MSF22482: Level Of Development (LOD) 2016: When to Draw the Line (and Where to MODEL IT!)

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Principal
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Class summary

The presentation will provide an in-depth discussion of fabrication and Level Of Development (LOD) from the 2016 AGC BIM Forum LOD Specification from one of the specifications authors. It will address model elements at the different stages in a building life cycle: Design, Construction and Ownership. The framework of the discussion will consider the LOD Specification that defines models on a scale of 100 to 500 with a particular focus of LOD 350 which the speaker originally authored and introduced to the LOD Specification committee. The content will discuss how structural element models are used by architects, mechanical engineers, construction managers, sub-contractors and fabricators. This will demonstrate how the newly issued LOD Specification can be used to define team expectations of what should be modeled. Practical examples of model detail issues will be shown along with effective approaches to resolve the challenges using the LOD Specification as an early BIM planning tool.
Key learning objectives

At the end of this class, you will be able to:

1. Define what is Model Element Level Of Development (LOD) for design.
2. Understand what the AGC BIM Forum LOD Specification 2016 is and how you can address LOD in projects with it.
3. Understand how the LOD Specification can be used with design and construction teams to lower risk.
4. Understand why LOD discussions are crucial early on in a project.

IKERD

People | Building | Clarity

- Began in 2003
- IKERD is an internationally recognized consulting group in buildings, civil and industrial construction markets.
- Using our knowledge of engineering, team dynamics, communication and technology, we have built an extensive breadth of experience on a wide variety of integrated construction project types with BIM.
- Engineering and construction grade modeling.
- 3D laser scanning.
Board of Directors, served since 2008

Co-Chair of the SEI – CASE Joint Committee on BIM Chair Sub-Committee on Dev., Soft. & Train. Served since 2007

Mid-90’s Graduate Work in Parametric Structural Engineering of Buildings with EDI

Washington University in St. Louis
Major Take Away

“Everything should be made as simple as possible, but not one bit simpler.”

Albert Einstein
Why LOD?: Model Element Handoffs

There’s many a slip between the cup and the lip

BIM Forum Level of Development

Milestones/Deliverables

PARTICIPATING ORGANIZATIONS

- The American Institute of Architects
- AGC of America
- PCI: Precast/Prestressed Concrete Institute
- USIBD

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BIMFORUM Level of Development Specification

- Scope cannot address all of BIM
- There is NO LOD of a whole model.
- LOD does not always match design phase.
- **2008** - American Institute of Architects (AIA) First Published definition for 100, 200, 300 & 400 in 2008 E202.
- **2009-10** LOD 350 was authored and first presented at Autodesk University sessions by Ikerd.
- **2011** - BIM Forum LOD Taskforce formed
- **2013** – BIM Forum published the first LOD Spec ratifying LOD 350
LOD 100

The Model Element may be graphically represented in the Model with a symbol or other generic representation, but does not satisfy the requirements for LOD 200. Information related to the Model Element (i.e. cost per square foot, tonnage of HVAC, etc.) can be derived from other Model Elements.

BIMForum Interpretation: LOD 100 elements are not geometric representations. Examples are information attached to other model elements or symbols showing the existence of a component but not its shape, size, or precise location. Any information derived from LOD 100 elements must be considered approximate.

LOD 200

The Model Element is graphically represented within the Model as a generic system, object, or assembly with approximate quantities, size, shape, location, and orientation. Non-graphic information may also be attached to the Model Element.

BIMForum Interpretation: At this LOD elements are generic placeholders. They may be recognizable as the components they represent, or they may be volumes for space reservation. Any information derived from LOD 200 elements must be considered approximate.
LOD 300

**BIMForum LOD SPEC. 2016**

The Model Element is graphically represented within the Model as a specific system, object or assembly in terms of quantity, size, shape, location, and orientation. Non-graphic information may also be attached to the Model Element.

**BIMForum Interpretation:** The quantity, size, shape, location, and orientation of the element as designed can be measured directly from the model without referring to non-modeled information such as notes or dimension call-outs.

LOD 350: Detailed Coordination

**BIMForum LOD SPEC. 2016**

The Model Element is graphically represented within the Model as a specific system, object, or assembly in terms of quantity, size, shape, location, orientation, and interfaces with other building systems. Non-graphic information may also be attached to the Model Element.

**BIMForum Interpretation:** Parts necessary for coordination of the element with nearby or attached elements are modeled. These parts will include such items as supports and connections. The quantity, size, shape, location, and orientation of the element as designed can be measured directly from the model without referring to non-modeled information such as notes or dimension call-outs.
LOD 400: Fabrication Assemblies

The Model Element is graphically represented within the Model as a specific system, object or assembly in terms of size, shape, location, quantity, and orientation with detailing, fabrication, assembly, and installation information. Non-graphic information may also be attached to the Model Element.

**BIMForum Interpretation:** An LOD 400 element is modeled at sufficient detail and accuracy for fabrication of the represented component. The quantity, size, shape, location, and orientation of the element as designed can be measured directly from the model without referring to non-modeled information such as notes or dimension call-outs.

**CONCRETE CAST-IN-PLACE**

<table>
<thead>
<tr>
<th>LOD 200</th>
<th>LOD 300</th>
<th>LOD 350</th>
</tr>
</thead>
</table>

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WHY LOD 350 – CROSS TRADE COORD.

LOD 300
PERMIT

LOD 400
FABRICATED

~20% OF EFFORT
W/ ~80% CONSTRUCTION $$$

Steel Base Plate Design Drawings

C.L. OF BASE | Q. SAME AS COL. UNLESS OTHERWISE DETAILED OR NOTED.
COLUMN
DOUBLE NUT & WASHER
CONCRETE
1 OF 4, 3/4"DIA.
(A307) A.B.
PL- 1/4"x4"x0'-4" & HEAVY HEX NUT (TYP.)
## LOD Specification

Below is a table showing LOD details for structural frames and columns. The table includes information on LOD 100, 200, and 400. The table is followed by an image of a base plate LOD 100.

### LOD 100

- **Description:** Simplified view of structural components.
- **Notes:** Includes basic structural elements without detailed geometry.

### LOD 200

- **Description:** Detailed structural frame.
- **Notes:** Includes more detailed geometry and connections to other structural elements.

### LOD 400

- **Description:** Highly detailed structural frame.
- **Notes:** Includes complex connections and detailed geometry.

### Base Plate LOD 100

- **Components:** Base plate, bolts, and connections.
- **Notes:** Includes all necessary components for assembly and detailed connections.
Base Plate LOD 200

Base Plate LOD 300
**LOD Specification Example**

300 ➔ 350 ➔ 400

Images courtesy of IKERD Consulting, LLC

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**Cold Formed Metal Framing (CFMF) BIM**

Images courtesy of IKERD Consulting, LLC
LOD 200

BIMFORUM

LOD 300

BIMFORUM
LOD 300

LOD 350

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LOD 400

Masonry

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Precast Structural Double Tee

100

1. Type of structural concrete system
   - Approximate geometry (e.g., depth of structural elements)

300

2. Precast structural elements to include:
   - Precast beam or girders
   - Precast floor and wall panels
   - Precast structural precast panels
   - Precast column or wall panels
   - Precast structural precast panels
   - Precast structural precast panels

400

3. Precast structural precast panels
   - Precast structural precast panels
   - Precast structural precast panels

500

4. Precast structural precast panels
   - Precast structural precast panels
   - Precast structural precast panels

LOD 200

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LOD 400

Precast Stairs

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Highway Bridges: Precast Structural Girder

LOD 200
LOD Specification - Attribute Table

- Contains three categories pertaining to the options for an element
- The Baseline category contains a suggested list of attributes to be populated when no other attributes are known
- The Additional category contains a list of possible attributes to consider
- The last category contains milestones
## LOD Specification - Attribute Table

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Date Type</th>
<th>Units</th>
<th>Option Examples</th>
<th>Commentary</th>
<th>3D</th>
<th>3D 200</th>
<th>3D 300</th>
<th>3D 400</th>
<th>Est. 1</th>
<th>Bid</th>
<th>Fig.</th>
<th>Check</th>
<th>Submit</th>
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<td>Glass - Material</td>
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<td>Glass - Configuration</td>
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<tr>
<td>Glass - Condition</td>
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</tr>
</tbody>
</table>

### LOD Specification - Attribute Table

- **B - Ext. Glazed Openings**
- **Part 1 - Attribute Description**
- **Part 2 - LOD Profile**
- **Part 3 - Project Specific Milestones [Examples]**
When is Close Enough, Close Enough?

Acceptable Forms of Measurement?
Level of Accuracy Specification

Struggles & Issues

- Unmet Expectations (Procurer’s View)

Image Courtesy of CyArk
Struggles & Issues

- Expectation Management (Provider’s View)

Client’s Expectation  Client’s Budget

Struggles & Issues

- Speaking Different Languages
What LOA Does **NOT** Define

- Targeted audience
- Sensors and data acquisition methods
- Explicit LOA values (only ranges)
- QC procedures (only QA levels)
- Cost-benefit

**USIBD 5 Defined Levels of Accuracy**

<table>
<thead>
<tr>
<th>Level</th>
<th>Upper Range</th>
<th>Lower Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOA10</td>
<td>User defined</td>
<td>5cm *</td>
</tr>
<tr>
<td>LOA20</td>
<td>5cm *</td>
<td>15mm *</td>
</tr>
<tr>
<td>LOA30</td>
<td>15mm *</td>
<td>5mm *</td>
</tr>
<tr>
<td>LOA40</td>
<td>5mm *</td>
<td>1mm *</td>
</tr>
<tr>
<td>LOA50</td>
<td>1mm *</td>
<td>0 *</td>
</tr>
</tbody>
</table>

*Specified at the 95 percent confidence level.
USIBD LOA Ranges

<table>
<thead>
<tr>
<th>Level Of Accuracy</th>
<th>LOA10</th>
<th>LOA20</th>
<th>LOA30</th>
<th>LOA40</th>
<th>LOA50</th>
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</thead>
<tbody>
<tr>
<td>Upper Range (Imperial)</td>
<td>-</td>
<td>2&quot;</td>
<td>5/8&quot;</td>
<td>1/4&quot;</td>
<td>1/16&quot;</td>
</tr>
<tr>
<td>Lower Range (Imperial)</td>
<td>2&quot;</td>
<td>5/8&quot;</td>
<td>1/4&quot;</td>
<td>1/16&quot;</td>
<td>0</td>
</tr>
<tr>
<td>Upper Range (Metric)</td>
<td>-</td>
<td>5cm</td>
<td>15mm</td>
<td>5mm</td>
<td>1mm</td>
</tr>
<tr>
<td>Lower Range (Metric)</td>
<td>5cm</td>
<td>15mm</td>
<td>5mm</td>
<td>1mm</td>
<td>0</td>
</tr>
</tbody>
</table>

In terms of standard deviation (1 Sigma)

Measured vs. Represented

<table>
<thead>
<tr>
<th>Measured Accuracy</th>
<th>$$$$$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absolute</td>
<td>If Absolute - describe reference frame here</td>
</tr>
<tr>
<td>Relative</td>
<td>If Relative - describe measure of relativity here</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Represented Accuracy</th>
<th>$$$$$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absolute</td>
<td>If Absolute - describe reference frame here</td>
</tr>
<tr>
<td>Relative</td>
<td>If Relative - describe measure of relativity here</td>
</tr>
</tbody>
</table>

Measured point

Object surface

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Orthogonal vs. Real World

Out-of-plumb Conditions
Concealed Conditions & Best Fit

Steel Member of Unknown Size
Point Cloud

Uneven Point Cloud Surface of Fire Proofing
Best Fit Model of Surface of Fire Proofing

CSI UniFormat™ 2010

A. SUBSTRUCTURE
B. SHELL
C. INTERIORS
D. FITTINGS
E. EQUIPMENT & FURNISHINGS
F. SPECIAL CONSTRUCTION & DEMOLITION
G. BUILDING SITWORK
### CSI UniFormat™ 2010

#### Level 1

### A: SUBSTRUCTURE

- **A10** Foundations
  - A1010 Standard Foundations
  - A1020 Special Foundations
- **A20** Subgrade Enclosures
  - A2010 Wells for Subgrade Enclosures
- **A40** Slab on Grade
  - A4010 Standard Slab on Grade
  - A4020 Structure Slab on Grade

### B: SHELL

- **B10** Superstructure
  - B1010 Pacific Construction
  - B1020 Roof Construction
- **B20** Exterior Vertical Enclosures
  - B2010 Exterior Building Skin

### C: INTERIORS

- **C10** Interior Construction
- **C20** Interior Finishes

---

**USIBD**

USIBD (U.S. Treasury of Building Documentation)

**Autodesk**

AUTODESK UNIVERSITY 2010
Suggested LOA’s

These ‘suggested’ selections are based on the most common building documentation applications. Specialized applications, such as heritage documentation, plant documentation, etc. may require LOA’s other than what are suggested here.
LOA Validation

Measurement validation
A: No data check
B: Check by overlapping data sets
C: Check by independent measurements or methods

Representation validation
A: No check
B: Double check
C: Triple check

Specification Schema

<table>
<thead>
<tr>
<th>Measured Accuracy Validation</th>
<th>Relative (rel)</th>
<th>Represented Accuracy Validation</th>
<th>Relative (rel)</th>
</tr>
</thead>
<tbody>
<tr>
<td>YY</td>
<td>A</td>
<td>rel</td>
<td>ZZ</td>
</tr>
</tbody>
</table>

| YY : 30 Measurement accuracy (standard deviation) of 5 to 15mm |
| A : B Check by overlapping data sets |
| rel : rel Relative accuracy (standard deviation) in regards to a reference system |
| ZZ : 20 Representation accuracy (standard deviation) of 15 to 50mm |
| A : A No check of the final representation |
| rel : rel Relative accuracy (standard deviation) in regards to a reference system |
Specification Schema

LOA 30B-rel-20A-rel

| YY  | 30 | Measurement accuracy (standard deviation) of 5 to 15mm |
| A   | B  | Check by overlapping data sets                           |
| rel | rel| Relative accuracy (standard deviation) in regards to a reference system |
| ZZ  | 20 | Representation accuracy (standard deviation) of 15 to 50mm |
| A   | A  | No check of the final representation                      |
| rel | rel| Relative accuracy (standard deviation) in regards to a reference system |

What’s New in Version 2.0?

- New Illustrations in the Guide
What **Does** The LOA Spec Provide?

- Independent standard
- Easy to use flexible template
- Suggested accuracy levels as a guideline for inexperienced users or when under time constraints
- Distinction between data acquisition and “the model”
- Extensibility for future enhancements
- Metric and imperial values

**LOD SPECIFICATION TASKFORCE**

- BIMforum.org/LOD
- No LOD of whole Model, only Elements
- All delivery methods
- Dictionary for BIM

Jim Bedrick, FAIA  
BIM Forum

Jan Reinhardt  
BIM Forum

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BxP SAMPLE TASKFORCE

- Will Ikerd, PE, BIM Forum
- Benjamin Crosby, BIM Forum
- David Merrifield, NISD CD-BIM.com
- John Russo, USIBD.org

1. Builds off CD-BIM sample BxP
2. 140+ projects with over 12 GCs
3. Developed by practitioners.
4. BIMforum.org/BxP

Coordination Guide Taskforce

- David Epps
- Mark Mergenschroer
- David Merrifield, NISD CD-BIM.com
- John Russo, USIBD.org

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4) Targeted at beginning and experienced BIM team members

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Friday, January 20, 2017
Friday, February 17, 2017
Friday, March 17, 2017
Friday, April 21, 2017
Friday, May 19, 2017
Friday, June 16, 2017
Friday, July 21, 2017
Friday, August 11, 2017
Friday, September 15, 2017
Friday, October 20, 2017
Friday, November 17, 2017
Friday, December 15, 2017

CD-BIM.com/LOA
8-11am PT

Friday, January 27, 2017
Friday, February 24, 2017
Friday, March 24, 2017
Friday, April 28, 2017

have teamed together to provide the LOA workshop and Exam Online.

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CD-BIM.com is providing a training course in the use of USBD’s Level of Accuracy (LOA) Specification document. This course will cover Session 2 of this document. This training will provide an overview of the document and show how it will close the gap in your clients’ expectations by increasing communication, ensuring the right use of available or chosen technology and get the right results more easily, accurately and efficiently.

Once certified, individuals can use their expertise in the LOA documents when discussing proposals with clients and colleagues. Individuals who pass the test will be certified based upon Version 2 of the documents they test for (there is no separation data).

The current Version 1 of the LOA is the most downloaded document currently published by USBD.

This document provides a flexible approach to specifying accuracy regardless of the size or project, ultimately serving as a risk reduction tool for both the client and the service provider.

This training will dovetail with the publication of Session 2 of the LOA. Version 2 has been updated to include over-revised appendices, comprehensive LOA suggestions, expanded reference frame specification, and now also includes a heritage overlay.

LOA Workshop Calendar

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>PT (Los Angeles)</th>
<th>MT (Denver)</th>
<th>CT (Chicago)</th>
<th>ET (New York)</th>
<th>GMT (London)</th>
<th>France</th>
<th>Poland</th>
<th>India</th>
<th>Philippines</th>
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</thead>
<tbody>
<tr>
<td>Friday, January 27</td>
<td>USBD/LOA Workshop</td>
<td></td>
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Other AU Session

**FAB2538**  
Fabrication and 2016 Level Of Development (LOD) Specification  
60 minutes  
Industry talk  
Primary Speaker

11/16/16 (Wednesday) 1:00 PM – Marcello 4405, Level 4

Pre-registered Attendees (109 people)

**FAB2624**  
Drawings with Advance Steel  
60 minutes  
Industry talk  
Co-Speaker

11/15/16 (Tuesday) 4:45 PM – Marcello 4405, Level 4

Pre-registered Attendees (54 people)

**LD2481-L**  
A Tale of 2 Coordinate Systems: Bridging AutoCAD Civil 3D and Revit Together  
90 minutes  
Hands-on lab  
Primary Speaker

11/13/16 (Thursday) 3:00 PM – San Polo, 3503, Level 3

Pre-registered Attendees (86 people)

**MSF22492**  
Level Of Development (LOD) 2016: When to Draw the Line (and Where to MODEL IT)  
60 minutes  
Industry talk  
MSF Speaker

11/14/16 (Monday) 8:45 AM – Murano 3302, Level 3

Pre-registered Attendees (83 people)

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