats” or shortcuts to represent an object if there is a better BIM component/family available
  - Example: don’t use Revit curtain walls for doors or punched windows
  - Example: don’t use Revit walls to wrap columns

- Model structural and architectural elements to reflect likely construction logic
  - For BNB, we can provide input regarding construction joints and sequencing
  - Example: don’t use a single 4-story concrete column if it will be site-cast as (4) one-story columns, but a 2-story steel column is okay if that’s the way it’s fabricated/erected

- Details still best left to detailers

* There’s more than one way to model, but often there is a “best” way
9. Revisions: Managing Change

- Develop a strategy early for revision control during design and construction
  - Publish models in (near) real-time with frequent/nightly data transfers so everybody has (nearly) live and up-to-date data at all times
  - Use technology that supports collaboration, not just allows communication
  - For BNB, a common/shared project server is superior to frequent postings and downloads with an FTP site

- Team should determine how to manage changes to the design (or as-builds) during/after coordination and construction

* Revision control and management continues plague our industry. Not unique to BIM, but cultural issues magnified by the technology.
10. Test early, test often

- Immediately, all team members contribute sample, representative data to be compiled and coordinated.
- Verify alignment of geometry in single master model.
- Supplement early model submissions with screenshots from your native software so others can verify what they see (versus what you hope they might see).

* Not unique to BIM, just common sense!
BIM for Constructability Review of Building Envelopes

WHAT’S NEXT
What’s Next

- All BIM, all the time
  - LEGAL
    - Model-sharing more prevalent in AEC
  - CULTURAL
    - “Old school” designers and builders changing habits, changing careers
  - REGULATORY
    - Agency review
  - PHYSICAL
    - “Paperless construction” at project sites trending towards Augmented Reality
  - OPERATIONAL
    - “6D” use of BIM to support facilities operations and maintenance
Thank you

Dace.Campbell@BNBuilders.com