Creating 3D Engineered Models

January 8, 2013
11:00 am – 12:30 pm EST
Welcome & Introductions

Douglas Townes, P.E.
FHWA Resource Center
### Introduction: Webinar Topics

| 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 Engineered Models for Construction |
| Webinar 7: Steps to Requiring 3D Engineered Models for Construction |
| Webinar 8: The Future: Adding Time, Cost and other Information to 3D Model |
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|Webinar 8: The Future: Adding Time, Cost and other Information to 3D Model |
Overview of 3D Engineered Models for Construction

www.fhwa.dot.gov/3D
<table>
<thead>
<tr>
<th>Speaker</th>
<th>Topic</th>
</tr>
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<tbody>
<tr>
<td>Douglas Townes (FHWA-RC)</td>
<td>Welcome and Introductions</td>
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<tr>
<td>John Krause (Florida DOT)</td>
<td>Surveying Methods for 3D Models</td>
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<tr>
<td>Brett Wood (Florida DOT)</td>
<td>Surveying Methods for 3D Models</td>
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<tr>
<td>Francesca Maier (Parsons Brinckerhoff)</td>
<td>Creating 3D Models in Design</td>
</tr>
<tr>
<td>Mike Pullen (Multnomah County)</td>
<td>Using 3D Models in Public Outreach</td>
</tr>
<tr>
<td>Douglas Townes (FHWA-RC)</td>
<td>Information on Next Webinar and Close</td>
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</table>
Supporting 3D Design
Florida Department of Transportation Surveying & Mapping Office
John Krause, PSM and Brett Wood, PSM
Learning Objectives

• Identify best practice for capturing existing conditions
• Describe how survey data is processed into useful outputs for design and construction
3D design efficiencies start early and go on throughout the life of the project

- To fully realize the cost savings of 3D design FDOT is moving towards providing the contractors with digital 3D design plans.
  - This will allow the contractors to estimate the project more accurately.
  - Project packages can be sent to responding contractors much faster and more efficiently than traditional paper hard copies.
  - All respondents will be estimating from the same “sheet of music”.

- Supporting certified digital survey data of existing conditions.
  - Typically this would include a topographic surface and 3D data.
  - Provided with digital signatures using
SOME KEY ELEMENTS DRIVING 3D DESIGN ARE THE ADVANCEMENTS IN SURVEYING WHICH ALLOW SWIFT COLLECTION OF REMOTELY SENSED IMAGERY DATA WITH ACCURACIES SUFFICIENT FOR DESIGN.

The Old Way

Imagery Characteristics:

- Often includes valuable ancillary information
- Details difficult if not impossible to collect conventionally
- Better representation of change
- More detail
- Downside – storage!

FDOT Implementation of Terrestrial Mobile LiDAR

- TML Task Team established in 2012 by the State Surveyor and District Surveyors
- Establish Consistent, Predictable & Repeatable (CPR) survey processes and documentation
- Included FDOT Central Office Remote Sensing and Location Survey personnel.
- Representatives from each FDOT District
- Interested consultants with experience using technology
- Limited Team size to maintain functionality.

**TML Guidelines**

**TML General Scope**

**TML Project Staff Hour Form**

<table>
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General Mobile LiDAR Survey Methods and Vertical Accuracies

- Fixed Wing Aerial LiDAR Mapping (ALS) = +/- 0.5 – 1.0 feet
- Low Altitude MLS = +/- 0.1 – 0.2 feet
- Vehicle TMLS = +/- 0.050 – 0.1 feet
- Static Laser Scanning = +/- 0.005 – 0.05 feet

3D Design projects are beginning to be supported by several survey imagery technologies.
### Improving Technology

#### Low Altitude LiDAR Testing in District 3

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### Every Day Counts
Managing LiDAR Data

- Using TopoDOT to filter Mobile LiDAR Data for quality control
- Usual step is to delineate point cloud data by vehicle trajectory
- Compare passes for coverage and to estimate vertical precision.
Managing LiDAR Data

- Using TopoDOT to filter Mobile LiDAR Data into manageable sizes
- Usual step is to segregate point cloud data by uniform tile areas with matching filenames
- Be careful when thinning data
  - Filter, don’t delete
  - Always be mindful of final object design criteria as it relates to accuracy and point density
Combining Photography With Mobile LIDAR

- Combining the two remote sensing technologies yields better 3D survey information
- Keep in Mind it is not independent if processed from same SBET
Photogrammetry - Autocorrelation

Fort Pickens
Advantage of Additional Datasets

Global Mapper Software – Comparing Image Data
Verifying USGS DEM Surface for Orthophotography

FDOT - SMO

Autocorrelation from Digital Mapping Camera (DMC) Imagery
Summary

- When measured on a common datum, imagery from different sources can be very beneficial
  - Verify Accuracy
  - More complete Information
  - Change detection
- The 3D model - Greater than the some of it’s parts

Photogrammetry, LiDAR, and Conventional Surveying

Rutting on Interstate 10
Verify Learning Outcomes

• Identify best practice for capturing existing conditions
• Describe how survey data is processed into useful outputs for design and construction
Creating 3D Engineered Models in Design

Francesca Maier, PE
Parsons Brinckerhoff
Learning Objectives

• Identify rapid 3D Modeling tools using GIS data
• Describe types of 3D models developed during design
• Describe how 3D models are prepared for Automated Machine Guidance
Lifecycle Data
Use of 3D Data in Planning

Source: Washington State DOT
3D Context Models from GIS Data

Source: Parsons Brinckerhoff
Growing Detail in Design Models
Growing Detail in Design Models

Source: Bentley Systems
Growing Detail in Design Models

Source: HNTB
What’s in your design workflow?

• CADD alignments, profiles and superelevation
• Criteria for cross-sections and earthworks
• Corridor models for cross-sections and earthworks
• Proposed TINs for earthworks
• Outputting LandXML for bidding
• Outputting line strings for bidding
• Releasing corridor models for bidding
Detail Needed for Construction: Design Intent

Source: Bentley Systems
Detail Needed for Construction: AMG

Source: Sundt Construction
Detail Needed for Construction: AMG

Source: Florida DOT
3D for Plans versus 3D for AMG
3D for Plans versus 3D for AMG
Surface Definitions for AMG

Roadway Model Surface - Top

Roadway Model Surface - Pavement

Source: Wisconsin DOT
Roadway Model Surface - Datum

Source: Wisconsin DOT
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 digital data
Sharing 3D Models with Others

Welcome Land Development Professionals!

Quick Statistics
November 28, 2013

Members: 757
Organizations: 664
Countries: 41
Registered Software: 70

Stay informed and participate by joining the LandXML.org Industry Consortium.
See LandXML.org members from 2006 mapped in Google Earth.

View the message archives.

LandXML.org in a Nutshell
Launched January 2000, LandXML.org is committed to providing an non-proprietary data standard (LandXML), driven by an industry consortium of partners. There is no direct cost to join LandXML.org, nor specific level of participation required.
Once you join, stay informed and participate by using the

News December 8, 2013

Thanks to Ladd Nelson of Carlson Software for updating the web site UI and layout.

New web application to convert FAA NGS survey data to LandXML-1.2 on web applications.

Expanded domain/email mapping to Google Earth & Google Maps web application

Is your software LandXML Registered and Certified?
Software vendors Apply for Registered Software status today

LandXML.org has resumed active status. Contact us

LandXML Validator & Report Generator on the Web Applications page.

LandXML to SVG Web Application (Works for LandXML-1.0, LandXML-1.1, LandXML-1.2 files)

Is your software application LandXML Registered and Certified?

LandXML.org XML Data Exchange Standards

LandXML-1.2 schema: Ratified/Standardized on August 15, 2008
LandXML-1.1 schema: Ratified/Standardized on July 21, 2006
LandXML-1.0 schema: Ratified/Standardized on July 17, 2002
Convert Data to Exchangeable Format

Every Day Counts | 43
Convert Data to Exchangeable Format

**Image Description:**

A screenshot of a software interface titled "LandXML Settings - SectionROW". The interface includes several sections and properties:

- **Import**
  - Property: Translation
    - Translated Northing: Off
    - Base Point Northing: 0.0000'
    - Base Point Easting: 0.0000'
    - Base Point Elevation: 0.0000'
    - Translated Coordinate Northing: 0.0000'
    - Translated Coordinate Easting: 0.0000'
    - Translated Coordinate Elevation: 0.0000'

- **Rotation**

- **Point Import Settings**

- **Surface Import Settings**
  - Surface Data: full import
  - Create snapshot after import: On
  - Create Source data in Drawing: On
  - Convert Survey Foot to International Foot: Off

- **Pipe Network Import Settings**

- **Conflict Resolution Settings**

- **Default Diameter Units**

- **Alignment Import Settings**
  - Element Constraint Assignment: Free and floating curve groups

**Description:**

Element Constraint Assignment: Determines how constraints will be assigned to each element in the alignment. Fixed only: Assigns a fixed constraint to all elements. Floating off the first element: Assigns a fixed constraint to the first element, all subsequent elements are assigned a float constraint. Free and floating curve groups: Assigns free or float constraints to supported Civil 3D curve group types.
Build a Model from Exchanged Data
### Coordinate System

<table>
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<tr>
<th>Name</th>
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<tr>
<td>Description</td>
<td>NAD83 Pennsylvania State Planes, Southern 2</td>
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<td>Projection</td>
<td>Lambert Conformal Conic</td>
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<td>Source</td>
<td>Calculated from PA83-S by Mentor Software</td>
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<td>Units</td>
<td>US Survey Foot</td>
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<td>First Standard Parallel</td>
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<td>Second Standard Parallel</td>
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### Datum

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### Vertical Datum

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**Build a Model from Exchanged Data**

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Build a Model from Exchanged Data

Image of a dialog box titled "Geographic Coordinate System Changed" with the following message:

The units of Geographic Coordinate System PA83-SF are US Survey Foot, but the Storage Units in the model are Foot.

- [ ] Don't change the storage units. Data will be drawn in Foot.
- [ ] Change the storage units in the model from Foot to US Survey Foot to match the Geographic Coordinate System.

Options to select: OK, Cancel.
Build a Model from Exchanged Data
Build a Model from Exchanged Data
Build a Model from Exchanged Data
Compare Exchanged Model to Design Model
Compare Exchanged Model to Design Model
Compare Exchanged Model to Design Model
Compare Exchanged Model to Design Model
Compare Exchanged Model to Design Model
Source: Iowa State University
Verify Learning Outcomes

• Identify rapid 3D Modeling tools using GIS data
• Describe types of 3D models developed during design
• Describe how 3D models are prepared for Automated Machine Guidance
3D Modeling as a Public Information Tool
Multnomah County’s Sellwood Bridge Project

Mike Pullen
Multnomah County
Does your organization use 3D models for public outreach?

- Yes
- No
- Not Sure
Overview

• Project Background
• Phased Construction vs. Detour
• Public Information Challenge
• 3D Model as Tool
• Results
Sellwood Bridge in Portland, Oregon
Project Background

- Investigated closing bridge during construction of new bridge
- Significant economic and business concerns
- County commitment to keep crossing open
- Goal = no more than 30 days of closure during 3-year bridge replacement
Staged Construction

• Original assumed option
• Bridge built in 2 phases, 1 half at a time
• Keep bridge in service during work
• Use existing bridge while first half of new bridge is built on southside
• Traffic shifts to south half of new bridge
• Old bridge removed
• North half of new bridge built to form one new bridge
• Proposed in 2011 by newly-hired design and construction teams

• Approved by County Board in June 2011

• Old bridge moved north, out of work zone

• Bridge moved *carefully and safely* by specialty subcontractor

• Detour bridge will not include worst sections of old bridge
Detour Construction

• Uses portion of old east approach
• Detour bridge as strong or stronger than old bridge (including seismic)
• New bridge can be built in one phase
• Similar number of bridge closure days
Detour Bridge Benefits

• **Time:**
  – Reduce construction by up to 12 months

• **Money:**
  – Reduce cost ($5 to $10 million) in materials, labor, and equipment

• **Safety:**
  – Separation improves safety for workers and travelling public.

• **Design:**
  – Eliminates redundant features
  – Improves appearance (two arch ribs instead of four)

• **Environmental Impacts:**
  – Fewer temporary work bridges
  – Less construction time
  – Less in-water and riparian impacts
New Bridge if built in one phase (detour option)

New Bridge if built in two phases (staged option)
Detour Construction: Early Phase
Detour Construction: Approaches & Piers

Potential Staging Area

Temporary Work Platform

Access

Potential Staging Area and Temporary Parking

Access

Detour Alignment Option 1
Detour: Slide Old Bridge North
Detour: Construct New Bridge

Potential Staging Area

Temporary Work Platform

Potential Staging Area and Temporary Parking

Access

Detour Option 1 - Stage 2, East Approach First Stage Construction
Detour: Fill In East Approach
Detour: Completed Bridge
Public Information Challenges

• Public doubts about moving the old bridge, then re-opening it

• Neighbor concerns about proximity of new alignment

• Risks to regional traffic flow and county’s reputation if bridge was damaged during move
Public Information Tools

• Meetings with neighbors, businesses
• Newsletter
• Drawings to explain bridge move
• Website update
• Media (news conferences, tours)
• Timelapse video
• 3D model
• Animated 3D model by general contractor Slayden-Sundt prepared for proposal

• County and web consultant added narration by general contractor and titles to video for lay audience

• Posted video with 3D model to website and shared with public audiences to show bridge move sequence
Screen 3D animation of bridge construction sequence
3D Model Images of Detour Bridge

Concept for detour bridge construction
3D Model Images of Detour Bridge

Constructing detour bridge near residences
Traffic on detour bridge during construction of new bridge
Completed new bridge after removal of detour bridge
Results

• Successful bridge move in January 2013
• Bridge closure limited to five days, over holiday weekend
• Positive local and national media coverage
• Large public turnout on bridge move day
• Increased credibility for project owner, contractor and design team
Bridge Move Facts and Figures

• Truss span moved –
  – 6.8 million pounds (3,400 tons)
  – 1095 feet long
  – 31 feet wide
  – 32 feet tall

• Lift – about 2-1/2 inches

• Sliding
  – 66 feet North at West End
  – 33 feet North at East End
  – Maximum Speed – 6 inches per 10 seconds
  – Move Time = 14 hours
• Overall budget - $307.5 million
• Traffic on detour bridge – January 2013
• Traffic on new span – Summer 2015
• East approach/Hwy. 43 interchange complete – Summer 2016
Bridge Move Team

• Slayden/Sundt Joint Venture – General Contractor (prepared 3D model)

• Omega Morgan – Heavy move Subcontractor

• T. Y. Lin International – Design in-river piers

• Multnomah County – Owner, oversight
Verify Learning Outcomes

• Describe uses of 3D models during design and construction
Questions
Upcoming Webinars and Close

Douglas Townes, P.E.
FHWA Resource Center
## Webinar Series Topics

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Applications of 3D Models in the Contractor’s Office

February 19, 2014
1:00 pm – 2:30 pm

www.fhwa.dot.gov/3D

Douglas.townes@dot.gov