Overview of 3D Engineered Models for Construction

November 20, 2013
1:00 pm – 2:30 pm EST
Why Webinars?

Webinars are one of the three legs of the 3-D Engineering Models for Construction stool
Webinars are one of the three legs to successful implementation.
Target Audience for the Webinars

- Government Owners (DOTs, Counties, Cities, etc.)
- Consultants
- Contractors
- Industry
1. Overview of 3D Models for Construction

November 20, 2013, 1:00 – 2:30 pm

- FHWA Introduction
- DOT perspective
- Contractor perspective
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<td>Overview from the Contractor’s Perspective</td>
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<td>Welcome &amp; Overview of EDC2 3D Engineered Models for Construction Initiative</td>
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<td>Dan Belcher (Michigan DOT)</td>
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<td>Alexa Mitchell (Missouri DOT)</td>
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<td>Summary and Audience Interaction</td>
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Contact: Douglas Townes, Phone 404-562-3914, douglas.townes@dot.gov
The Contractor Perspective

Rich Juliano
Senior Vice President
American Road & Transportation Builders Association
• **Section 1304 – Innovative Project Delivery Methods**
  – Projects including use of innovative technology may be eligible for greater federal share of funding
  – Examples include “digital 3-dimensional modeling techniques”

• **Section 1503 – Project Approval and Oversight**
  – The Secretary “shall encourage the use of advanced modeling technologies during environmental, planning, financial management, design, simulation, and construction processes of [federal-aid] projects.”
  – Compile information and industry best practices
  – Disseminate information and best practices to state DOTs
  – Develop and publish a comprehensive plan
• Policymaking group which includes these three national associations, with participation from FHWA

• 2012 Joint Position Statement: “Best Practices for Electronic Data-Sharing Between State DOTs and Contractors”
  – Prospective bidders should be provided all project electronic files
  – DOTs not expected to convert to vector format
  – Bidder can rely on data in static files as complete
  – For plans with cross-sections, vector files should also be provided; bidder responsible for verifying the accuracy of data

• Model liability limitation language to clarify designer’s responsibility
Some Further Thoughts from Industry…

- General Consensus
- “Horizontal” vs. “Vertical”
  - BIM
- Software and Contract Requirements
- Contractors Embrace Innovation
- FHWA’s Every Day Counts
- Contact: rjuliano@artba.org
- THANK YOU!
3D Engineered Models for Construction

Bryan Cawley
Construction Management Team Leader
Office of Infrastructure

Bryan.cawley@dot.gov 202-366-1333
3D Engineered Models for Construction

• Project represented in 3D, with accuracy and precision
  – Rotated, tilted, and manipulated to provide varying views
  – Perform “clash” analysis
  – Improved quality with quantity takeoffs
  – Digital Terrain Model (DTM) for Automated Machine Guidance (AMG)

• With 4D (time) virtual construction
• With 5D (money) cash flow

Image Courtesy Wisconsin DOT
Overall Better Project Outcomes
- 44%
Reduce Rework
- 44%
Fewer Claims / Litigation
- 38%
Reduce Errors in Documents
- 33%
Reduce Workflow Cycle Time
- 33%
Reduce Project Duration
- 33%
Reduce Construction Cost
- 22%

Every Day Counts | 15

Notes:
1. Fine-grading using CAT 140H motor grader (Jonasson et al., 2002)
2. Trench excavation using CAT 330DL hydraulic excavator (Aðalsteinsson, 2008)
3. Earth moving and fine grading (general values; not project specific) (Forrestel, 2007)
4. Earth moving and fine grading project - Port of Brisbane (Higgins, 2009)
5. Bulk earth moving and subgrade fine grading using CAT D6N dozer (gain in the number of passes; Caterpillar, 2006)
7. Base course fine grading using CAT 140H motor grader (gain the number of passes; Caterpillar, 2006)
Texas Legislature commissioned Texas A&M Institute Construction Innovations

- Design-Build/Just-in-Time Design/Design on the Fly
- 3-D Design
- Electronic Plans
- Delayed Closures to Accommodate Special Holidays
- Holiday/Event Black Out Period
- Night & Weekend Closures
- Wireless Paving
- Intelligent Compaction
- Smart Concrete Truck
- Asset Management through Equipment Telematics
- GPS-equipped Vehicles and Equipment
- Use of Rock for Retaining Wall Backfill
- Full Attack Construction/Aggressive Construction
- Highly Integrated City Coordination
- Selected Full Closure for Bridge Reconstruction
- Mobility Coordinator
- Night Utility Relocation
- Higher-Level Utility Coordination
- Consolidate Utility Efforts
- Pre-Cast Facilities/Pre-Cast In-Situ
- Recycling In-Place
- Use of Asphalt Pavement
- Pre-Cast Composite Steel/Concrete Caps
- Executive Meetings
- Scheduling Tools
- Play of the Day Meetings
- Weekly Coordination Meetings
- Co-location of All Offices
- Monthly 4-square matrix
- On-site Maintenance Shop
- Condition Appropriate Span Lengths
- Use of Recycled Rock Material in Lieu of Lime

http://mobility.tamu.edu/mip/
• **Benefits:**
  – **Time Savings:** Visualization leads to faster decision-making; profiling is simpler and faster calculations for earthwork can be generated; more interactions of designs can be developed more quickly; and problems are more easily spotted and corrected earlier in the design process.
  – **Cost Savings:** Lower bids, lower survey costs and less rework; more accurate estimates; and fewer change orders and field modifications.
  – **Quality:** Ability to catch avoidable mistakes; earthwork calculations are more representative of the proposed project; and conflicts can be resolved before the bid process begins.
  – **Improvements in Customer Relations:** Builds belief in the design and confidence in the engineer-client relationship.

• **Challenges:**
  – Education and training, software limitations, and resistance to change.
3D Activities & tools

- National Website and Technical Support Service Center - Jan 2014
  - Specs, Details, Case Studies, etc.
  - Technical Assistance
  - Inquiries from State DOTs, LPAs, Contractors & Engineers
- Webinars – Fall 2013 & throughout 2014
- 1-day Training – Spring 2014
- Demonstration Workshops
  - Design to Asphalt Pave – Oregon
  - Design to Construction of Steel Structures - Pennsylvania
  - Design to Concrete Slip-form Pave – Missouri
- Tech Briefs and Web-based Training – Summer 2014
  - NYState DOT – Steel Bridge Fabrication 3D Modeling
- Implementation Manuals – Summer 2014
  - Iowa DOT
• More Information on EDC Technologies:
  – http://www.fhwa.dot.gov/everydaycounts/

• More Information on 3D Engineered Models for Construction

• ACPA Stringless Concrete Slip-Form Paving
  – http://acpa.scholarlab.com/ Pavement1
3D Engineered Models for construction: Who can you contact?

- **Chris Schneider** FHWA Office of Infrastructure, christopher.schneider@dot.gov 202-493-0551
- **David Unkefer** FHWA Resource Center, david.unkefer@dot.gov 404-562-3669
- **Bryan Cawley** FHWA Office of Infrastructure, bryan.cawley@dot.gov 202-366-1333
- **Douglas Townes** FHWA Resource Center, douglas.townes@dot.gov 404-562-3914
- **Kathryn Weisner** FHWA Resource Center, kathryn.weisner@dot.gov 410-962-2484
3D Engineered Models for Construction from the DOT Perspective

Daniel Belcher, P.E., P.S.
Michigan Department of Transportation
3D IS $2B

Mac, we’ve been doing this for over 100 years there’s nothing to worry about!
We Squeezed all the Efficiency Out of 2D CAD
Design

Courtesy Dean Bowman, Bentley Systems
Construction

Courtesy Dean Bowman, Bentley Systems
Contractors - Machine Guidance
Inspectors - Stake Diet
Asset Management
Performance Based Operations
Intelligent Transportation Systems
Operations & Maintenance
Decision Support
Performance Measurement
MAP 21
Transparency in Government
Autonomous Vehicles
Automated Design & Construction
Assets
Hatch Mott McDonald
Northwest PATH Pedestrian Tunnel
Toronto, Canada
Challenges

- Change
- Training
- Standards
- 3D Model QA/QC
- Risk – Contractor V’s DOT
Creating and Delivering 3D Models

Alexa Mitchell, P.E.
MoDOT – CADD Services Engineer
Traditional Design Models

- Fragmented design – rigid – inefficient
- Lack of design intent
- Inhibit collaboration
Traditional Design Models

- Inhibit innovation and technology use
- Incomplete model for construction
- Increased bidding risk + change orders
Benefits of 3D Design Models for Construction

- Design model for multiple purposes (PR, R/W, decision making)
- Design intent is communicated
- Decreased risk = competition
- Virtual construction = fewer change orders
- Provide opportunity for innovation (ATC’s, VE, AMG, etc.)
Technical Challenges

• Lack of guidelines or best practices
• Lack of $ to set up technical infrastructure (storage, bandwidth, accessibility, etc.)
• Mismatched technological advances (software vs. hardware)
• Lack of expertise
• Lack of investment in training and technology
• Accelerated deadlines = no time to learn
• Lack of consistency from contractors (type of data & format – one size does not fit all)
Legal Challenges

- Electronic plans vs. electronic data
- Change orders and model modifications
- Validation of data and disputes
- Engineer of record
Conclusions

• 3D Models are better than traditional 2D models

• We have a number of technical, institutional and legal challenges we must overcome as an agency

• So it’ll take the agencies time to completely move to 3D workflows, but we must start now
Poll Pod
Using 3D Models in Bidding and Construction

Eric Cylwik
Sundt Construction
Developing Models
Developing Models - Parametric
Alignment Data

Profile Data

Standard Detail
• Import Surface Data
  – LandXML, DTM, Etc…
• Import Alignment Data
  – LandXML, CSV
• Import Line Work Data
  – DGN, DWG, DXF
Using Models for Bidding
Use in Bidding – Means and Methods
Using Models during Construction
Use During Construction
Use in Construction

DO
“THIS”

Real World Location

Design Model

Machine Orientation

Every Day Counts | 54
Conclusion
Benefits of Using Models

• Critical data input, reducing repetition
• Faster, more accurate, and more responsive estimates
• Deeper understanding of construction documents
• Reduce risk in planning and execution
• Right Here, Right Now information
Webinar 1: Overview of 3D Engineered 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
2. Creating 3D Engineered Models

January 8, 2014, 1:00 – 2:30 pm

- Survey Methods
- Legal issues with sharing survey data
- Creating a DTM
- Creating 3-D Models
- Data Exchange formats
3. Applications of 3D Models in the Contractor’s Office

February 19, 2014, 1:00 – 2:30 pm

• Contractor’s perspective
  – Preparing models for estimates
  – Preparing models for clash detection
  – Preparing models for AMG
  – Benefits of using AMG
April 2, 2014, 1:00 – 2:30 pm

• DOT perspective
  – Safety issues
  – Public outreach
  – Project staking, AMG & QA
  – Benefits of using AMG
  – 3D models on mobile devices
May 7, 2014, 1:00 – 2:30 pm

- The data structure for the 3D Engineered Model
- Sharing data in a point cloud
- Data formats and data exchange
- Specifying 3D models by element and LOD
- Certifying electronic documents
- Validating construction models
6. Overcoming Challenges to Using 3D Engineered Models for Construction

September 10, 2014, 1:00 – 2:30 pm

• Overcoming technological implementation barriers
  – DOT issues
  – Contractor issues
• Developing a plan for implementation
• Resources for overcoming barriers
7. Steps to Requiring 3D Engineered Models for Construction

October 15, 2014, 1:00 – 2:30 pm

• Identifying champions
• Evaluate pilot projects
• DOT Specifications, policies & procedures
• Contract language to accommodate technology and manage liability
8. The Future: Adding Time, Cost and other Information to 3D Model

November 19, 2014, 1:00 – 2:30 pm

• 4D

• 5D
Participant Interaction

Francesca Maier, P.E.
Parsons Brinckerhoff
Summary of Benefits

- Better communication of the design intent
- Reduced clashes
- Savings of up to 30% on earthworks
- Better construction quality
- Enhanced safety

Images courtesy of ConnDOT
Summary of Challenges

• Technological challenges
  – Enabling infrastructure
  – Education and training
  – Data management

• Institutional challenges
  – Creating standards and specifications
  – Changing workflows
  – Legal frameworks
  – Time and fiscal constraints
Participant Interaction

• Poll pods
• Question and Answer
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http://www.fhwa.dot.gov/everydaycounts/edctwo/2012/3d.cfm