Welcome & Introductions

Douglas Townes, P.E.
FHWA Resource Center
| Webinar 1: Overview of 3D Models for Construction |
| Webinar 2: Creating 3D Engineered Models |
| Webinar 3: Applications of 3D Models in the Contractor’s Office |
| Webinar 4: Applications of 3D Models on the Construction Site |
| Webinar 5: Managing and Sharing 3D Models for Construction |
| Webinar 6: Overcoming Challenges to Using 3D Models for Construction |
| Webinar 7: Steps to Requiring 3D Engineered Models for Construction |
| Webinar 8: Adding Time, Cost and other Information to 3D Models |
Recordings of Previous Webinars

http://www.fhwa.dot.gov/construction/3d/webinars.cfm

3D Engineered Models Webinar Series

One of the technologies for the FHWA’s Every Day Counts (EDC) Initiative is 3D Engineered Models for Construction. A series of eight webinars have been developed to assist the FHWA’s transportation partners in adopting this proven technology. The webinars are given in a “cradle to grave” sequence. Participants will hear how contractors incorporate 3D engineered models in their workflow of bidding and preparing to execute construction. Topics and guest speakers include:

Recorded Webinars

- **Overview of 3D Engineered Models for Construction**
  November 20, 2013 1:00 p.m. - 2:30 p.m. Eastern
- **Creating 3D Engineered Models**
  January 8, 2014 1:00 p.m. - 2:30 p.m. Eastern
Does your agency produce 3D deliverables?

- Yes
- No
- Not Sure

When does your agency provide 3D deliverables to contractors?

- Pre-bid
- Post-award
- Never
What is in your design workflow?

- CADD alignments, profiles and superelevations
- Criteria for cross-sections and earthworks
- Corridor models for cross-sections and earthworks
- Proposed TINs for earthworks
- Outputting LandXML for bidding
- Releasing Corridor models for bidding
- Outputting line strings for bidding
Do you have concerns about releasing Digital Data for Information Only?

- Yes, I'd rather not release any digital data
- Yes, but I'll release PDFs of the plans
- Yes, but I'll release Alignments, Control Points, and Existing Surfaces
- Yes, but I'll release LandXML & 3D line strings
- No, I'd release all data
<table>
<thead>
<tr>
<th>Speaker</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Douglas Townes (FHWA-RC)</td>
<td>Welcome and Introductions</td>
</tr>
<tr>
<td>Brian Deery (AGC)</td>
<td>Contractor's Organization Perspective</td>
</tr>
<tr>
<td>Brian Smith and Sam Kloes (IMCO Construction)</td>
<td>Using Available Data to Create Construction Models</td>
</tr>
<tr>
<td>Karthik &quot;RK&quot; Ramkrishnan (Walsh Construction)</td>
<td>Planning Construction Activities and Clash Detection</td>
</tr>
<tr>
<td>Ryan Forrestel (Cold Spring Construction)</td>
<td>Executing Construction with 3D Engineered Models</td>
</tr>
<tr>
<td>Douglas Townes (FHWA-RC)</td>
<td>Information on Next Webinar and Close</td>
</tr>
</tbody>
</table>
What type of organization do you represent?

- DOT Construction Division
- DOT Design Division
- DOT Survey Division
- DOT Other Division
- Local Authority
- FHWA Division Office
- FHWA Other Office
- Other Federal Agency
- Contractor
- Consultant
- Vendor
- Industry Representative
Contractor’s Organization Perspective
Brian Deery
Associated General Contractors of America (AGC)
Introduction

• BIM used in vertical industry for years
• AGC created BIM Forum to address 3D needs
• Contractors use 3D for bidding, AMG, means & methods, staging, clash detection, collaboration
• EDC Initiative to help push adoption in horizontal industry
AASHTO-AGC-ARTBA 2012 Joint Position Statement

Topic: Best practices for electronic data-sharing between state DOTs and contractors

Electronic technology is being used more and more as a tool in the design and construction of highway, bridge and other transportation projects. In particular, more transportation construction projects are being designed using 3D models to help visualize and simulate project ideas before they’re ever built.
Using Available Data to Create Construction Models

Brian K. Smith and Sam Kloes
IMCO Construction
Learning Objectives

• List different ways to create 3D Engineered Models for Construction

• Describe how 3D models can be used for Quantity Take-off
What type of data do you provide/receive pre-bid?

- Raster PDF
- Vector PDF
- 2D CAD Linework
- 3D CAD Linework
- LandXML
- 3D Model
- None
Types of Data Received by Contractors

For a General Contractor there are mainly two different types of data received.

• PDF’s (Raster and Vectorized)
• Electronic CAD and design files
Types of Data Received by Contractors

Raster Adobe PDF’s

- No tangible electronic data
- Pixelized data
- Must digitize using software to import to CAD
- Lowest quality of data to import
- Typically from scans of plots
Vectorized Adobe PDF’s

- Contains data with numerical values for lines, curves, etc.
- Direct export from design software
- Requires software to rebuild data for import to CAD
- Best PDF option
Types of Data Received for Contractors

Electronic CAD and Design Data

CAD formats (DWG, DGN, DXF, RVT, SHP)

- 2D & 3D files
- 3D polylines
- Surfaces
- Design information (profiles and assemblies)

3D model exchange formats

- XML’s (landXML, gbXML)
- DTM, TIN, NED (3D surface files)
- LAS (3D point cloud data)

Disclaimer:

By opening the enclosed electronic media files, work files, due to the potential for exposure to Inc.’s ownership, protected electronic files or alterations to Inc.’s files, furthermore, directs its officers, employees, agents, contractors, or liability of any kind or characterization of the electronic files or alteration.

The enclosed files are for information dissemination purposes. The electronic representations may or may not reflect the current status of the project. If there are any discrepancies or changes, the contractor is responsible to correct and other data as detailed in the contract requirements.

The contractor assumes full responsibility for any changes resulting from the use, and the contractor undertakes to bring in conformance to the control specifications.
Stop Asking For “CAD” and Start Asking for Project Specific Data Sets

When requesting Data remember these helpful guidelines:

• Using common terminology (File Format, Software Utilized, Release, etc.)

• Use non-threatening language ie: "We want your CAD" = Bad

• Internal training on expectation vs. request

• Managing expectations - what we expect as a contractor
When building a model the level of detail and accuracy is determined by the individual task, available data, and resource allocation.

The different types of 3D Models built are:

- Quantity Takeoffs
- Construction Ready
- Rework

We start with a process we have coined **Forensic Plan Reading**
Quantity Take-off Model Workflow

1. Analyze Data
2. Meet with Project Managers
3. Export Quantities to Heavy Bid
4. Create a 3D CADD Model
5. Digitize PDF Data

Every Day Counts
Construction Ready Data
Models have a very high level of accuracy and detail. They are easily revised or adapted in the event of a change of condition or change order directive.

Some uses of the construction ready model data are:

- Stakeout of Utilities
- Right of Ways
- Roadway Features
- Grading Limits
- Erosion Control Measures
Construction-Ready Model Workflow

- Analyze Data
- Meet with Project Managers
- Supplement/recreate data
- Review Means & Methods

- Migrate Data to the Field
- Share models with Engineering and Subcontractors
- Review & Back-check Models
- Create Grading & Utility Models
# Quantifiable Cost Savings

### Productivity Gain

<table>
<thead>
<tr>
<th>Task</th>
<th>Conventional Way</th>
<th>New Way AccuGrade</th>
<th>Productivity Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staking</td>
<td>07:31</td>
<td>00:54</td>
<td>6:37 hours saved</td>
</tr>
<tr>
<td>Bulk Earthmoving D6N 330D</td>
<td>04:40 02:23</td>
<td>04:18 01:53</td>
<td>+ 9 % + 27 %</td>
</tr>
<tr>
<td>Subgrade grading D6N 330D</td>
<td>03:48 02:56</td>
<td>01:28 02:43</td>
<td>+ 159 % + 8 %</td>
</tr>
<tr>
<td>Base Course grading D6N</td>
<td>02:24</td>
<td>00:53</td>
<td>+ 172 %</td>
</tr>
<tr>
<td>Base course fine grading 140H</td>
<td>01:49</td>
<td>00:32</td>
<td>+ 241%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>24:32</strong></td>
<td><strong>11:50</strong></td>
<td>+ 101%</td>
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### Additional Head count

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<tr>
<th>Role</th>
<th>Conventional Way</th>
<th>New Way</th>
<th>Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foreman Operators (x4)</td>
<td>Full Time 24:32 hours 98:08 hours 18:14 hours 18:14 hours</td>
<td>Full Time 11:50 hours 47:20 hours 00:54 hours 18:14 hours</td>
<td>Half time</td>
</tr>
<tr>
<td>Surveyor Worker</td>
<td></td>
<td></td>
<td>95 % of time saved 1 person less</td>
</tr>
</tbody>
</table>

### Accuracy

<table>
<thead>
<tr>
<th>Task</th>
<th>Conventional Way</th>
<th>New Way</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subgrade</td>
<td>35%</td>
<td>86%</td>
</tr>
<tr>
<td>Base course</td>
<td>45%</td>
<td>98%</td>
</tr>
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</table>
3.9 – Fuel consumption

<table>
<thead>
<tr>
<th>Conventional Way</th>
<th>New Way – AccuGrade</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Design</strong>: SouthRoad</td>
<td><strong>Design</strong>: NorthRoad</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>330D</th>
<th>D6N</th>
<th>140H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional Way</td>
<td>231</td>
<td>210</td>
<td>22</td>
</tr>
<tr>
<td>New Way – AccuGrade</td>
<td>123</td>
<td>136</td>
<td>7</td>
</tr>
</tbody>
</table>
Improved Safety and Reduced Exposure to Hazards
Are 3D models reviewed prior to construction?

• 3D model review is required by the owner
• 3D model review is volunteered by the contractor
• 3D model review is requested by the designer
• No 3D model review occurs
Managing Revisions

A 3D Model Simply and Clearly Communicates Revisions & Issues

- Share models and issues with engineering and subcontractors
- Review issues in 3D Design or requested changes
- Meet with Project Managers
- Propose resolution
- Proposed revision made to In-House Drawing
- Send revised drawing with RFI to Design Engineer
- Receive authorization to proceed (faster turn-around)
- Migrate data to Field
Contractors Concerns Using 3D Models

- Professional design responsibility
- Liability for design intent
- Determining Means and Methods of construction
- Taking responsibility for updating models and ensuring accuracy
As-Builts from 3D Models & Integrated Field Data

As-Builts

On a grading or road project 3D as-built data may include:

- XML or DTM of prepared surface topo
- XML or DTM of final as-built
- ASCII, CSV or DWG containing point groups of all surfacing survey points
- 3D linework or pipe network of installed utilities
- ASCII, CSV or DWG containing survey data on newly installed and existing utilities located
- 3D Laser Scans in PTS or LAS format
Benefits of Sharing Models with Owners & Subcontractors
Benefits of 3D Modeling

- 3D Models are easier to understand
- Design optimization
- Collaboration
- Clash detection
- Construction staging
- Better control over the Means and Methods of construction
- Management of expectations
• List different ways to create 3D Engineered Models for Construction
• Describe how 3D models can be used for Quantity Take-off
Contact Information

Thank You! Please feel free to contact either of us directly.

Brian K. Smith
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C.360.393.8821

Sam Kloes
skloes@IMCOconstruction.com
C.360.393.8821
Learning Objectives

• Describe different ways to plan construction activities using 3D models
• Discuss different uses of clash detection
How extensive is your 3D pre-planning?

- Review project staging
- Review MPT/MOT staging
- Plan equipment movements
- Prepare critical pick plans e.g. erection sequences
- Prepare graphics for constructability reviews
- Prepare graphics for public involvement
- We do not pre-plan in 3D
Crucial activity for the Contractor

- Planning starts at **bid time**
  - Access to/from the jobsite
  - Resource location (Material + Equipment)
  - Construction clearance from existing utilities
- **Dynamic** nature of construction – Job Phasing
Basics of Jobsite Planning - Options

Use Internal Resource

As Built Plans

- As Built condition – **Valid/ Accurate?**

Image Courtesy: Google Images
Basics of Jobsite Planning - Options

Satellite Images

- Latest condition?
- Visual Aid
- Street view – Only Major roads

Image Courtesy: Google Maps

Use External Resource

Street View

Google Maps

Image Courtesy: Google Maps
Basics of Jobsite Planning – Options

• LiDAR (Light Detection and Ranging)
  Refer Webinar Series 2 – Supporting 3D Design by John Krause (FDOT)
  @ www.fhwa.dot.gov/3D/

Captures - **What you see**

- **Scan**
  - Set Survey Control points
  - Gather 3D information /data set

- **Register**
  - Stitch multiple scan data sets together to generate one contiguous point cloud

- **Classify**
  - Clean up and remove Noise, if any
  - Categorize point cloud to assist modeling

Image Courtesy: Google Images
LiDAR Scans - Example

OSHA Requirement
1926.1408(a)(2)(iii) Table A

50-200kV ~ 15’ clearance
(115kV)

Walsh Requirement
Min. 20’ clearance even for De-Energized line.
LiDAR Scans - Lessons Learned

• **Post Processing - Scan data**
  • Aligning scan data to correct State Plane coordinates – **Need Survey**
  • Carefully clean **NOISE** – Live Traffic, Vegetation, etc.
  • Point Cloud density (Size) / Photogrammetry – RGB value/ Intensity
Complex Virtual Mock-ups

Milton - Madison Bridge
Kentucky / Indiana
Critical Construction Simulation

• Visualize/ Simulate crane picks with defined weight and ambient conditions.
• Accurate dimensions with In-Cabin Load charts +900 crane models
• Provides most economical crane configuration.

3D Models of all Construction Equipment available online - VALIDATE

Image Courtesy : 3D Lift Plan (http://www.3dliftplan.com/)
Critical Construction Simulation - Examples

Validate Safe Crane Pick

CRANE
 Manitowoc 2250 Series 3 w/ Heavy Lift Top
1.60' Heavy Lift at 79.5'
Base/Crawler
Counterweights: 249,200 lbs + 120,000 lbs
F.L. Lift Radius (360°)
 Crane Capacity at 39.3° = 170,500 lbs
LOAD
Rigid Line 2,400 lbs
Block 1,456 lbs
Hook 600 lbs
Cable Shackle (2) 1250 lbs
Wire Rope (2) 1,200 lbs
Cable Shackle (2) 107 lbs
Total Load 116,950 lbs
12% of Capacity
Sling Tension 68,327 lbs

CRANE
 Tadano AT-500-1
149.6' Main Boom at 77°
Basis 100% Outriggers 31.6' x 31.6' ft
Counterweights 342,800 lbs
Lift Radius (360°)
Cran Capacity at 34.9° = 203,400 lbs
LOAD
Rigid Line 2,400 lbs
Block 1,456 lbs
Hook 600 lbs
Cable Shackle (2) 1250 lbs
Wire Rope (2) 1,200 lbs
Cable Shackle (2) 107 lbs
Total Load 116,950 lbs
16% of Capacity
Sling Tension 68,327 lbs

Not issued for construction. For pre-planning only.
Critical Construction Simulation - Examples

Access during Phasing
Do you use 3D clash detection?

- Always
- Usually
- Sometimes
- Would like to
- No
Clash Detection in Heavy Construction

CLASH DETECTION
Avoiding field issues ahead of time
• Hard Clashes – Members directly conflict
• Soft Clashes – Tolerance issues
• Time related - Constructability issues

Image courtesy- Synchro
Clash Detection - Examples
Identify Tolerance Issue in the virtual world.
Unknown Risk – We know what we see

Underground Utilities
As an Industry we all share tremendous risk when dealing with underground utilities.

- Outdated Utility Plans – Old abandoned lines are still found On-Site, causing delay and additional cost.

- Technology Inhibitions – Advanced GPR can only provide approximate details, range restrictions.

- Reliance on Test Pits
Verify Learning Outcomes

• Describe different ways to plan construction activities using 3D models
• Discuss different uses of clash detection
Executing Construction with 3D Engineered Models

Ryan Forrestel
Cold Spring Construction
Learning Objectives

• Describe how 3D models are used with survey equipment to execute construction
• Discuss the different equipment/model needs to achieve tolerance for different construction activities
How do you use electronic design data?

- To get a better understanding of the plans
- Creating a construction model for AMG
- Checking a finished model
- Construction layout with rovers
- Checking construction tolerances (QA)
- Determining quantities for payment (Measurement)
- Other (please identify in Chat)
- Do not use it
Preparing Models for AMG
Preparing Models for AMG

Wireless Data Sync

Synchronizing compact flash card data to Connected Community.

(16 of 18) Uploading - 48% transferred
EXCAVATOR 2D VA BOOM.MCH

Press Esc to return to the Menu.
Press Stop to interrupt the transfer.
Using 3D Models for Layout
Stakeless Grading
Stringless Asphalt Paving
Stringless Concrete Paving
Stringless Concrete Paving
Enhanced Safety
• Describe how 3D models are used with survey equipment to execute construction
• Discuss the different equipment/model needs to achieve tolerance for different construction activities
Upcoming Webinars and Close

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| Webinar 1: Overview of 3D Models for Construction |
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Applications of 3D Models on the Construction Site

April 2, 2014
1:00 pm – 2:30 pm

www.fhwa.dot.gov/3D

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