Applications of 3D Models on the Construction Site

April 2, 2014
1:00 pm – 2:30 pm EST
Welcome, Introductions and Safety Message
Douglas Townes, P.E.
FHWA Resource Center
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
| 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: Implementing 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:

Recoded 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
Tweet along on Twitter:

#EDC2 @USDOTFHWA
## Today’s Speakers

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<td>Lance Parve (Wisconsin DOT)</td>
<td>Supporting 3D/4D Construction Applications in Preconstruction</td>
</tr>
<tr>
<td>John Lobbestael (Michigan DOT)</td>
<td>Supporting AMG on site for QA</td>
</tr>
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<td>Francesca Maier (Parsons Brinckerhoff)</td>
<td>Moderated Question &amp; Answer Session</td>
</tr>
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<td>Douglas Townes (FHWA-RC)</td>
<td>Information on Next Webinar and Close</td>
</tr>
</tbody>
</table>
Learning Objectives

• Describe how 3D models can enhance safety on the construction site
Hello. My name is Charlie Brown. I am the State Location & Surveys Engineer for the North Carolina Department of Transportation. I have nearly 30 years of experience doing route location surveys, and am a Professional Engineer and Professional Land Surveyor in North Carolina.

We at the NCDOT have been utilizing GPS and now GNSS applications and tools since they became commercially available. Our first GPS project was in 1992; we made a major purchase of GPS equipment in 1994, and have expanded our GPS/GNSS capabilities ever since. Not only did we see the potential for GPS technology to allow us to work faster, with less traversing, but early on we saw the safety potential in this equipment.
NCDOT began using GPS and GNSS in 1992

Safety enhanced through efficiency gains and no need for line-of-sight

Safety factored into the decision-making on where to locate control points

Location awareness reduces the need for stakes, keeps people out of the path of equipment

Faster, Better, Safer
March 18, 2014

Douglas Towers, P.E.
Construction Engineer
FHWA Resource Center
61 Forsyth Street, Suite 17726
Atlanta, GA 30303

Dear Mr. Towers,

The New York State Department of Transportation (NYS DOT), Office of Construction, has supported use of 3D modeling technology since 2005 when we started leasing GPS equipment for our Construction field staff. It started slowly, originally being deployed only on major earthwork projects and included site-specific training along with support from vendors and in-house staff. With continued use, staff have become more familiar and comfortable with the equipment and technology and started using it for multiple applications and data collection purposes on these projects. Realizing the major time savings, increased accuracy and the overall safety benefits that result from the technology, compared to traditional methods, NYS DOT is requesting that GPS equipment be included beyond the major earthwork projects.

Some of the benefits expressed by our field staff have been the ability to easily and safely measure irregular areas (topsoil, seeding and mulch, sidewalks), quickly verify contractor’s layout/grades (less time wasted waiting for survey support), map utility locations (both above ground and below) and create accurate As-Built plans to avoid design/Utility conflicts with future projects.

Contractors have also realized their benefits from using the technology and regularly request the designer’s electronic geological data (EED) for use with their Automated Machine Guidance (AMG) systems. Now, they have the ability to complete large volumes of earthwork, excavation and roadway grading operations more accurately and in a reduced timeframe. This creates savings by reducing work operation hours for personnel and machines and reduces equipment fuel consumption by reducing machine idle time and number of passes to accomplish the desired results. Our Department then started using 3D models and GPS equipment on more work operations to verify layout, collect quantities, locate features, grades and surfaces for contract payments. Eventually, the data collected is used to create an electronic As-Built record.
James Tynan, PE NYSDOT
Director, Office of Construction

- Supported the use of 3D Modeling since 2005
- Leased GPS equipment initially only for major earthworks projects
- Now used for multiple applications and data collection, with time savings, increased accuracy and *overall safety benefits*
- Easily and safely measure irregular areas, quickly verify layout and grades, map utility locations, create as-builts
- Added bonus: resolve discrepancies at the project level results in *less disputed work, avoiding claims and litigation*
• Describe how 3D models can enhance safety on the construction site
Supporting 3D/4D Construction Applications in Preconstruction

Lance Parve, PG
Wisconsin Department of Transportation
Learning Objectives

• Describe applications and support activities using 3D and 4D models for construction

• Discuss construction site survey requirements for using 3D models

• Describe ways an owner can use 3D models to reduce risk of change orders, delays and claims
3D Construction Applications in the Design-Construction Process
Transportation Facilities Design-Construction 3D Engineered Modeling Workflow

**Surveying, 3D D.C., & Mapping:**
- Control, Mapping Limits, 3D Data Collection of Existing Features-Surfaces using LiDAR & Integrated GPS-Total Station
- Design-Grade Survey

**3D Design & Analysis:**
- Development of 3D Model Alignments/Profiles/X-secs/Corridors
- Proposed 3D Features-Surfaces & Multi-Disciplinary Clash Detection & Constructability/Staging Analysis

**Construction Field Applications:**
- Contractor 3D Model Refinement, AMG Grading & Stringless Paving, GPS Rovers Field Inspection, Field Surveying/QA-QC & Post-Construction 3D As-builting

**Construction Plans, Specifications & Estimates + Models Deliverables:**
- 2D PS&E Construction Docs + 3D Models + 4D Stage Models & Bid Docs & Procurement

**Milestone:**
- Approved Environmental Document & Preferred Alt

**Milestones:**
- Final PS&E-30%/60%/90% +2D-3D-4D-5D Models

Every Day Counts
Transportation Facilities Design-Construction & 3D Engineered Modeling

- Program-Project Initiation
- Highway Needs-Priorities
- Data Collection
- 3D Survey & Data Fusion of LiDAR, GPS, TS, AP
- 3D CAD DTMs & Features
- 3D Existing Model + GIS
- Funding-Finance

- Public Involvement
- Environmental Impacts
- 3D Existing Model
- Feasibility Analysis
- Alternatives Analysis
- Preferred Alternative
- CSD/CSS
- Public Support

- 30% / 60% Prelim Design
- Plans, Specs & Estimating
- Roadways, Pavement, Structures, Traffic, Utilities, Real Estate, Geotech
- Clash Detection-Resolution
- Simulation & Analysis
- Constructability Analysis
- PS&E & 3D/4D Models
- Bid Docs & Advertising
- Construction Bid
- Prebuild Model + RFIs
- GC + Subcontractors
- Shop Drawings
- Digital Prototyping
- Materials Procurement
- QA/QC Management

- PS&E & 3D Models
- 4D Staging Models
- Scheduling / Costs
- Construction Reviews
- AMG, SL Paving
- Rovers & Inspection
- RFIs, DINs, CCOs
- Quantity Pay Items
- As-builds Data Collection

- 3D As-built Models + GIS
- Asset Management
- Pavement Management
- Structures Management
- Life Cycle Management
- Facilities Maintenance
- Traffic Operations
- Monitoring
- RRR Program

Civil Integrated Modeling Virtual Design-Construction Process for Transportation Infrastructure Facilities Collaboration Shared Database Information Management Model throughout the entire project life cycle

Every Day Counts
Poll Pod: Equipment for QA & Measurement

What equipment do you use on site for QA and Measurement?

- GPS/GNSS Rovers
- Robotic Total Stations
- Digital Levels
- Static LiDAR
- Mobile LiDAR
- Traditional Total Stations
- Traditional Levels
- Stakes
- Hubs and Strings/Wires
- Straight Edges
- Measuring Wheels
- Wireless Data Collectors/Tablets
- Pen and Paper
Surveying, 3D Data Collection, & Mapping
Surveying, 3D Data Collection, & Mapping
Surveying, 3D Data Collection, & Mapping

- Georeferenced Hi-res Digital Images
- 3D XYZ LAS Point Clouds Fused Survey Data
- 3D Feature Lines TINs
- 3D Features DTM
Surveying, 3D Data Collection, & Mapping

- **Fixed Wing Aerial LiDAR/Photogrammetry**
  ± 3”- 6” Vertical Accuracy (Low and Slow)

- **Low Altitude Helicopter LiDAR/Photogrammetry**
  ± 1”-2” Vertical Accuracy

- **Terrestrial Surveying GPS-HATs/Supplemental**
  ± ½” – 1” Vertical Accuracy

- **Mobile LiDAR Mapping System**
  ± ½”-1” Vertical Accuracy

- **Tripod-Mounted Static LiDAR Mapping System**
  ± ¼” - ½” Vertical Accuracy

- **Terrestrial Surveying TS/Leveling-Check Sections**
  < ± ¼” - ½” Vertical Accuracy
3D Design & Analysis
3D/4D Applications and Support Activities in Construction
Poll Pod: 4D Modeling

Who uses 4D Modeling on your projects?

• Designer
• Contractor
• Engineer
• Program Manager
• No 4D Modeling used
• Benefits of 3D/4D Models for Construction
• Design Model to be provided to Bidders at Advertisement
• Bidders prebuild Model from PS&E and refine Model
• RFIs and CRIs are submitted by Bidders
• Project Modeling Matrix (PMM)
• Project Execution Plan (PXP)
• Construction Review of Model
• Construction Applications and Trends
Construction Review & Constructability Analysis

Reduced CCOs, RFIs and DINs
Benefits of 3D/4D Models for Construction

- Visualization of PS&Es
- Integrate and aggregate readily multi-disciplinary data
- Design, visualize, analyze, optimize and simulate project “virtually” digitally in office before constructing in the field
- Find/fix conflicts earlier in process with Clash-Gap Detection
- Reduce CCOs, DINs, project risk, re-work, cost and schedule
- Cost Avoidance/Cost Savings during Construction
- Increase Communication, Coordination, and Collaboration
- Design Model to be provided to Bidders at Advertisement
- Use of AMG/AMC and Stringless/Wireless Paving
- Reduce field inspection labor w/Tablet PCs/Rovers QA/QC
- Enhance Construction Site with WiFi and UAS/UAVs
Construction Requirements for Using 3D/4D Engineered Models
• What is in & not in the Model (Model Content) for Construction?
• Will the Model include PS&E, Addendums, & Plan Revisions?
• Will the Model include Utilities & Geotech info?
• What formats (CAD, XML, GIS) will the Model be in?
• What is the Model’s geospatial info (Coordinate System, Projection, & Level of Accuracy-LOA)?
• What is the Level of Development-LOD (2D, 3D, 4D, 5D, nD)?
• Will Staged, Temporary Construction & 4D Models be included?
• Will and when will Model & Staged Models be delivered?
• Will 4D project scheduling be integrated with Model?
• Will file, format, & version conversions be required?
• Will xyz coordinate translation, rotation, & scaling be required?
• How are project standards and protocols maintained?
• How and who will update the Model?
• How is project data transferred and archived?
• How will the Model be reviewed, validated, & QA/QC’ed?
• How is a Common Data Environment (CDE) handled for Survey for Construction?
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<th>LOD-CD</th>
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### Bridges-Proposed

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### Retaining Walls-Proposed

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### MSE-Proposed

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### Cast-in-Place-Proposed

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## Pile and Lagging—Proposed

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<td>&lt;0.06’</td>
<td>3D</td>
<td>3D</td>
<td>Yes</td>
</tr>
<tr>
<td>Face of Pile</td>
<td>DGN/DWG/XML</td>
<td>&lt;0.06’</td>
<td>3D</td>
<td>3D</td>
<td>Yes</td>
</tr>
<tr>
<td>Top and Toe of Sheets</td>
<td>DGN/DWG/XML</td>
<td>&lt;0.06’</td>
<td>3D</td>
<td>3D</td>
<td>Yes</td>
</tr>
</tbody>
</table>

## Sign Bridges—Proposed

<table>
<thead>
<tr>
<th>Description</th>
<th>Format</th>
<th>Scale</th>
<th>Format</th>
<th>Scale</th>
<th>Yes/No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Footing</td>
<td>DGN/DWG/XML</td>
<td>&lt;0.06’</td>
<td>3D</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Pile</td>
<td>DGN/DWG/XML</td>
<td>&lt;0.06’</td>
<td>3D</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Structure</td>
<td>DGN/DWG/XML</td>
<td>&lt;0.06’</td>
<td>3D</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

## Other Structures—Proposed

<table>
<thead>
<tr>
<th>Description</th>
<th>Format</th>
<th>Scale</th>
<th>Format</th>
<th>Scale</th>
<th>Yes/No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise Walls</td>
<td>DGN/DWG/XML</td>
<td>&lt;0.06’</td>
<td>3D</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Screening Fence</td>
<td>DGN/DWG/XML</td>
<td>&lt;0.06’</td>
<td>3D</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Tunnel-Utility</td>
<td>DGN/DWG/XML</td>
<td>&lt;0.06’</td>
<td>3D</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

## Special Foundations—Proposed

<table>
<thead>
<tr>
<th>Description</th>
<th>Format</th>
<th>Scale</th>
<th>Format</th>
<th>Scale</th>
<th>Yes/No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drilled Shafts</td>
<td>DGN/DWG/XML</td>
<td>&lt;0.06’</td>
<td>3D</td>
<td>3D</td>
<td>Yes</td>
</tr>
<tr>
<td>Driven Piles</td>
<td>DGN/DWG/XML</td>
<td>&lt;0.06’</td>
<td>3D</td>
<td>3D</td>
<td>Yes</td>
</tr>
<tr>
<td>Bored Piles</td>
<td>DGN/DWG/XML</td>
<td>&lt;0.06’</td>
<td>3D</td>
<td>3D</td>
<td>Yes</td>
</tr>
<tr>
<td>Caissons</td>
<td>DGN/DWG/XML</td>
<td>&lt;0.06’</td>
<td>3D</td>
<td>3D</td>
<td>Yes</td>
</tr>
</tbody>
</table>
### Special Foundation Walls—Proposed

<table>
<thead>
<tr>
<th>Foundation Anchors</th>
<th>DGN/DWG/XML</th>
<th>&lt;0.06’</th>
<th>3D</th>
<th>3D</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underpinning</td>
<td>DGN/DWG/XML</td>
<td>&lt;0.06’</td>
<td>3D</td>
<td>3D</td>
<td>Yes</td>
</tr>
<tr>
<td>Pile Caps</td>
<td>DGN/DWG/XML</td>
<td>&lt;0.06’</td>
<td>3D</td>
<td>3D</td>
<td>Yes</td>
</tr>
<tr>
<td>Grade Beams</td>
<td>DGN/DWG/XML</td>
<td>&lt;0.06’</td>
<td>3D</td>
<td>3D</td>
<td>Yes</td>
</tr>
<tr>
<td>Tiebacks</td>
<td>DGN/DWG/XML</td>
<td>&lt;0.06’</td>
<td>3D</td>
<td>3D</td>
<td>Yes</td>
</tr>
</tbody>
</table>

### Lighting—Proposed

<table>
<thead>
<tr>
<th>Poles/Masts/Bases</th>
<th>DGN/DWG</th>
<th>&lt;0.06’</th>
<th>3D</th>
<th>3D</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conduit/Pull Boxes</td>
<td>DGN/DWG</td>
<td>&lt;0.06’</td>
<td>3D</td>
<td>3D</td>
<td>Yes</td>
</tr>
</tbody>
</table>

### FTMS—Proposed

<table>
<thead>
<tr>
<th>DMS/CMS</th>
<th>DGN/DWG</th>
<th>&lt;0.06’</th>
<th>2D</th>
<th>N/A</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>FTMS Fiber Optic lines</td>
<td>DGN/DWG</td>
<td>&lt;0.06’</td>
<td>3D</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>FTMS Huts/Cabinets</td>
<td>DGN/DWG</td>
<td>&lt;0.06’</td>
<td>2D</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### Signs—Proposed

<table>
<thead>
<tr>
<th>Signs-Type 1</th>
<th>DGN/DWG</th>
<th>&lt;0.06’</th>
<th>2D</th>
<th>2D</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signs-Type 2</td>
<td>DGN/DWG</td>
<td>&lt;0.06’</td>
<td>2D</td>
<td>2D</td>
<td>Yes</td>
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</tbody>
</table>

### Traffic Signals—Proposed

<table>
<thead>
<tr>
<th>Poles/Heads/Bases</th>
<th>DGN/DWG</th>
<th>&lt;0.06’</th>
<th>3D</th>
<th>3D</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conduit/Pull Boxes</td>
<td>DGN/DWG</td>
<td>&lt;0.06’</td>
<td>3D</td>
<td>3D</td>
<td>Yes</td>
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</tbody>
</table>

### Water Main Proposed

<table>
<thead>
<tr>
<th>Pipes</th>
<th>DGN/DWG</th>
<th>&lt;0.06’</th>
<th>3D</th>
<th>N/A</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrants/Valves/Fittings/ Standpipes</td>
<td>DGN/DWG</td>
<td>&lt;0.06’</td>
<td>3D</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### Sanitary Sewer—Proposed

<table>
<thead>
<tr>
<th>Pipes</th>
<th>DGN/DWG</th>
<th>&lt;0.06’</th>
<th>3D</th>
<th>N/A</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manholes</td>
<td>DGN/DWG</td>
<td>&lt;0.06’</td>
<td>3D</td>
<td>N/A</td>
<td>N/A</td>
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</tbody>
</table>
## 3D Engineered Model Delivery
### Project Modeling Matrix & Project Execution Plan

#### Utilities - Existing/Relocated/Abandoned *

<table>
<thead>
<tr>
<th>Utility</th>
<th>Format</th>
<th>Depth</th>
<th>Type</th>
<th>N/A</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drainage/Storm Sewer</td>
<td>DGN/DWG</td>
<td>&lt;0.10’</td>
<td>3D</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Water Main</td>
<td>DGN/DWG</td>
<td>&lt;0.10’</td>
<td>3D</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Sanitary Sewer</td>
<td>DGN/DWG</td>
<td>&lt;0.10’</td>
<td>3D</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Lighting</td>
<td>DGN/DWG</td>
<td>&lt;1.5’</td>
<td>2D</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>FTMS</td>
<td>DGN/DWG</td>
<td>&lt;1.5’</td>
<td>2D</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Traffic Control</td>
<td>DGN/DWG</td>
<td>&lt;1.5’</td>
<td>2D</td>
<td>N/A</td>
<td>N/A</td>
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</table>

#### Other Utilities - Existing/Relocated/Abandoned *

<table>
<thead>
<tr>
<th>Utility</th>
<th>Format</th>
<th>Depth</th>
<th>Type</th>
<th>N/A</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas</td>
<td>DGN/DWG</td>
<td>&lt;1.5’</td>
<td>2D</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Steam</td>
<td>DGN/DWG</td>
<td>&lt;1.5’</td>
<td>2D</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Electrical</td>
<td>DGN/DWG</td>
<td>&lt;1.5’</td>
<td>2D</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Communications</td>
<td>DGN/DWG</td>
<td>&lt;1.5’</td>
<td>2D</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Fiber Optic</td>
<td>DGN/DWG</td>
<td>&lt;1.5’</td>
<td>2D</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Telephone/Data</td>
<td>DGN/DWG</td>
<td>&lt;1.5’</td>
<td>2D</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>CATV/Data</td>
<td>DGN/DWG</td>
<td>&lt;1.5’</td>
<td>2D</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

*2D and 3D existing/proposed/abandoned utilities are approximate and other utilities may not be shown.*

2D and 3D existing/proposed/abandoned utilities are generated from a variety of sources and formats including: from plans with line and grade, from plans without line and grade, from surveys, from Digger’s Hotlining, from as-buils, from municipality records, from pot holing/hydrovac, and from RD/EMI/GPR/SPAR and are provided in the model, for purposes of information only, requiring confirmation from Digger’s Hotline and Utility Providers.
Construction Review & Constructability Analysis

Reduced CCOs, RFIs and DINs
Construction Issues & Builder’s Risk Claims
Construction Applications Using 3D/4D Models, Mobile Devices Rovers & UAS/UAVs
Do you capture as-built data digitally?

- Contractor provides digital files
- Engineer provides digital files
- Design files updated with paper mark-ups
- Paper record only
- No as-built data is captured
Mobile Device/GPS Rover Applications on the Construction Site

- GPS Rovers Field Inspection QA/QC using 3D Model for Automated Machine Guidance (AMG)/Control (AMC)
- Field Tablet PCs (Pilot) connected to GPS Rovers for more accurate Utility Relocations Inspection and Field Inspection
Mobile Device/GPS Rover/Wi-Fi Applications on the Construction Site

Design-Construction Reviews using Tablet PCs & Field Mobile Devices with GPS Rovers connected to Wi-Fi Cloud-based Services
Post-Construction: As-built Record Updating of 3D Models
Construction Trends
UAV/UAS Applications on the Construction Site

Construction Trends
UAV/UAS Applications on the Construction Site

In-progress and Post Construction Data Collection using UAS/UAVs - <100 lbs, <400 ft Ceiling, Cameras, On-board Stability, GPS, IMU, LOS, Need COA, High-resolution Aerial Imagery, Videos, LiDAR, Infared, etc.
In-progress and Post Construction Data Collection using UAS/UAVs - <100 lbs, <400 ft Ceiling, Cameras, On-board Stability, GPS, IMU, LOS, Need COA, High-resolution Aerial Imagery, Videos, LiDAR, Infrared, etc.
Thank you! Feel free to contact me directly.

Lance Parve, Sr. Project Engineer
WisDOT SE Freeways Design-Construction
lance.parve@dot.wi.gov
C.414.750.1330 / C.414.731.5375
Verify Learning Outcomes

- Describe applications and support activities using 3D and 4D models for construction
- Discuss construction site survey requirements for using 3D models
- Describe ways an owner can use 3D models to reduce risk of change orders, delays and claims
Learning Objectives

• Discuss how a contractor’s work plan can manage use of 3D models on site
• Discuss the training needs for Construction Engineers and Inspectors
• Describe different approaches to procuring equipment and training for the owner’s representatives
Poll Pod: QA when the Contractor uses AMG

How do you QA stakeless/wireless/ stringless construction?

• QA method agreed and documented in the Contractor’s work plan; varies by activity and experience level
• Agency Rovers and reviewed Model to verify tolerances
• Agency Rovers to survey and compare to plans
• Agency Static LiDAR to survey and compare to plans
• Borrow Contractor’s Rovers to check tolerances against Contractor’s model
• Observe Contractor’s checks with their Rover and Model
• Contractor sets stakes and/or hubs and strings/wires
Overview

• General Comments
• Equipment & Training
  – Procurement Options
  – Building Competency
• Contractor’s Work Plan / Intent
• Verifying Construction Accuracy / QA
• Measurement
Poll Pod: Contractor use of AMG

Are contractors using AMG on your projects?

• GPS/GNSS for earthworks and excavation
• Laser-augmented GPS/GNSS for fine grading
• Laser-augmented GPS/GNSS for paving
• Robotic Total Stations for fine grading
• Robotic Total Stations for asphalt paving
• Robotic Total Stations for concrete paving
• No, but they want to
• Not yet
General Comments

• Enable AMG
  – Catch up
• Focus on Quality Assurance
• Utilize Modern Technology

Look Mom, No Strings!
Equipment

OLD

NEW
Equipment
Equipment Considerations

• Cost vs. Benefit
• Support
• Procurement
• Training
Equipment Considerations: Cost vs. Benefit

- Robotic Total Station
  - ~$20k
- GPS Receiver / Antenna
  - ~$20k
- Controller
  - ~$4k
- Digital Level
  - ~$6k
Equipment Considerations: Support

- Hardware
- Software
- Firmware
- Connectivity

"Have you tried turning it off and back on again?"
Equipment Considerations: Training

- Survey Concepts
- Plan Reading & Data
- Device Specific Concepts
- When to employ which tool
- Troubleshooting
• Fundamental Concepts
  – Train Control Freaks!
  – GPS & TPS Do’s & Don’ts
  – Units of Measure
  – Coordinate Systems
  – Grid vs. Ground
  – Calculations
  – Data Use
  – Data Collection
  – Field Practices
Poll Pod: Coordinate Systems

What Coordinate System do you use?

• State Plane
• Modified State Plane
• Standardized Low Distortion Projection
• Project Low Distortion Projection
• Local Coordinate System
• Not sure
Equipment : Procurement Options

• Agency Procured
• Contractor Procured
• Consultant

• Pros & Cons
## Agency Procured Pros vs. Cons

<table>
<thead>
<tr>
<th>PROS</th>
<th>CONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potential easier to standardize.</td>
<td>Expensive investment</td>
</tr>
<tr>
<td>Flexibility on use of equipment.</td>
<td>Need to manage the assets</td>
</tr>
<tr>
<td>Don’t need contract language developed.</td>
<td></td>
</tr>
<tr>
<td>Implies independence &amp; competency.</td>
<td></td>
</tr>
</tbody>
</table>
## Contractor Procured Pros vs. Cons

<table>
<thead>
<tr>
<th>PROS</th>
<th>CONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less investment pain</td>
<td>Harder to standardize across a dept.</td>
</tr>
<tr>
<td>Contractor provided training</td>
<td>Stipulations on use being project related</td>
</tr>
<tr>
<td>Uniformity on a per project basis</td>
<td>Perception of dependence</td>
</tr>
</tbody>
</table>
## Consultant Services Pros vs. Cons

<table>
<thead>
<tr>
<th>PROS</th>
<th>CONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipped, knowledgeable provider</td>
<td>Does not build internal competency</td>
</tr>
<tr>
<td>Absorbed into project CE costs</td>
<td>Scheduling / administration burdensome</td>
</tr>
<tr>
<td>Delegation &amp; division of tasks optimal for some projects</td>
<td>Costly</td>
</tr>
</tbody>
</table>
Contractor’s Work Plan / Intent

- Work with Contractor’s Trade Organization to develop.
- Contractor determines means & methods
- Promote Innovation
- Define Interactions
- Path to problem solving
- Provisions for revisions
Verifying Construction Accuracy / Q.A.
Office Preparations

- Standardize Deliverables
- Make them accessible
- Explore opportunities for data streamlining
Do you review design models prior to releasing them pre- or post-award?

- Review for conformity with standards
- Review for completeness
- Review for consistency with plans
- Review for constructability
- Review for utility of the data
- No design model review
Core Information

• A model contains information to answer: Where do we put this project and the proposed design features contained within it?
  – Foundation: NSRS Language: Station Offset
Which enables:

- A direct import of all project alignments to roading software on a survey device (MS Field Genius) in **seconds**!
Which enables:

- A direct import of all project alignments to roading software on a survey device (MS Field Genius) in **seconds**!
Which enables:

- A direct import of all project alignments to roading software on a survey device (MS Field Genius) in seconds!
Which enables:

- A direct import of all project alignments to road surveying software on a survey device (MS Field Genius) in **seconds**!
Which enables:

- A direct import of all project alignments to roading software on a survey device (MS Field Genius) in seconds!
This allows the user to:

- See x,y position relative to station – offset & record observations in automated reports relative to same.
1. Un-roll paper plan set
2. Manually key in each tangent and curve section
3. Assign stationing

- Subject to entry errors.
- On complex jobs with multi alignments – TIME CONSUMING.
- Multiply this tedious function by many users and you have – UNECESSARY TIME LOSS.
• A model contains information to answer: Where is the proposed grade?
Which enables:

- Which enables a direct import of surface .xml into roading software on a survey device in minutes!
Which enables:

- Which enables a direct import of surface .xml into roading software on a survey device in minutes!
Which enables:

- Which enables a direct import of surface .xml into roading software on a survey device in minutes!
Which enables:

- Which enables a direct import of surface .xml into roading software on a survey device in minutes!
Which enables:

• Which enables a direct import of surface .xml into roading software on a survey device in minutes!
Which enables:

- Which enables a direct import of surface .xml into roading software on a survey device in minutes!
This allows the user to:

- See x,y,z position relative to proposed grade anywhere on the site & record observations in automated reports relative to same.

<table>
<thead>
<tr>
<th>Station</th>
<th>Offset</th>
<th>Offset Length</th>
<th>As Built Pt</th>
<th>Design N</th>
<th>Design E</th>
<th>Design El</th>
<th>As Built El</th>
<th>Cut(-)/Fill(+)</th>
<th>Delta N</th>
<th>Delta E</th>
</tr>
</thead>
<tbody>
<tr>
<td>43200.000</td>
<td>Left</td>
<td>11.996</td>
<td>5022</td>
<td>542095.914</td>
<td>13625583.048</td>
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<td>0.039</td>
</tr>
<tr>
<td>43250.000</td>
<td>Left</td>
<td>12.007</td>
<td>5023</td>
<td>542054.784</td>
<td>13625612.297</td>
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<td>668.912</td>
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<td>-0.075</td>
<td>0.043</td>
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<tr>
<td>43300.000</td>
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<td>542012.535</td>
<td>13625639.903</td>
<td>667.743</td>
<td>667.767</td>
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<td>-0.053</td>
<td>-0.004</td>
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<tr>
<td>43350.000</td>
<td>Left</td>
<td>12.001</td>
<td>5025</td>
<td>541969.231</td>
<td>13625665.825</td>
<td>666.433</td>
<td>666.429</td>
<td>0.004</td>
<td>-0.039</td>
<td>0.021</td>
</tr>
</tbody>
</table>
• A model contains information to represent: The true 3D location of proposed objects critical to design.
Which enables:

- Which enables a direct import of 3D .dxf into roading software on a survey device in minutes!
• Position relative to a 3D design **faster than ever before** with little pre-computation of design features!
• Recover and check control!
• Protect it!
• Plan approach and tools needed
• Compute scale factor(s) if design on grid.
• Calibrate to the site – lock down!
Verifying Construction Accuracy / Q.A. During Construction - Field

- Build comfort
- Spot check often
- Utilize automated reports
- Right tool for the job!
Measurement

Abutment b wall bearings

1000.77 BM 584 on EB I-96 outside shoulder / NCI = 1000.75
+11.805
1012.575 HI
-0.57
1012.005 BM 589 on S.W. corner of abutment a footing / NCI = 1011.97
+10.569
1022.574 HI

-5.429 A = 1017.145 / plan = 1017.12 / diff = 0.025
-5.263 B = 1017.31 / plan = 1017.29 / diff = 0.021
-5.093 C = 1017.481 / plan = 1017.45 / diff = 0.031
-4.924 D = 1017.650 / plan = 1017.62 / diff = 0.030
-4.766 E = 1017.808 / plan = 1017.78 / diff = 0.028
-4.599 F = 1017.975 / plan = 1017.95 / diff = 0.025
-4.505 G = 1018.069 / plan = 1018.03 / diff = 0.039
-4.680 H = 1017.894 / plan = 1017.86 / diff = 0.034
-4.484 J = 1017.726 / plan = 1017.69 / diff = 0.036
-5.018 K = 1017.556 / plan = 1017.52 / diff = 0.036
-5.188 L = 1017.386 / plan = 1017.35 / diff = 0.036
-5.364 M = 1017.210 / plan = 1017.18 / diff = 0.030

7/2/2013

1012.005 BM 589
+10.643
1022.648 HI

-5.512 A = 1017.136 / plan = 1017.12 / diff = 0.016
-5.350 B = 1017.298 / plan = 1017.29 / diff = 0.008
-5.185 C = 1017.463 / plan = 1017.45 / diff = 0.013
-5.008 D = 1017.640 / plan = 1017.62 / diff = 0.02
-4.862 E = 1017.786 / plan = 1017.78 / diff = 0.006
-4.691 F = 1017.957 / plan = 1017.95 / diff = 0.007
-4.615 G = 1018.033 / plan = 1018.03 / diff = 0.003
-4.774 H = 1017.874 / plan = 1017.86 / diff = 0.014
-4.941 J = 1017.707 / plan = 1017.69 / diff = 0.017
Questions / Comments

Contact Information
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• Discuss how a contractor’s work plan can manage use of 3D models on site
• Discuss the training needs for Construction Engineers and Inspectors
• Describe different approaches to procuring equipment and training for the owner’s representatives
Please add your questions to the Q&A Pod

You may add suggestions for poll pods!
Upcoming Webinars and Close

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: Implementing 3D Engineered Models for Construction |
| Webinar 8: Adding Time, Cost and other Information to 3D Models |
Managing & Sharing 3D Models

May 7, 2014
1:00 pm – 2:30 pm

www.fhwa.dot.gov/3D

Douglas.townes@dot.gov