Model-based Design

Presenters:
Greg Goyette, John Barone, Steven Costa, and Brad Hollister

Stantec
Agenda

1. Industry Overview
2. Introductions
3. Stantec Overview
4. Chicago Transit Authority, Red and Purple Line Modernization
5. BIM Deliverable/Modeling
6. Industry move to Model-Based Design
Industry Overview

Technology is disrupting the transportation infrastructure industry

- Contractors – digital layout and GPS systems, construction job site data
- Designers – BIM, 3D model-based design, visualization
- Owners – asset management applications, data hubs
- Vendors – construction-driven engineering applications and software
Introductions

Greg Goyette, Principal, Transportation Practice
John Barone, Digital Practice Manager
Steven Costa, Digital Practice Specialist
Brad Hollister, Digital Practice Specialist
Stantec Overview

Stantec

Digital Practice
- CTA CAD Standards
- Deliverables
  - Connect Version of Bentley Products
  - BIM
- Proposal Phase/Design Phase
- Subconsultants
Chicago Transit Authority
Introduction
Project Background

- Reconstruct, modernize and build 1.9 miles of elevated tracks, including bridges and support structures along Chicago’s busiest transit corridor

- Demolish and construct four new stations
Project Background

- A new rail bypass / flyover north of Belmont Station
Project Background

- 150 design packages within 22 months; 48 months of construction
- $2.1B in construction cost
Chicago Transit Authority
Challenges
Challenge #1
First project using Bentley Open Suite within Stantec.

SOLUTION:
Engage vendors at start of project and listen to user issues.
Challenge #2

Daily file conversion/replication between Revit files hosted on BIM 360 and Bentley Open Suite files hosted on ProjectWise.

SOLUTION:

Leveraged scripting to automate the conversion process for hundreds of drawings.
Challenge #3

Coordination on project of this complexity and density cannot effectively be done with 2D plans

**SOLUTION:**

Federate model using data from Bentley and Autodesk platforms to properly coordinate data and clash resolution for all project disciplines
Chicago Transit Authority Solutions
CTA AUTOMATED REPLICATION

PROJECTWISE

- Revit references converted from DWG
- Open Suite DGN references

AUTOMATED REPLICATION PROCESS

- Convert to DGN and replace in ProjectWise

- Check DGN reference timestamp in ProjectWise
  - Yes
    - Newer than converted DGN in ProjectWise?
      - Yes
        - Convert to DWG and replace in BIM 360
      - No
        - NO ACTION
  - No
    - NO ACTION

BIM 360

- Revit DWG references
- Open Suite references converted from DGN
The Industry Move to Model Based Design

ACEC/VTRANS
Transportation Technical Workshop

Stantec
Digital Practice - Infrastructure
Design Processes

Plans

Secondary deliverables such as staking reports, AMG grading models, etc.

PRIORITY #1

LOW PRIORITY

Old-School Design
Model Based Design

- Design Processes
- Model
- Plans
- Other deliverables such as staking reports, AMG grading and other model types

BIM Design Processes
Model Based Design

Model Based Design

Geometric Design Models

BIM Design Processes
Michigan DOT 3D Highway Design Model Cost Benefit Analysis*

- Studied projects from 2012 – 2016
- 65 projects with traditional 2D + 3D deliverables
- 192 projects with traditional 2D delivery only

The historical data statistical analysis revealed that project sizes of $5 million to $20 million benefit the most from the use of 3D models. However, 3D models (indiscriminate of project size) consistently produced bids that were lower than the engineer’s estimate. When bids came in higher than the engineer’s estimate, 3D models produced fewer change orders than 2D plans.”
Bid Amount Effects

Equation 1. Formula for calculating award growth parameter.

\[
\text{Award Growth} = \frac{\text{Awarded Contract Value} - \text{Engineer’s Estimate}}{\text{Engineer’s Estimate}} \times 100
\]

Table 8. Historical data award growth analysis summary (for all regions).

<table>
<thead>
<tr>
<th></th>
<th>Award growth – All Regions</th>
<th>2D Plans</th>
<th>3D Models</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Count</strong></td>
<td>192</td>
<td>65</td>
<td></td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td>+3.0%</td>
<td>-1.4%</td>
<td></td>
</tr>
<tr>
<td><strong>Standard Deviation</strong></td>
<td>15%</td>
<td>15%</td>
<td></td>
</tr>
</tbody>
</table>

Net 4.4% Change

Table 21. Summary of calculations for the 5-year ROI of MDOT’s implementation of RID 3D models.

<table>
<thead>
<tr>
<th>Value</th>
<th>Output ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Construction Program ($)</td>
<td>$ 1,249,400,000</td>
</tr>
<tr>
<td>Timeframe</td>
<td>5 Years</td>
</tr>
<tr>
<td>Cost Over Timeframe ($)</td>
<td>$ 56,752,963</td>
</tr>
<tr>
<td>Benefits Over Timeframe ($)</td>
<td>$ 74,964,000</td>
</tr>
<tr>
<td>Net Benefits</td>
<td>$ 18,211,037</td>
</tr>
<tr>
<td>5-Year ROI (%)</td>
<td>32.03%</td>
</tr>
<tr>
<td>Breakeven Year</td>
<td>Year 1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>2D (TRADITIONAL)</th>
<th>2D + 3D</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Estimated Construction Cost</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$1,000,000.00</td>
<td>$1,000,000.00</td>
</tr>
<tr>
<td><strong>Design Cost</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9% of Estimated Cost</td>
<td>$90,000.00</td>
<td>$99,000.00</td>
</tr>
<tr>
<td>+ 10% to the Design Cost</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Bid Results</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Estimated Cost +3%</td>
<td>$1,030,000.00</td>
<td>$986,000.00</td>
</tr>
<tr>
<td>Estimated Cost -1.4%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Final As-Let Cost</td>
<td>$1,120,000.00</td>
<td>$1,085,000.00</td>
</tr>
<tr>
<td><strong>As-Let Cost Savings</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$1,120,000.00 - $1,085,000.00 = $35,000.00</td>
<td></td>
</tr>
</tbody>
</table>
Project Level Benefit on Bid Cost

$35,000

Project Delivery Cost Savings equals 39% of Design Effort

($35,000/$90,000)
Wisconsin Lessons Learned

Deliver Design Model Pre-Bid
Wisconsin Lessons Learned

3D Design Workflow is Different From Traditional Approaches
Wisconsin Lessons Learned

Match Model Content to Project Needs
• Type of Content
• Level of Detail, Level of Development
Wisconsin Lessons Learned

Moving the Entire Industry – Leave No One Behind
Stantec and BIM for Infrastructure
Internal and External

How can we help?
Questions