1. BIM Overview
2. BIM Level of Development
3. Evolution of the Drawing Process
4. BIM Workflow
   - Internal
   - Between Consultants
5. Model Development
   - Programming and Pre-Design
   - Schematic Design
   - Design Development
   - Construction Documents
6. Case Study

what will be covered...
1 BIM: OVERVIEW
An OLD process does not work with a NEW tool
“Building Information Modeling, or BIM is a parametric, 3D model that is used to generate plans, sections, elevations, perspectives, details, schedules – all of the necessary components to document the design of a building”
- Mastering Autodesk Revit Architecture 2011

“A Building Information Model serves as a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life cycle from inception onward.”
- BuildingSMART Alliance
Multiple views are generated from one model, such as:

- Floor Plans
- Sections
- Elevations
- Details
BIM: Development

Working in Multiple Views
BIM: Information

Not just a Model

It’s a Database
BIM: Types of Data

<table>
<thead>
<tr>
<th>Identity Data</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Assembly Code</td>
<td>C2020</td>
</tr>
<tr>
<td>Material Type</td>
<td>Exterior Doors</td>
</tr>
<tr>
<td>Manufacturer</td>
<td></td>
</tr>
<tr>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>Assembly Description</td>
<td>Interior Doors</td>
</tr>
<tr>
<td>Fire Rating</td>
<td></td>
</tr>
<tr>
<td>Cost</td>
<td></td>
</tr>
<tr>
<td>OpenClass Number</td>
<td>23-29.83.80</td>
</tr>
<tr>
<td>OpenClass Title</td>
<td>Doors</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Test</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>HW Set</td>
<td></td>
</tr>
<tr>
<td>Frame Detail - Header</td>
<td>26/473</td>
</tr>
<tr>
<td>Frame Detail - Jamb</td>
<td></td>
</tr>
<tr>
<td>Frame Detail - Sill</td>
<td></td>
</tr>
<tr>
<td>Materials and Finishes</td>
<td></td>
</tr>
<tr>
<td>Frame Material</td>
<td></td>
</tr>
<tr>
<td>Finish</td>
<td></td>
</tr>
<tr>
<td>Door Material</td>
<td></td>
</tr>
<tr>
<td>Door Glazing</td>
<td></td>
</tr>
<tr>
<td>Frame Glazing</td>
<td></td>
</tr>
<tr>
<td>Identity Data</td>
<td></td>
</tr>
<tr>
<td>Over Assembly Type</td>
<td>INT DOUBLE EGRES</td>
</tr>
<tr>
<td>Comments</td>
<td>MAGNETIC, DOOR 130X120</td>
</tr>
<tr>
<td>Mark</td>
<td>126</td>
</tr>
<tr>
<td>Workset</td>
<td>Buildout</td>
</tr>
<tr>
<td>Edged By</td>
<td></td>
</tr>
<tr>
<td>Design Option</td>
<td>Main Model</td>
</tr>
<tr>
<td>Phasing</td>
<td></td>
</tr>
<tr>
<td>Phase Created</td>
<td>New Construction</td>
</tr>
<tr>
<td>Phase Demolished</td>
<td>None</td>
</tr>
<tr>
<td>Other</td>
<td></td>
</tr>
<tr>
<td>Head Height</td>
<td>7' 0&quot;</td>
</tr>
</tbody>
</table>
1 BIM: Organizational Data

Identity Data
- Assembly Code: C1020
- Keynote
- Model
- Manufacturer
- Type Comments
- URL
- Description
- Assembly Description: Interior Doors
- Type Mark: 8
- Fire Rating
- Cost
- OmniClass Number: 23.30.10.00
- OmniClass Title: Doors

Materials and Finishes
- Frame Material
- Finish
- Door Material
- Door Glazing
- Frame Glazing
- Identity Data
- Door Assembly Type: H-INT DOUBLE EGRESS
- Comments
- Mark: 1506
- Workset: Buildout
- Edited by
- Design Option: Main Model
- Phasing
- Phase Created: New Construction
- Phase Demolished: None
- Other
- Head Height: 7' 0"
# BIM: Identity Data

## Identity Data

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assembly Code</td>
<td>C1020</td>
</tr>
<tr>
<td>Keynote</td>
<td></td>
</tr>
<tr>
<td>Model</td>
<td></td>
</tr>
<tr>
<td>Manufacturer</td>
<td></td>
</tr>
<tr>
<td>Type Comments</td>
<td></td>
</tr>
<tr>
<td>URL</td>
<td></td>
</tr>
<tr>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>Assembly Description</td>
<td>Interior Doors</td>
</tr>
<tr>
<td>Type Mark</td>
<td>8</td>
</tr>
<tr>
<td>Fire Rating</td>
<td></td>
</tr>
<tr>
<td>Cost</td>
<td></td>
</tr>
<tr>
<td>OmniClass Number</td>
<td>23.30.10.00</td>
</tr>
<tr>
<td>OmniClass Title</td>
<td>Doors</td>
</tr>
</tbody>
</table>

## Text

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Text</td>
<td></td>
</tr>
<tr>
<td>HW Set</td>
<td></td>
</tr>
<tr>
<td>Frame Detail - Head</td>
<td>E4/A691</td>
</tr>
<tr>
<td>Frame Detail - Jamb</td>
<td></td>
</tr>
<tr>
<td>Frame Detail - Sill</td>
<td></td>
</tr>
</tbody>
</table>

## Materials and Finishes

### Frame Material

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finish</td>
<td></td>
</tr>
<tr>
<td>Door Material</td>
<td></td>
</tr>
<tr>
<td>Door Glazing</td>
<td></td>
</tr>
<tr>
<td>Frame Glazing</td>
<td></td>
</tr>
</tbody>
</table>

### Identity Data

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Door Assembly Type</td>
<td>H-INT DOUBLE EGRESS</td>
</tr>
<tr>
<td>Comments</td>
<td>MAGNETIC DOOR HOLDER</td>
</tr>
<tr>
<td>Mark</td>
<td>1506</td>
</tr>
<tr>
<td>Workset</td>
<td>Buildout</td>
</tr>
<tr>
<td>Edited by</td>
<td></td>
</tr>
<tr>
<td>Design Option</td>
<td>Main Model</td>
</tr>
</tbody>
</table>

## Phasing

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase Created</td>
<td>New Construction</td>
</tr>
<tr>
<td>Phase Demolished</td>
<td>None</td>
</tr>
<tr>
<td>Other</td>
<td></td>
</tr>
<tr>
<td>Head Height</td>
<td>7' 0&quot;</td>
</tr>
</tbody>
</table>
1 BIM: Data Standards

NBIMS: National Building Information Modeling Standard

IFC: The Industry Foundation Classes

IFD: Industry Foundation Dictionary
BIM: Authoring Programs

- AUTODESK REVIT
- ARCHICAD
- BENTLEY ARCHITECTURE
- TEKLA (STRUCTURAL)
BIM: Data Standards

**Knowledge Databases**
- Best Practice Knowledge
- Own Practice

**Laws and Regulations**
- Building Regulations
- Building Specifications

**Briefing**
- Functional Requirements
- Estimates
- Conditions
- Requirements

**Construction Management**
- Scheduling
- Logistics, 4D

**Facility Management**
- Letting, sale, operations
- Maintenance
- Guaranties

**Requirements**
- Demolition, refurbishment
- Rebuild
- Demolition
- Restoration

**Procurement**
- Product databases
- Price databases

**CAD Software**
- Drawings, calculations
- Architect, engineer...

**Simulations**
- Comfort
- Ventilation, heating
- Life cycle cost
- Light, sound
- Insulation
- Fire, usage
- Environment
- Life time predictions

**Specifications**
- Specification sheets
- Classification standards
- Estimates, accounting

**VRML**
- Visualization, 3D models

**IFC+IFD Product Model**

*National Building Information Modeling Standard*
BIM: INTEROPERABILITY

Construction Industry Trends:

Compared to all Non-Farm related industries the Construction Industry has actually become less productive.

By utilizing a “Complete BIM” The downward trend can potentially be reversed
According to the National Institute of Standards and Technology, Owners and Operators have the largest interoperability costs of all the stakeholders in the AEC industry.

Owners/Operators bear 68% of the estimated $15.8 billion lost due to inadequate interoperability.

This equates to a loss of over $10.6 billion.

*The study also revealed that an inordinate amount of time is spent locating and verifying specific facility and project information from previous activities.
2 BIM: LEVEL OF DEVELOPMENT
LEVEL OF DEVELOPMENT:
Building Information Modeling Protocol Exhibit

COMMON QUESTIONS:

How detailed should my model be?

How much information should I include in my model?

Who is responsible for modeling “X”?

Should this be considered an additional service?
LEVEL OF DEVELOPMENT: Building Information Modeling Protocol Exhibit


Building Information Modeling Protocol Exhibit

This Exhibit is incorporated into the accompanying agreement (the “Agreement”) dated the day of in the year.
(In words, indicate day, month and year.)

BETWEEN:
(Name, address and contact information, including electronic addresses)

This document has important legal consequences. Consultation with an attorney is encouraged with respect to its completion or modification.
MODEL ELEMENT:
Component, System or Assembly within a BIM

MODEL ELEMENT AUTHOR:
Party responsible for model elements (Architect, Contractor, Mechanical, Etc. ....)

MODEL USER:
Individual or Entity allowed to use the model for Analysis, Estimating, or Scheduling.
LEVEL OF DEVELOPMENT:
Describes the completeness to which a Model Element is developed.

- LOD: 100 Conceptual Geometry  
  “Schematic Design”
- LOD: 200 Approximate Geometry  
  “Design Development”
- LOD: 300 Precise Geometry  
  “Construction Documents”
- LOD: 400 Fabrication  
  “Construction Model”
- LOD: 500 “As-Built”
LEVEL OF DEVELOPMENT:
LOD: 100 (Schematic Design)

CONCEPTUAL GEOMETRY:
Overall Building Massing Indicative of Area
Height
Volume
Location
Orientation.

MODEL ELEMENT AUTHOR(S):
Architect

APPLICATIONS:
Early Visualization - Massing
Site Analysis
Environmental Impact - Solar Design
LEVEL OF DEVELOPMENT: LOD: 200 (Design Development)

APPROXIMATE GEOMETRY:
Generalized Systems
Assemblies with Approximate Quantities
Size
Shape
Location
Orientation.

MODEL ELEMENT AUTHOR(S):
Architect
Consultants

APPLICATIONS:
Visualization - Materiality
Coordination with multiple disciplines
LEVEL OF DEVELOPMENT:
LOD: 300 (Construction Documents)

SPECIFIC GEOMETRY:
Specific Assemblies
Accurate in Terms of Size
Shape
Location
Quantity
Orientation

MODEL ELEMENT AUTHOR(S):
Architect
Consultants

APPLICATIONS:
Construction Documents
LEVEL OF DEVELOPMENT:
LOD: 400 (Construction Model)

FABRICATION MODEL:
Specific Assemblies
Accurate in Terms of Size
Shape
Location
Quantity
Orientation
Complete Fabrication

MODEL ELEMENT AUTHOR(S):
Contractor
Sub-Contractors

APPLICATIONS:
Detailed Visualization
Reduction of Conflicts
Direct to Fabrication
Construction Scheduling
LEVEL OF DEVELOPMENT:
LOD: 500 (As-Built Model)

AS-BUILT MODEL:
Constructed Assemblies
Actual and Accurate in Terms of Size
Shape
Location
Quantity
Orientation.

MODEL ELEMENT AUTHOR(S):
Contractor
Sub-Contractors

APPLICATIONS:
Equipment maintenance and procurement
Locating MEP and related services
### § 4.3 Model Element Table

Identify (1) the LOD required for each Model Element at the end of each phase, and (2) the Model Element Author (MEA) responsible for developing the Model Element to the LOD identified.

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 Element</th>
<th>LOD</th>
<th>MEA</th>
</tr>
</thead>
<tbody>
<tr>
<td>B20 Exterior Enclosure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B2010 Exterior Walls</td>
<td>100</td>
<td>A</td>
</tr>
<tr>
<td>B2020 Exterior Windows</td>
<td>100</td>
<td>A</td>
</tr>
<tr>
<td>B2030 Exterior Doors</td>
<td>100</td>
<td>A</td>
</tr>
<tr>
<td>C10 Interior Construction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1010 Partitions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1020 Interior Doors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1030 Fittings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C20 Stairs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C2010 Stair Construction</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
What types of information should be included in a LOD 300 exterior wall?

According to

AIA E202

LOD 300 - Specific Geometry:
Specific Assemblies that are accurate in terms of size, shape, location, quantity, and orientation.
LEVEL OF DEVELOPMENT:
Building Information Modeling Protocol Exhibit

SUPPLEMENT THE AIA E202 WITH ANOTHER MORE DETAILED GUIDE

VA OBJECT/ELEMENT MATRIX
LEVEL OF DEVELOPMENT:
VA Object Element Table

BIM OBJECT/ ELEMENT MATRIX:

Developed by the Department of Veterans Affairs as part of VA BIM Guide.

It depicts Building Information Typologies/Types, when they are relevant, and to what level of development (LOD) throughout a building lifecycle.

It is an expansion of the E-202 to support a greater level of understanding of BIM information use.

Highly Detailed list of various requirements as they relate to a BIM’s Level of Development.

* Free downloadable Excel file from VA website
LEVEL OF DEVELOPMENT:
VA Object Element Table

INFORMATION TYPES:
Information Categories include Functional and performance characteristics that may extend across current OmniClass Tables

Building Program & Project Meta Data
Physical Properties of BIM Objects & Elements
GeoSpatial and Spatial Location of Objects & Elements
Manufacturer Specific Information Requirements
Specifications
Estimating
Value Engineering Requirements (BIM Use Case)
Energy Analysis Requirements (BIM Use Case)
Sustainable Material LEED or Other Requirements
Project Environmental & Site Conditions
Program/Space Compliance or Validation
Code Compliance/ Occupant Safety Requirements
Phases Time Sequencing & Schedule Requirements
Construction Logistics & Sequencing
Building Commissioning Requirements
Facilities/Asset Management (Organization Specific Standards)
Note/Remarks
## LEVEL OF DEVELOPMENT: VA Object Element Table

### Data Comparison

**Exterior Walls**

<table>
<thead>
<tr>
<th>AIA E-202</th>
<th>LOD</th>
<th>MEA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>B SHELL</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B10 Superstructure</td>
<td>B1010 Floor Construction</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B1020 Roof Construction</td>
<td></td>
</tr>
<tr>
<td>B20 Exterior Enclosure</td>
<td>B2010 Exterior Walls</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B2020 Exterior Windows</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B2030 Exterior Doors</td>
<td></td>
</tr>
<tr>
<td>B30 Roofing</td>
<td>B3010 Roof Coverings</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B3020 Roof Openings</td>
<td></td>
</tr>
</tbody>
</table>
**LEVEL OF DEVELOPMENT:**
VA Object Element Table

**EXTERIOR WALL:** LOD 100

<table>
<thead>
<tr>
<th>Overall Length</th>
<th>Overall Width</th>
<th>Overall Height</th>
<th>Overall Area</th>
<th>Overall Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>44' 0&quot;</td>
<td></td>
<td></td>
<td>880.00 SF</td>
<td>898.33 CF</td>
</tr>
<tr>
<td></td>
<td>1' 0 1/4&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Physical Properties of BIM Objects & Elements

![BIM Object Properties](image)
## Manufacturer Specific Information Requirements

### Costing Requirements

- Value Based Costing (i.e. Cost SqFtg)

### Sustainable Material LEED or Other Requirements

- LEED Items per Quantity Values

### Program/Space Compliance or Validation

#### Program Room Requirements

- Exterior Wall Construction

### General Type

- Keynote
- Model
- Manufacturer
- Type Comments
- URL
- Description
- Assembly Description
- Assembly Code
- Type Mark
- Fire Rating
- Cost
- Fire Rating Requirement
- Building Type Selection
- Time Sequence
- Order of Project Milestones
**LEVEL OF DEVELOPMENT:** VA Object Element Table

**EXTerior WALL:** LOD 300

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Exterior Finish</th>
<th>Exterior Finish Surface</th>
<th>Interior Finish</th>
<th>Interior Finish Surface</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material Class</td>
<td>Stucco</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Description</td>
<td>Exterior finish</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comments</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Keywords</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manufacturer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>URL</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annotation Information</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Keywords</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mark</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
LEVEL OF DEVELOPMENT: VA Object Element Table

EXTERIOR WALL: LOD 400

Phases Time Sequencing & Schedule

Installation Time
Installation Sequence
Installation Start Date
Installation End Date

Properties
Basic Wall
Exterior - EIFS on Mtl. Stud

Constraints
Location Line
Basic Constraint
Base Offset
Base is Attached
Base Extension Dim.
Top Constraint
Top Offset
Top is Attached
Top Extension Dim.
Room Bounding
Related to Mass

Construction
Installation Time
Fabrication Time
Installation Sequence
Installation Start Date
Installation End Date

Structural
Structural Usage
Non-bearing

Dimensions

Properties help
Apply
**LEVEL OF DEVELOPMENT:**
VA Object Element Table

**EXTERIOR WALL:** LOD 500

<table>
<thead>
<tr>
<th>LOD 500-As-Built</th>
<th>GeoSpatial and Spatial Location of Objects &amp;</th>
<th>GIS Tag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constructed Assemblies Actual and Accurate in Terms of Size, Shape, Location, Quantity, and Orientation</td>
<td>GeoSpatial and Spatial Location of Objects &amp;</td>
<td>GPS Tag</td>
</tr>
<tr>
<td></td>
<td>GeoSpatial and Spatial Location of Objects &amp;</td>
<td>GPS Position</td>
</tr>
<tr>
<td></td>
<td>Manufacturer Specific Information Requirements</td>
<td>Condition</td>
</tr>
<tr>
<td></td>
<td>Manufacturer Specific Information Requirements</td>
<td>Defects</td>
</tr>
<tr>
<td>Costing Requirements</td>
<td>Recorded Actual Cost</td>
<td></td>
</tr>
<tr>
<td>Costing Requirements</td>
<td>Installed Cost</td>
<td></td>
</tr>
<tr>
<td>Costing Requirements</td>
<td>Cost Over-Run</td>
<td></td>
</tr>
<tr>
<td><strong>Sustainable Material LEED or Other Requirements</strong></td>
<td>Leed Documentation</td>
<td></td>
</tr>
<tr>
<td><strong>Sustainable Material LEED or Other Requirements</strong></td>
<td>Green Performance Evaluations</td>
<td></td>
</tr>
<tr>
<td><strong>Facilities/Asset Management</strong></td>
<td>Maintenance</td>
<td></td>
</tr>
</tbody>
</table>
## LEVEL OF DEVELOPMENT: VA Object Element Table

### DATA ACCUMULATION

<table>
<thead>
<tr>
<th>LOD100</th>
<th>Costing Requirements</th>
<th>Conceptual Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Costing Requirements</td>
<td>Conceptual Unit Cost</td>
</tr>
<tr>
<td></td>
<td>Costing Requirements</td>
<td>Future Cost Assumptions</td>
</tr>
</tbody>
</table>

| LOD200 | Costing Requirements | Value Based Costing (i.e. Cost SqFt) |

<table>
<thead>
<tr>
<th>LOD300</th>
<th>Costing Requirements</th>
<th>Assembly Based Costing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Costing Requirements</td>
<td>Shipping Cost</td>
</tr>
<tr>
<td></td>
<td>Costing Requirements</td>
<td>Additional Tax</td>
</tr>
<tr>
<td></td>
<td>Costing Requirements</td>
<td>Total Ownership Cost</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LOD400</th>
<th>Costing Requirements</th>
<th>Purchase Information</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Costing Requirements</td>
<td>Retail Cost</td>
</tr>
<tr>
<td></td>
<td>Costing Requirements</td>
<td>Retail Cost Unit</td>
</tr>
<tr>
<td></td>
<td>Costing Requirements</td>
<td>Installation Cost</td>
</tr>
<tr>
<td></td>
<td>Costing Requirements</td>
<td>Set Assembly Cost</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LOD500</th>
<th>Costing Requirements</th>
<th>Recorded Actual Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Costing Requirements</td>
<td>Installed Cost</td>
</tr>
<tr>
<td></td>
<td>Costing Requirements</td>
<td>Cost Over-Run</td>
</tr>
</tbody>
</table>
# Level of Development: Model Element Table

## PM Considerations:

Make sure the entire project team is involved in filling out the Model Element Table.

Work with the owner to determine the actual needs in terms of LOD.

The higher the LOD, the higher the cost (300+)

### Model Element Table

<table>
<thead>
<tr>
<th>Model Elements Utilizing CSI Uniform™</th>
<th>LOD Design</th>
<th>LOD Development</th>
<th>LOD Construction</th>
<th>LOD O&amp;M</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A Substructure</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A10 Foundations</td>
<td>100 A</td>
<td>200 E</td>
<td>500 E</td>
<td>500 E</td>
</tr>
<tr>
<td>A1020 Special Foundations</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1030 Slab on Grade</td>
<td>100 A</td>
<td>200 E</td>
<td>500 E</td>
<td>500 E</td>
</tr>
<tr>
<td>A20 Basement Construction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A2010 Basement Excavation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A2020 Basement Walls</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>B Shell</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B10 Superstructure</td>
<td>100 A</td>
<td>200 A</td>
<td>500 A</td>
<td>500 A</td>
</tr>
<tr>
<td>B1020 Roof Construction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B20 Exterior Enclosure</td>
<td>100 A</td>
<td>200 A</td>
<td>500 A</td>
<td>500 A</td>
</tr>
<tr>
<td>B2020 Exterior Windows</td>
<td>100 A</td>
<td>200 A</td>
<td>500 A</td>
<td>500 A</td>
</tr>
<tr>
<td>B2030 Exterior Doors</td>
<td>100 A</td>
<td>200 A</td>
<td>500 A</td>
<td>500 A</td>
</tr>
<tr>
<td>B30 Roofing</td>
<td>100 A</td>
<td>200 A</td>
<td>500 A</td>
<td>500 A</td>
</tr>
<tr>
<td>B3020 Roof Openings</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>C Interiors</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C10 Interior Construction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1010 Partitions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1020 Interior Doors</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1030 Fittings</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C20 Stairs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3 EVOLUTION OF THE DRAWING PROCESS
Evolution of the Drawing Process
Drafting to BIM

Hand Drafting → Computer Aided Drafting → Building Information Modeling
Evolution of the Drawing Process
Drafting to BIM

File Structure

CAD vs. BIM

Model File → Sheet File → Sheet

Model → View → Sheet
Evolution of the Drawing Process
Drafting to BIM

Building Up vs. Cleaning Up

CAD

BIM
Evolution of the Drawing Process
Drafting to BIM

Traditional Process

Struct.  Arch.  MEP

Drawing Set

Contractor / Owner
Evolution of the Drawing Process
Drafting to BIM

BIM Process

Arch. -> BIM
 MEP -> BIM
 Struct. -> BIM

BIM -> Drawing Set
Drawing Set -> Contractor / Owner
Evolution of the Drawing Process

BIM working with other tools

BIM is a widely used tool, but it's not our only tool in our toolbox
3 Evolution of the Drawing Process
BIM working with other tools

BIM and CAD

Site Plan

Details
Evolution of the Drawing Process
BIM working with other tools

BIM and Presentation Oriented Programs

Sketch Up

3D Studio Max
Evolution of the Drawing Process
BIM working with other tools

BIM and Database Programs

Microsoft Access
3 Evolution of the Drawing Process
BIM working with other tools

BIM and Energy Modeling

Sun Path Study
Sun Exposure Study
Evolution of the Drawing Process
Capabilities for 3D

Example Project
Fine tuning the curtain wall system and lobby space
Evolution of the Drawing Process
Capabilities for 3D

Visualizing how things come together
Evolution of the Drawing Process
Capabilities for 3D

Visualizing the quality of space
Evolution of the Drawing Process
Capabilities for 3D

Comparing Options

Column VS. No Column
4 BIM: WORKFLOW
PM: Considerations

Staffing:
Most experienced modelers should be assigned at the start of the project. This person will work directly with the Architect/Engineer to develop the model.

This is an opportunity to share and strengthen the intellectual resources of your team by allowing the more experienced Architects to mentor and provide technical guidance while the modeler shares and teaches Architect about BIM software and other digital tools.
**BIM Workflow**

**Internal: Staffing**

**Legend:**
- **SD**: Modeler II (Most experienced Revit users on Team) works with PA/PM/PE on initial development of model.
- **CD**: Modeler I (Less experienced Revit users on Team) works on setting up views, detailing, etc.
- **Modeler**: Information Manager (PM/PA/PE) No Revit Experience Req. Responsible for Keynote database and specifications.
BIM Workflow
The Team Work Environment

Working out of “one” file
BIM Workflow

Staffing

How far to take the model?

Partial utilization of BIM

‘Disconnect’ model from drawings in CDs

Use of a BIM through CDs

Use of a BIM through Life Cycle of Building

Full utilization of BIM
What to plan for when setting deadlines

Suggested Schedule for CAD Projects

Suggested Schedule for BIM Projects
4 BIM Workflow
Between Design Professionals

Setting Deadlines with adequate time to catch changes
When linking models…

- Establish Coordinate system so all models align
- Set up linkable views for each discipline to use
- Set any imported CAD line work to black
- Organize links on separate worksets/ layers
- Adjust any visibility and graphic settings as needed
Controlling the graphics from a linked model

Structural Grid

Architectural Grid
Opportunities for Design Collaboration: Lighting Studies

Equinox at Noon

Summer Solstice at Noon

Winter Solstice at Noon
BREAK
5 BIM: MODEL DEVELOPMENT
5.1 PROGRAMMING
MODEL DEVELOPMENT: PROGRAMMING

A Building Information Model can be started as early as programming.

Programmatic Information furnished by the owner can be inputted into a BIM.

This information can be used as a reference throughout the entire project and it can be referenced at any time.

Excel Spreadsheet

BIM
MODEL DEVELOPMENT: PROGRAMMING

Rooms: Define a space within a model

Rooms will store all of the programmatic data and will be the primary tool used at this phase in the project.
MODEL DEVELOPMENT: PROGRAMMING

PROGRAM/SPACE COMPLIANCE & VALIDATION:

Types of information that can be included in a room:

- Space name
- Space number
- Space description
- Departmental requirements
- Required sf
- Required quantities
- Required equipment
- Required furniture
- Required built-ins
- Required finishes
- Ceiling heights
- Sound transmission resistance

Etc… (Data can be customized to meet your needs)
MODEL DEVELOPMENT: PROGRAMMING

PROGRAM/SPACE VALIDATION:

Scheduled can be used as a tool for validation to ensure that the needs have been met.

<table>
<thead>
<tr>
<th>Name</th>
<th>Number</th>
<th>Required SF</th>
<th>Actual SF</th>
<th>Area Validation</th>
<th>Required Equipment</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office</td>
<td>102</td>
<td>200 SF</td>
<td>195 SF</td>
<td>5 SF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reception</td>
<td>101</td>
<td>130 SF</td>
<td>130 SF</td>
<td>0 SF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conference</td>
<td>103</td>
<td>400 SF</td>
<td>345 SF</td>
<td>55 SF</td>
<td>Projector</td>
<td>Projector</td>
</tr>
</tbody>
</table>

OWNERS REVIT REQ. ➔ Update Revit model to meet owner’s programmatic requirements.
MODEL DEVELOPMENT: PROGRAMMING

VISUALIZE DATA:

Color legends can be developed based on an established criteria. (Revit)

Common criteria types include color by department/ name
PM CONSIDERATIONS:

BIM can be a powerful tool during the earliest stages of a project. Information gathered from this effort will be embedded within the model throughout all phases of the project. This will help to ensure that all of the programmatic requirements have been met.

Less experienced users can work at this stage as no actual geometry is created.
5.2 SCHEMATIC DESIGN
Conceptual Massing:
Quickly Generate massing models within your BIM authoring tool
Conceptual Massing:
Unlike most programs, the parametric nature of BIM allows for the quick and accurate quantification of your conceptual massing.

As the form is modified the schedule is automatically updated!
CONCEPTUAL ENERGY MODELING:
The conceptual massing can be exported to a gbxml or other format for early energy analysis.
Presentation Tool:
Most BIM Authoring programs have options for rendering your model for presentations.
**Project Drawings:**
Views can be preset so as you model; floor plans, elevations, sections, etc will be generated and updated automatically.
PM: Considerations

Staffing:

Most experienced modelers should be assigned at the start of the project. This person will work directly with the Architect/Engineer to develop the model.

This is an opportunity to share and strengthen the intellectual resources of your team by allowing the more experienced Architects to mentor and provide technical guidance while the modeler shares and teaches Architect about BIM software and other digital tools.
5.3 DESIGN DEVELOPMENT
5 MODEL DEVELOPMENT: DESIGN DEVELOPMENT

Concept to Reality:
The Conceptual surface can be converted into “real” objects such as walls, floors, roofs, etc...
5 MODEL DEVELOPMENT: DESIGN DEVELOPMENT

Concept to reality
Adding content
Assemblies are created
MODEL DEVELOPMENT:
WORKING IN MULTIPLE VIEWS
5 MODEL DEVELOPMENT: WORKING IN MULTIPLE VIEWS
MODEL DEVELOPMENT: WORKING IN MULTIPLE VIEWS

Working in Multiple Views
MODEL DEVELOPMENT:
WORKING IN MULTIPLE VIEWS

Working in Multiple Views
MODEL DEVELOPMENT:
Cutting Views on the Fly for Coordination

Moving a Column
MODEL DEVELOPMENT: Cutting Views on the Fly for Coordination

Moving a Wall
MODEL DEVELOPMENT: Cutting Views on the Fly for Coordination

Establishing Edge Distances

5"
Establishing Edge Distances
MODEL DEVELOPMENT:
Evaluating and Communicating a Change

New Top of Steel Heights
MODEL DEVELOPMENT:
Evaluating and Communicating a Change

New Top of Steel Heights
MODEL DEVELOPMENT:
Evaluating and Communicating a Change

New Top of Steel Heights
MODEL DEVELOPMENT:
Evaluating and Communicating a Change

New Top of Steel Heights
LIVE DEMONSTRATION
5.4 CONSTRUCTION DOCUMENTS
Experienced Modeler has developed a majority of the model.
Less experienced users can be added to the team to complete the construction documents.

These users will generate any additional plans, sections, elevations and callouts needed to complete the construction documents.
5 MODEL DEVELOPMENT: CONSTRUCTION DOCUMENTS

Annotation symbols such as section marks, elevation tags, and callout bubble are used to generate the actual views within the project.
Annotation symbols such as section marks, elevation tags, and callout bubble are used to generate the actual views within the project.
Process of checking to ensure that callouts are coordinated is no longer necessary. Views within Revit are tied directly to the callout symbol. If the view moves, it is automatically updated.

This view is already placed on Sheet: A1 - Floor Plan.

To place a similar view on a sheet, you can use the Duplicate View or Duplicate with Detailing command to create a copied view. You can also use the Duplicate as a Dependent command to create a new view that is tied to the original view, allowing you to split and crop these dependent views across multiple sheets.
5 MODEL DEVELOPMENT: CONSTRUCTION DOCUMENTS

Keynoting Options

Reference Keynotes
Keynoting Options

Sheet Keynotes
5 MODEL DEVELOPMENT: CONSTRUCTION DOCUMENTS

Keynoting Options

Text Notes
Managing Keynotes

Key Value | Keynote Text
--- | ---
06000 | Division 06 - Wood and Plastics
07000 | Division 07 - Thermal and Moisture Protection
07100 | Dampproofing and Waterproofing
07200 | Thermal Protection
07210 | Building Insulation
07210.A1 | R-11 Batt Insulation
07210.A2 | R-13 Batt Insulation
07210.A3 | R-15 Batt Insulation
07210.A4 | R-19 Batt Insulation
07210.A5 | R-21 Batt Insulation
07210.A6 | R-22 Batt Insulation
07210.A7 | R-25 Batt Insulation
07210.A8 | R-30 Batt Insulation
07210.A9 | R-38 Batt Insulation
07210.A10 | Batt Insulation
07210.B1 | 13mm Rigid Insulation
07210.B2 | 25mm Rigid Insulation
07210.B3 | 38mm Rigid Insulation
07210.B4 | 50mm Rigid Insulation
07210.B5 | 63mm Rigid Insulation
07210.B6 | 75mm Rigid Insulation
07210.C1 | 25mm Micromat
## Managing Keynotes

<table>
<thead>
<tr>
<th>Division</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>00</td>
<td>Procurement and Contracting Requirements</td>
</tr>
<tr>
<td>01</td>
<td>General Requirements</td>
</tr>
<tr>
<td>01.50</td>
<td>Temporary Facilities and Controls</td>
</tr>
<tr>
<td>01.53</td>
<td>Temporary Construction</td>
</tr>
<tr>
<td>01.53.A1</td>
<td>Temporary Dustproof Partition</td>
</tr>
<tr>
<td>01.53.A2</td>
<td>Temporary Protective Floor Cover</td>
</tr>
<tr>
<td>01.53.A3</td>
<td>Temporary Protective Passageway</td>
</tr>
<tr>
<td>01.53.A4</td>
<td>Temporary Protective Wall Cover</td>
</tr>
<tr>
<td>01.53.A5</td>
<td>&quot;Temporary Shoring, Bracing And Support&quot;</td>
</tr>
<tr>
<td>01.53.A6</td>
<td>Temporary Weatherproof Closure</td>
</tr>
<tr>
<td>02</td>
<td>Existing Conditions</td>
</tr>
<tr>
<td>02.40</td>
<td>Demolition and Structure Moving</td>
</tr>
<tr>
<td>02.41</td>
<td>Demolition</td>
</tr>
<tr>
<td>02.41.A1</td>
<td>Remove Existing Below Grade Construction</td>
</tr>
<tr>
<td>02.41.A2</td>
<td>Remove Demolition Materials From Site</td>
</tr>
<tr>
<td>02.41.A3</td>
<td>Remove Demolition Materials To Owner's</td>
</tr>
<tr>
<td>02.41.A4</td>
<td>Remove Existing Construction</td>
</tr>
<tr>
<td>02.41.A5</td>
<td>Existing Building To Be Removed</td>
</tr>
<tr>
<td>02.41.A6</td>
<td>Salvage Item, Return To Owner</td>
</tr>
<tr>
<td>02.41.A7</td>
<td>Salvage Item, Re-Use In New Work</td>
</tr>
<tr>
<td>02.41.B1</td>
<td>Disconnect And Seal Existing Utilities</td>
</tr>
<tr>
<td>02.41.B2</td>
<td>Maintain Existing Utilities In Service</td>
</tr>
<tr>
<td>02.41.C1</td>
<td>Topsoil Stockpile Area</td>
</tr>
<tr>
<td>02.41.C2</td>
<td>Asphalt Paving To Be Removed</td>
</tr>
<tr>
<td>02.41.C3</td>
<td>Concrete Walk To Be Removed</td>
</tr>
<tr>
<td>02.41.C4</td>
<td>Fence To Be Removed</td>
</tr>
<tr>
<td>02.41.C5</td>
<td>Concrete To Be Removed</td>
</tr>
<tr>
<td>02.41.C6</td>
<td>Concrete Porch To Be Removed</td>
</tr>
<tr>
<td>02.41.C7</td>
<td>Brick Masonry To Be Removed</td>
</tr>
<tr>
<td>02.41.C8</td>
<td>CMU's To Be Removed</td>
</tr>
<tr>
<td>02.41.C9</td>
<td>Stone Veneer To Be Removed</td>
</tr>
</tbody>
</table>
### Generating Specifications

#### Keynote Legend

<table>
<thead>
<tr>
<th>Key Value</th>
<th>Keynote Text</th>
</tr>
</thead>
<tbody>
<tr>
<td>03410.C1</td>
<td>1500 x 200mm Precast Concrete Hollow Core Slab</td>
</tr>
<tr>
<td>04220.A1</td>
<td>200x200x400mm CMU - 2 Core</td>
</tr>
<tr>
<td>06110.A2</td>
<td>Wood Blocking As Required</td>
</tr>
<tr>
<td>07210.B6</td>
<td>75mm Rigid Insulation</td>
</tr>
<tr>
<td>07220.A2</td>
<td>Tapered Rigid Insulation</td>
</tr>
<tr>
<td>07620.B1</td>
<td>Parapet Cap Flashing</td>
</tr>
</tbody>
</table>

Keynotes generated from default list.

Schedule of notes used in project can be used to development an outline specification.

All project keynotes can be reviewed in a single place.
Generating Specifications

Information Manager
Develops keynotes to be used within the project.

### Keynote Legend

<table>
<thead>
<tr>
<th>Key Value</th>
<th>Keynote Text</th>
</tr>
</thead>
<tbody>
<tr>
<td>03410.C1</td>
<td>1500 x 200mm Precast Concrete Hollow Core Slab</td>
</tr>
<tr>
<td>04220.A1</td>
<td>200x200x400mm CMU - 2 Core</td>
</tr>
<tr>
<td>06110.A2</td>
<td>Wood Blocking As Required</td>
</tr>
<tr>
<td>07210.B6</td>
<td>75mm Rigid Insulation</td>
</tr>
<tr>
<td>07220.A2</td>
<td>Tapered Rigid Insulation</td>
</tr>
<tr>
<td>07620.B1</td>
<td>Parapet Cap Flashing</td>
</tr>
</tbody>
</table>
5.5 COORDINATION
Traditional Coordination Process
Coordination
Coordination
5 MODEL DEVELOPMENT: CONSTRUCTION DOCUMENTS

Clash Detection

Mechanical Model

Structural Model

Navisworks
Clash Detection
5 MODEL DEVELOPMENT: CONSTRUCTION DOCUMENTS

Clash Detection

IFC File format

Tekla BIMsight
Coordination Meetings

Agenda:
Load models
Add tolerances (Fire Proofing)
Add Access clearances
Any other additional restrictions/geometry that should be accounted for.

Run Clash Detection
Review results
Each consultant receives list of clashes that need to be resolved.

Repeat meeting as needed. (Virtual weekly meeting via Go-To-Meeting)??
5.6 QA/QC PROCESS
QA/QC Process

PM does not need to know how to use the software to review drawings:

Process of exporting to dwg at the end of the day/week/when needed
(batch Export)

Markup tools:

Autodesk Design Review
Blue Beam
Etc....
5 MODEL DEVELOPMENT: CONSTRUCTION DOCUMENTS

Digital Review Process

Drawings can be exported as DWF files for use in various mark-up/review tools.
Digital Review Process

There are many mark-up/review programs that are available for free.
Digital Review Process

Most review tools are easy to use and will allow you to digitally “red-line” a drawing.
Digital Review Process

Most review tools are easy to use and will allow you to digitally “red-line” a drawing.
Digital Review Process

When exporting from a BIM, all of the associated data is saved within the DWF.
Review drawings from virtually anywhere!

5 MODEL DEVELOPMENT: CONSTRUCTION DOCUMENTS
Digital Review Process

Changes can be reloaded directly into BIM for team to address.
Digital Review Process
Digital Review Process

Digital redline can be archived if needed.
CASE STUDY:
PROTOTYPE PROJECT X
Case Study
The new fee structure

Project X

Prototype Project

This project was selected due to the fact that less design decisions were required so that inefficiencies could be filtered out to focus largely on the new tool “Revit”
Case Study
The new fee structure

Project X

Total Hours Per Phase

<table>
<thead>
<tr>
<th>Project Phase</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD</td>
<td></td>
</tr>
<tr>
<td>DD</td>
<td></td>
</tr>
<tr>
<td>CD</td>
<td></td>
</tr>
</tbody>
</table>

1st Revit Project: 1259 Hours

- Highly Experienced Team (AutoCAD): 773 Hours
- Minimally Experienced (Revit) Team: 694 Hours

Project: AutoCAD
Team Experience (1-10): 10
Team Size: 3-4

Project: 1st Revit Project
Team Experience (1-10): 0
Team Size: 3-4

Project: 2nd Revit Project
Team Experience (1-10): 4
Team Size: 3-4
Case Study
The new fee structure

Project X

Traditional Fee Distribution

<table>
<thead>
<tr>
<th>Hours</th>
<th>10%</th>
<th>20%</th>
<th>45%</th>
<th>5%</th>
<th>20%</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD</td>
<td>10%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DD</td>
<td></td>
<td>20%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CD</td>
<td></td>
<td></td>
<td>45%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BN</td>
<td></td>
<td></td>
<td></td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td>CA</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>20%</td>
</tr>
</tbody>
</table>

Current Fee’s do Not reflect effort!

CAD Project

BIM Project

What happens when a Revit project is put on hold before the CD phase?
Case Study  
The new fee structure

Project X

<table>
<thead>
<tr>
<th>Phase</th>
<th>25%</th>
<th>45%</th>
<th>15%</th>
<th>5%</th>
<th>10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CD</td>
<td>25%</td>
<td>45%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BN</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CA</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Proposed Fee Distribution

CAD Project

BIM Project

Project Phase

Hours
Case Study
The new fee structure

Evolution toward a new design process

1. Ability to impact cost and functional capabilities
2. Cost of design changes
3. Traditional design process
4. Preferred design process

Paradigm Shift moving to BIM

PD: Pre-design
SD: Schematic design
DD: Design development
CD: Construction documentation
PR: Procurement
CA: Construction Administration
OP: Operation

Graphic courtesy of Patrick MaLeamy AIA / HOK

Time
QUESTIONS ?