Workflow Changes to Support Digital Construction – Design Deliverables

Gabe Nelson, P.E.
Snyder & Associates, Inc.
Overview

• Getting Started
• Understanding Deliverables
• Quality Control of 3D Deliverables
• Level of Detail
What Is a 3D Engineered Model?

3D Engineered Model

• 3D Engineered Model: A digital graphical representation of proposed facility/site data consisting of x, y, and z coordinates for producing objects in three-dimensions to communicate design intent useful for visualization, analysis, animation, simulation, plans, specifications, estimates production, and life-cycle asset management.
Incorporating Cost and Schedule Information

Adding Project Schedules (4D)

Screenshot of 4D Model
Incorporating Cost and Schedule Information

- Adding Project Cost Information (5D)
  - FHWA defines 5D modeling as:
    
    “A 4D model intelligently linked with cost information for a project”
How to Get Started

• Establish Goals up Front!
  ➢ Calculation of Quantities
  ➢ Visualization/Virtual Reality
  ➢ Design Analysis/Quality Control
  ➢ Automated Machine Guidance
  ➢ BIM Execution Plan
    ➢ What are we modeling?
    ➢ When are we modeling it?
    ➢ To what level of detail are we modeling it?
## Level of Accuracy

**ITEM 625.1001 11 – 3D CADD MODEL**

<table>
<thead>
<tr>
<th>MSE-Proposed</th>
<th>DGN / XML</th>
<th>&lt;18 mm</th>
<th>3D</th>
<th>3D</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Straps</td>
<td>DGN / XML</td>
<td>&lt;18 mm</td>
<td>3D</td>
<td>3D</td>
<td>Yes</td>
</tr>
<tr>
<td>Footings</td>
<td>DGN / XML</td>
<td>&lt;18 mm</td>
<td>3D</td>
<td>3D</td>
<td>Yes</td>
</tr>
<tr>
<td>Top</td>
<td>DGN / XML</td>
<td>&lt;18 mm</td>
<td>3D</td>
<td>3D</td>
<td>Yes</td>
</tr>
<tr>
<td>Coping</td>
<td>DGN / XML</td>
<td>&lt;18 mm</td>
<td>3D</td>
<td>3D</td>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cast-in-Place-Proposed</th>
<th>DGN / XML</th>
<th>&lt;18 mm</th>
<th>3D</th>
<th>3D</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stone</td>
<td>DGN / XML</td>
<td>&lt;18 mm</td>
<td>3D</td>
<td>3D</td>
<td>Yes</td>
</tr>
<tr>
<td>Piles</td>
<td>DGN / XML</td>
<td>&lt;18 mm</td>
<td>3D</td>
<td>3D</td>
<td>Yes</td>
</tr>
<tr>
<td>Top of Footings</td>
<td>DGN / XML</td>
<td>&lt;18 mm</td>
<td>3D</td>
<td>3D</td>
<td>Yes</td>
</tr>
<tr>
<td>Face of Wall</td>
<td>DGN / XML</td>
<td>&lt;18 mm</td>
<td>3D</td>
<td>3D</td>
<td>Yes</td>
</tr>
<tr>
<td>Coping</td>
<td>DGN / XML</td>
<td>&lt;18 mm</td>
<td>3D</td>
<td>3D</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Level of Detail

• 100 – Conceptual
• 200 – Approximate Geometry
• 300 – Precise Geometry
• 400 – Fabrication
• 500 – Asbuilts

Table 4 - 3D CADD, 4D and 5D CIM MODEL LEVEL OF DEVELOPMENT BY DISCIPLINE

<table>
<thead>
<tr>
<th>Discipline</th>
<th>Model</th>
<th>LOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exist Conditions</td>
<td>Surface Terrain DTM</td>
<td>300</td>
</tr>
<tr>
<td>Exist Conditions</td>
<td>Bathymetry DTM</td>
<td>300</td>
</tr>
<tr>
<td>Exist Conditions</td>
<td>Elevated Structure including foundations, piers, abutments, main truss, approach framing and deck</td>
<td>200</td>
</tr>
<tr>
<td>Exist Conditions</td>
<td>Buildings to be demolished</td>
<td>200</td>
</tr>
<tr>
<td>Exist Conditions</td>
<td>Buildings – Context</td>
<td>100</td>
</tr>
<tr>
<td>Exist Conditions</td>
<td>Local Streets, other topographic features required for context</td>
<td>100</td>
</tr>
<tr>
<td>Proposed Civil</td>
<td>Local Streets – Paving</td>
<td>200</td>
</tr>
<tr>
<td>Proposed Civil</td>
<td>Local Streets – Relocated</td>
<td>300</td>
</tr>
<tr>
<td>Proposed Civil</td>
<td>Grading</td>
<td>300</td>
</tr>
<tr>
<td>Proposed Civil</td>
<td>Utilities</td>
<td>200</td>
</tr>
</tbody>
</table>
Enhanced Quality Assurance in Design

- 3D and Drivethrough views
- Clash Detection
- Clearance Measurements
Level of Detail – AMG Deliverables

• Depends on Ultimate Use
• Grading – 10’- 25’ is fine
• Paving 1’-5’ is better
• Needs to be closer in Vertical Curves and Superelevation Transitions
Understanding Deliverables

- Deliverables are Different for Grading and Paving
- Surfaces
- Accuracy
- 3D Breaklines
- Alignments
Automated Machine Guidance

• Grading Deliverables
  ➢ Surface – Triangulated Network (LandXML)
  ➢ 3D Breaklines
• Paving Deliverables
  ➢ 3D Breaklines

Photos Courtesy of Michigan Department of Transportation Photography and Video Services Unit
AMG Paving - Inputs
CAD Standards

• Level/Layer File names
• File Naming
• Alignments
• Templates
• Point Controls
• Makes it easier on your designers and on downstream users
• Document the files
AMG - Deliverables

- Alignments
  - LandXML format
- Grading Surfaces
  - LandXML format
- Paving
  - DXF
- Other CAD Files
- KMZ files
Other Considerations

• Delivery of Data to Contractor
  ➢ Pre-letting or Post-Letting

• Pre-letting allows the contractor to factor in the quality of the data they are getting

• Does not give any contractor a competitive advantage