Overview of 3D Engineered Models for Construction

November 20, 2013

1:00 pm – 2:30 pm EST

Every Day Counts

innovation ingenuity imagination invention

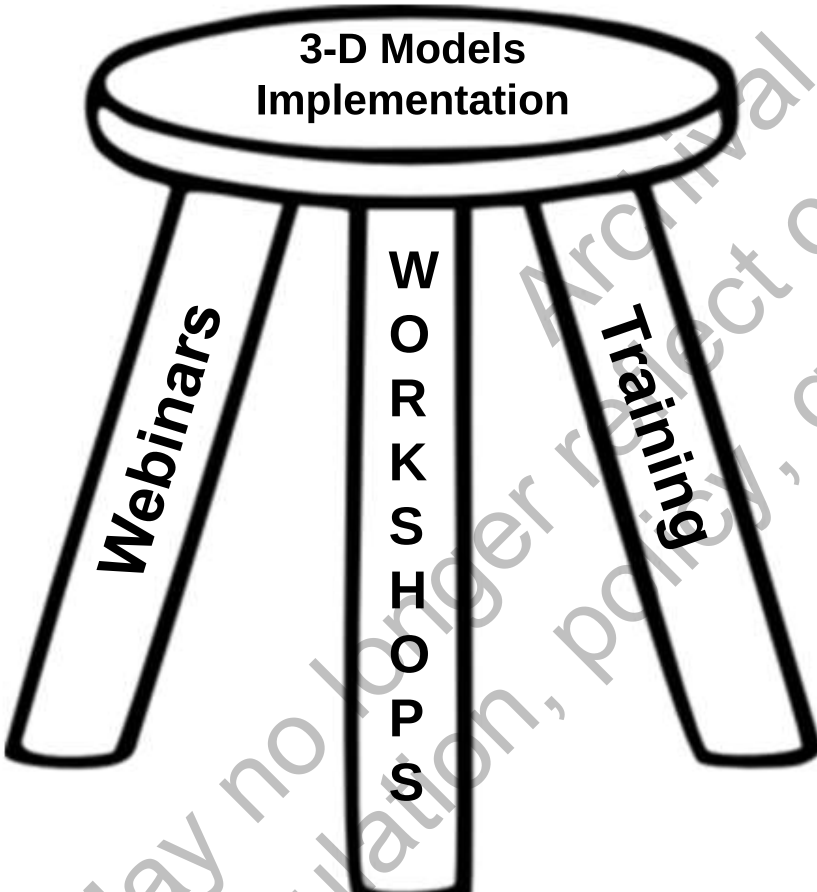
U.S. Department of Transportation

Federal Highway Administration

Why Webinars?

Webinars are one of the three legs of the 3-D Engineering Models for Construction stool

Why Webinars?



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**

Agenda

Speaker	Topic
Rich Juliano (ARTBA)	Overview from the Contractor's Perspective
Bryan Cawley (FHWA-HQ)	Welcome & Overview of EDC2 3D Engineered Models for Construction Initiative
Dan Belcher (Michigan DOT)	Overview from the DOT's perspective
Alexa Mitchell (Missouri DOT)	Creating and Delivering 3D models for Construction
Eric Cylwik (Sundt Construction)	Using 3D models in Bidding and Construction
Douglas Townes (FHWA-RC)	Information on Next Webinar and Close
Francesca Maier (Parsons Brinckerhoff)	Summary and Audience Interaction

Contact: Douglas Townes, Phone 404-562-3914, douglas.townes@dot.gov

The Contractor Perspective

Rich Juliano
Senior Vice President
American Road & Transportation
Builders Association

U.S. Department of Transportation
Federal Highway Administration

3D Modeling: MAP-21 Provisions

- 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

AASHTO-ARTBA-AGC Joint Committee

- 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!

Poll Pod

3D Engineered Models for Construction

Bryan Cawley
Construction Management Team Leader
Office of Infrastructure

Bryan.cawley@dot.gov 202-366-1333

U.S. Department of Transportation
Federal Highway Administration

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

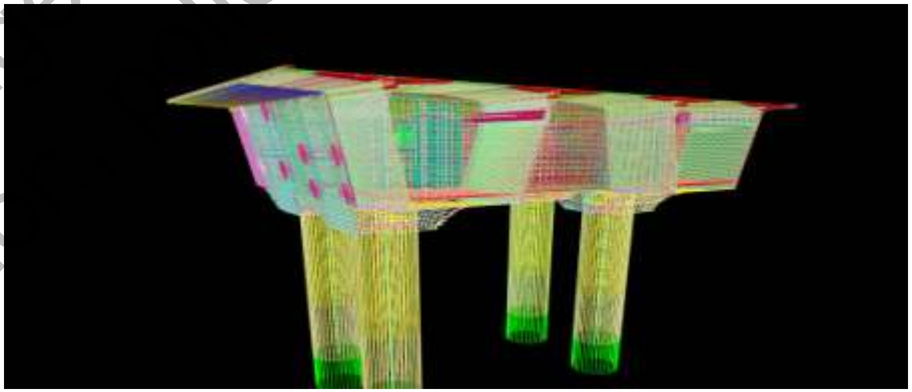
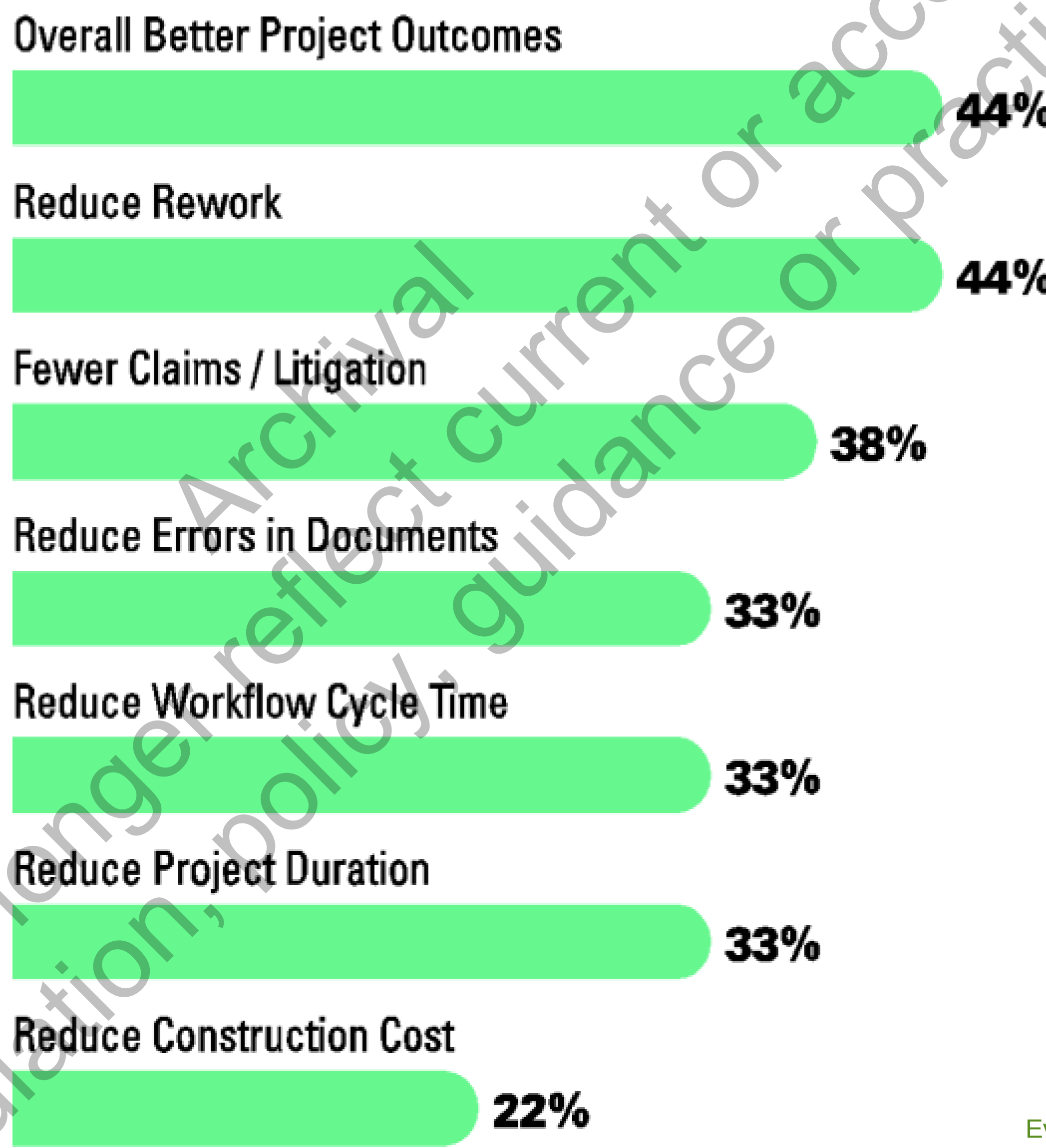
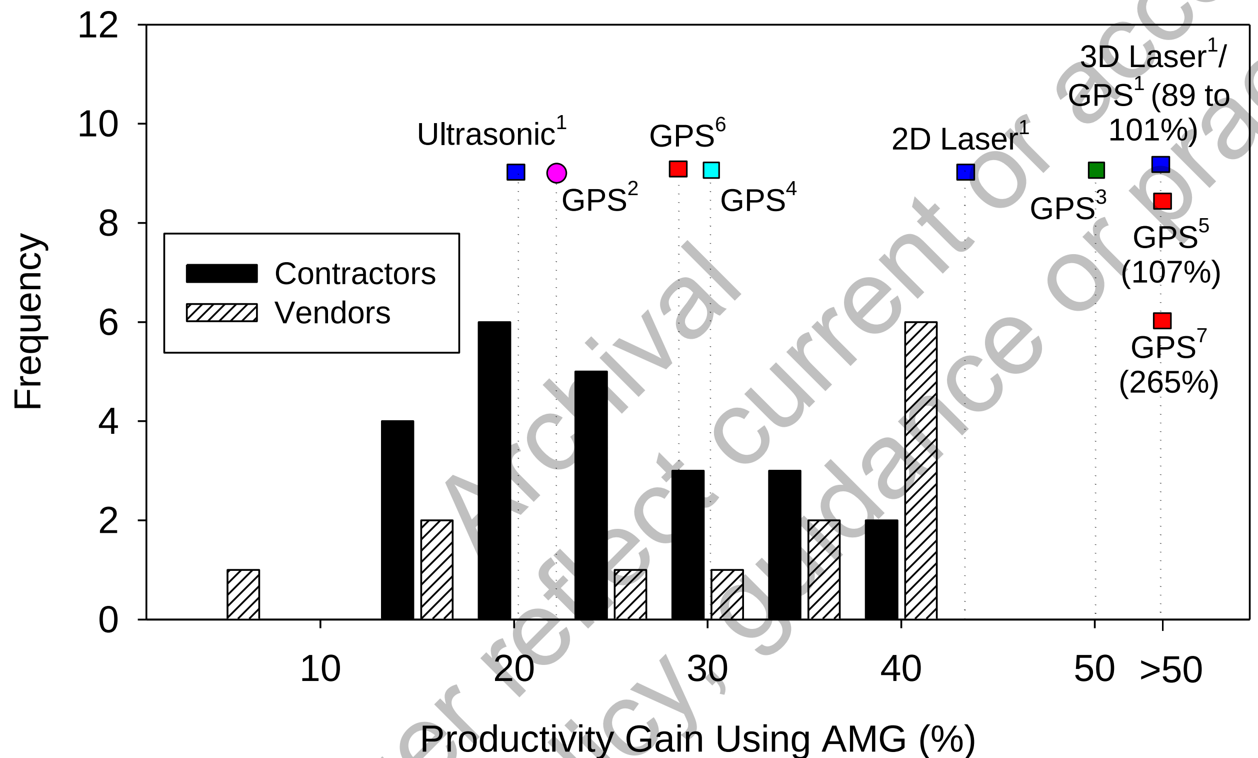


Image Courtesy Wisconsin DOT



Source: The Business Value of BIM for Infrastructure, McGraw Hill Construction, 2012



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)
[6]Bulk earth moving using CAT 330D excavator (Caterpillar, 2006)
[7]Base course fine grading using CAT 140H motorgrader (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/

Advanced modeling techniques for enhanced constructability review: a survey of state practices and related research – Caltrans March 2012

- 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.
    - Currently using: http://www.efl.fhwa.dot.gov/technology/dv.aspx
  - 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

- More Information on EDC Technologies:
  - http://www.fhwa.dot.gov/everydaycounts/
- More Information on 3D Engineered Models for Construction
  - http://www.efl.fhwa.dot.gov/technology/dv.aspx
- ACPA Stringless Concrete Slip-Form Paving
  - http://acpa.scholarlab.com/ Pavement1

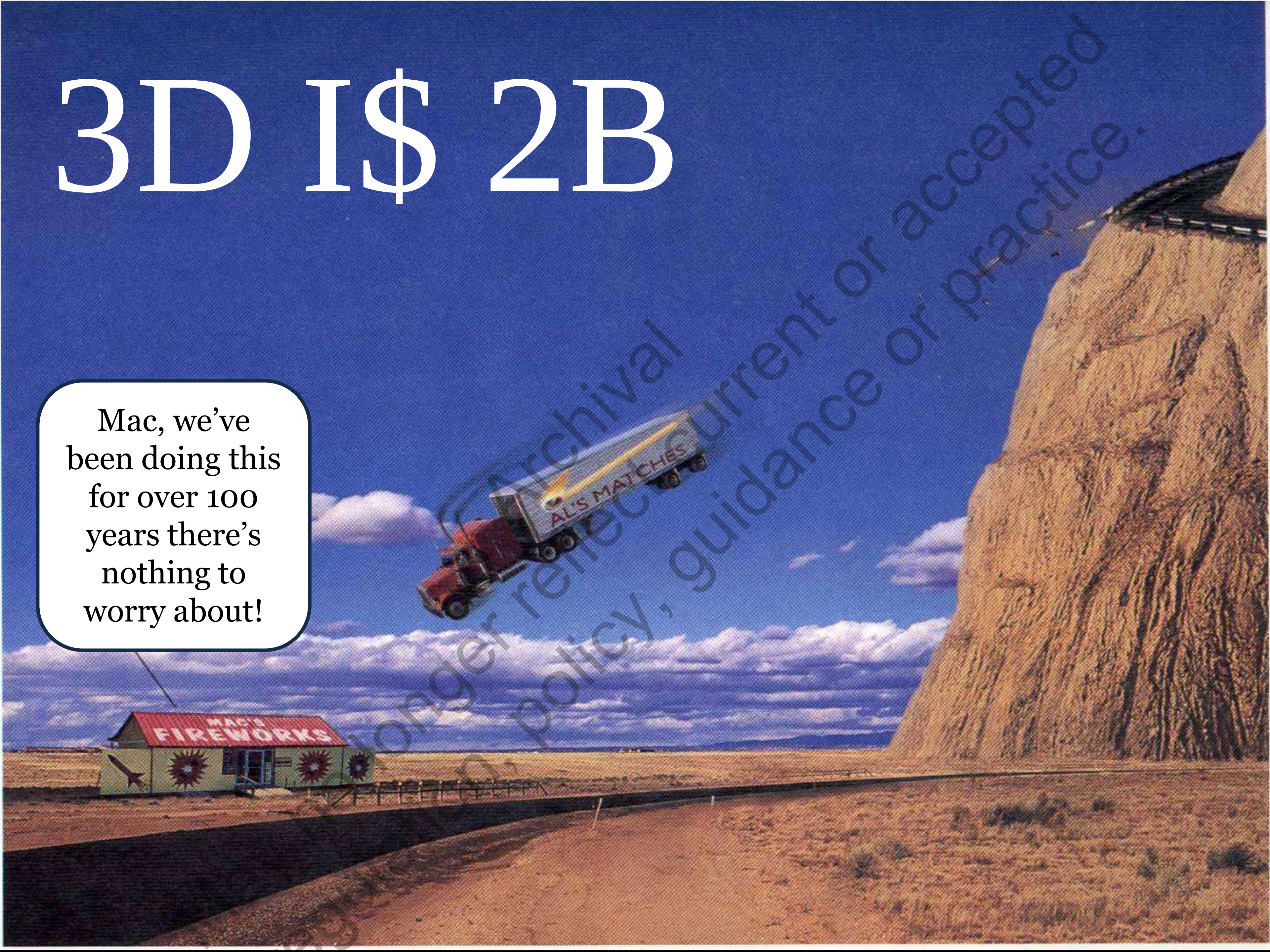
3D Engineered Models for construction: Who can you contact?

- 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

U.S. Department of Transportation
Federal Highway Administration


3D I$ 2B
Mac, we've been doing this for over 100 years there's nothing to worry about!
AL'S MATCHES
MAC'S
FIREWORKS

We Squeezed all the Efficiency Out of 2D CAD

Design

Courtesy Dean Bowman, Bentley Systems

Construction

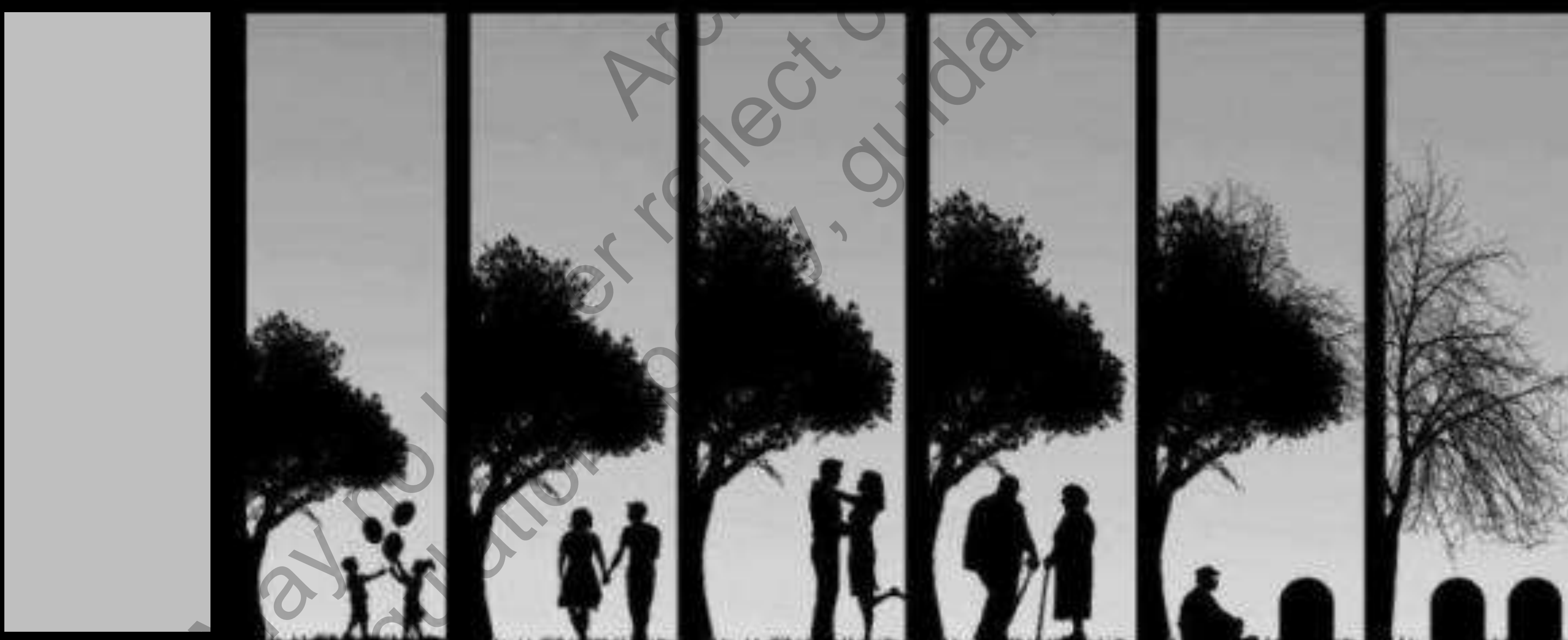
Courtesy Dean Bowman, Bentley Systems

Customers

Design

Construction

Maintenance & Operations



Contractors - Machine Guidance

Inspectors - Stake Diet

Performance
Based
Operations

Asset
Management

Intelligent
Transportation
Systems

Operations & Maintenance

A$$ET$

Decision
Support

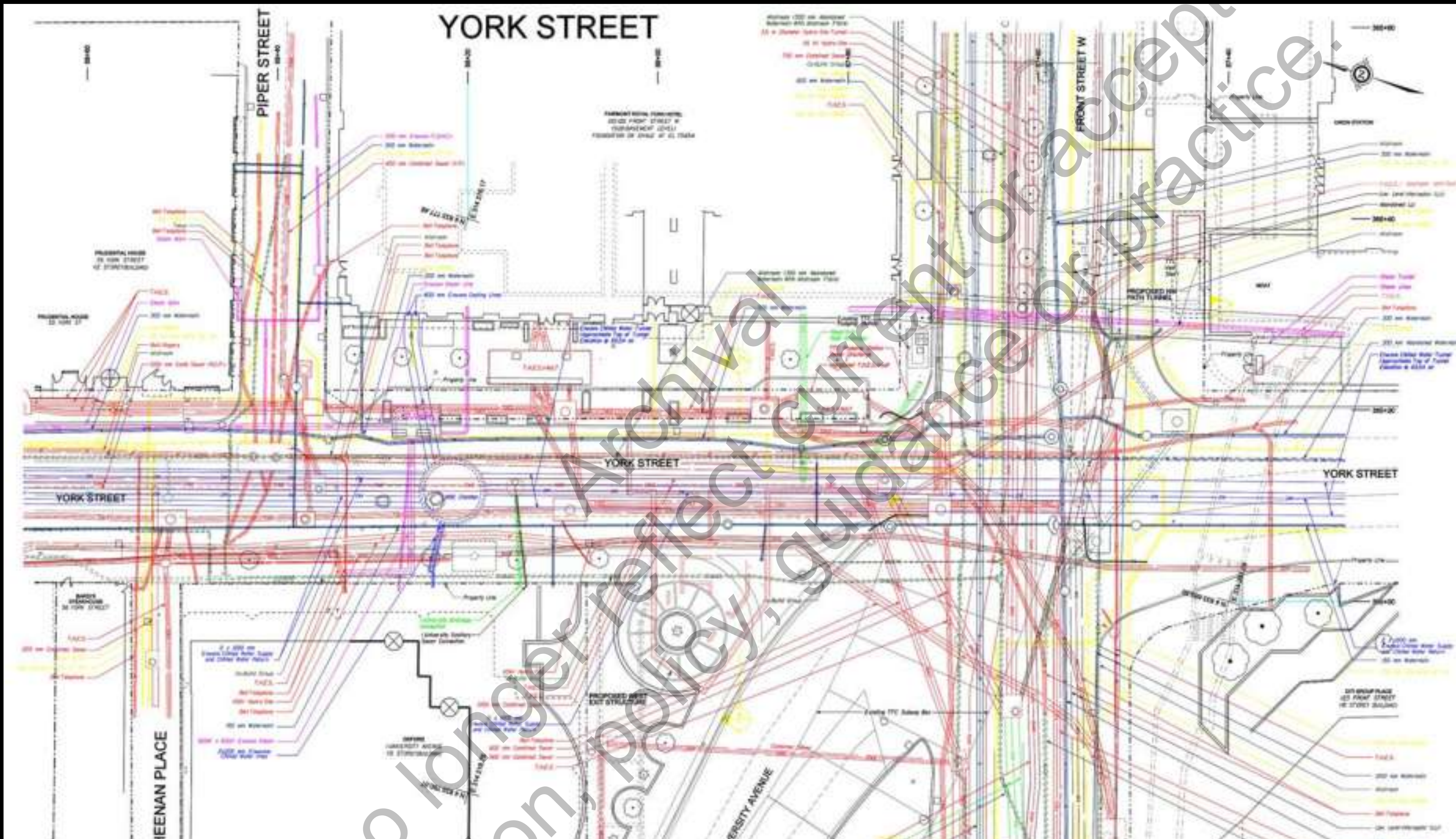
Performance
Measurement

MAP 21

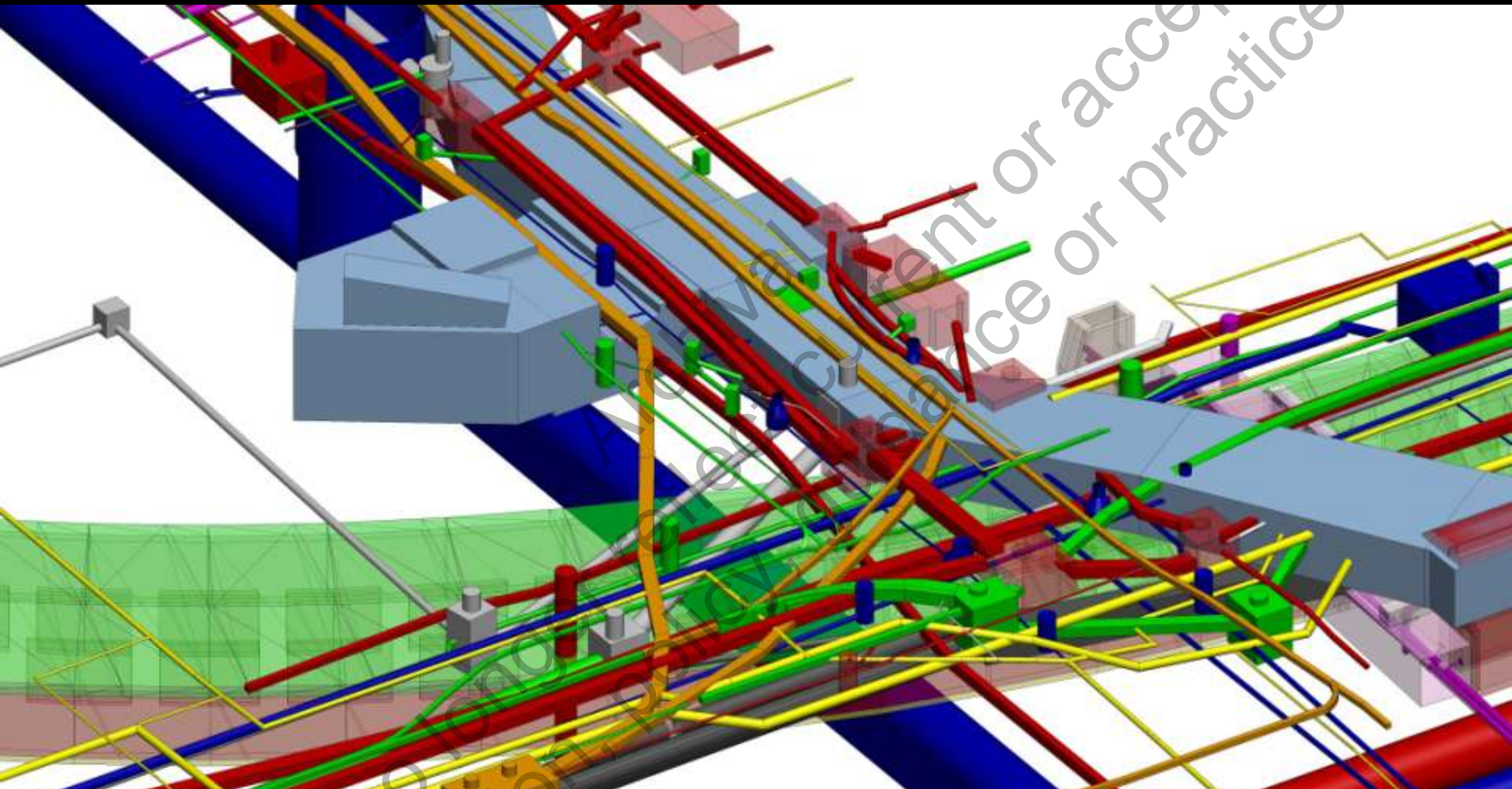
Autonomous
Vehicles

Automated
Design &
Construction

Transparency
in
Government



Hatch Mott McDonald
Northwest PATH Pedestrian Tunnel
Toronto, Canada



Hatch Mott McDonald
Northwest PATH Pedestrian Tunnel
Toronto, Canada

Challenges

- Change
- Training
- Standards
- 3D Model QA/QC
- Risk – Contractor V's DOT

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Creating and Delivering 3D Models

Alexa Mitchell, P.E.

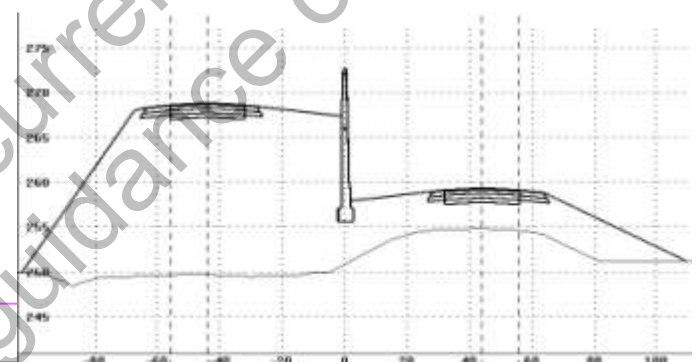
MoDOT – CADD Services Engineer

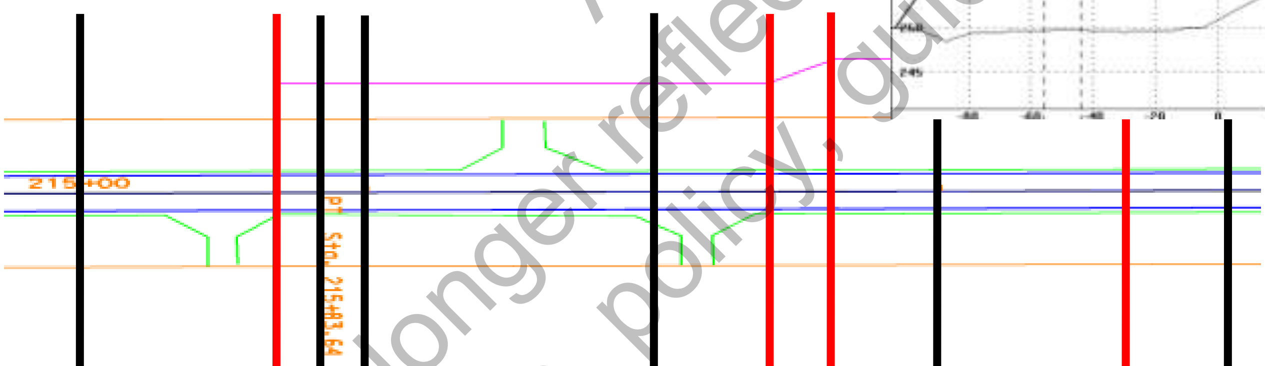
U.S. Department of Transportation

Federal Highway Administration

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

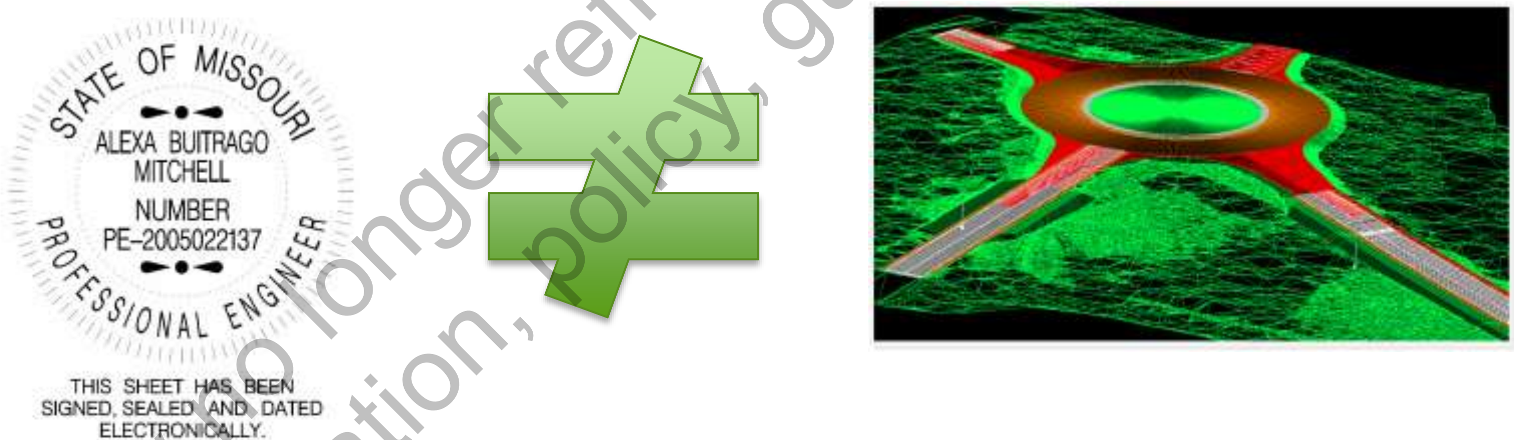
- Design model for multiple purposes
  (PR, R/W, decision making)
- Design intent is communicated
- Decreased risk = competition
- Virtual construction = fewer change orders
- Provide opportunity for innovation
  (ATC's, VE, AMG, etc.)

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

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Using 3D Models in Bidding and Construction

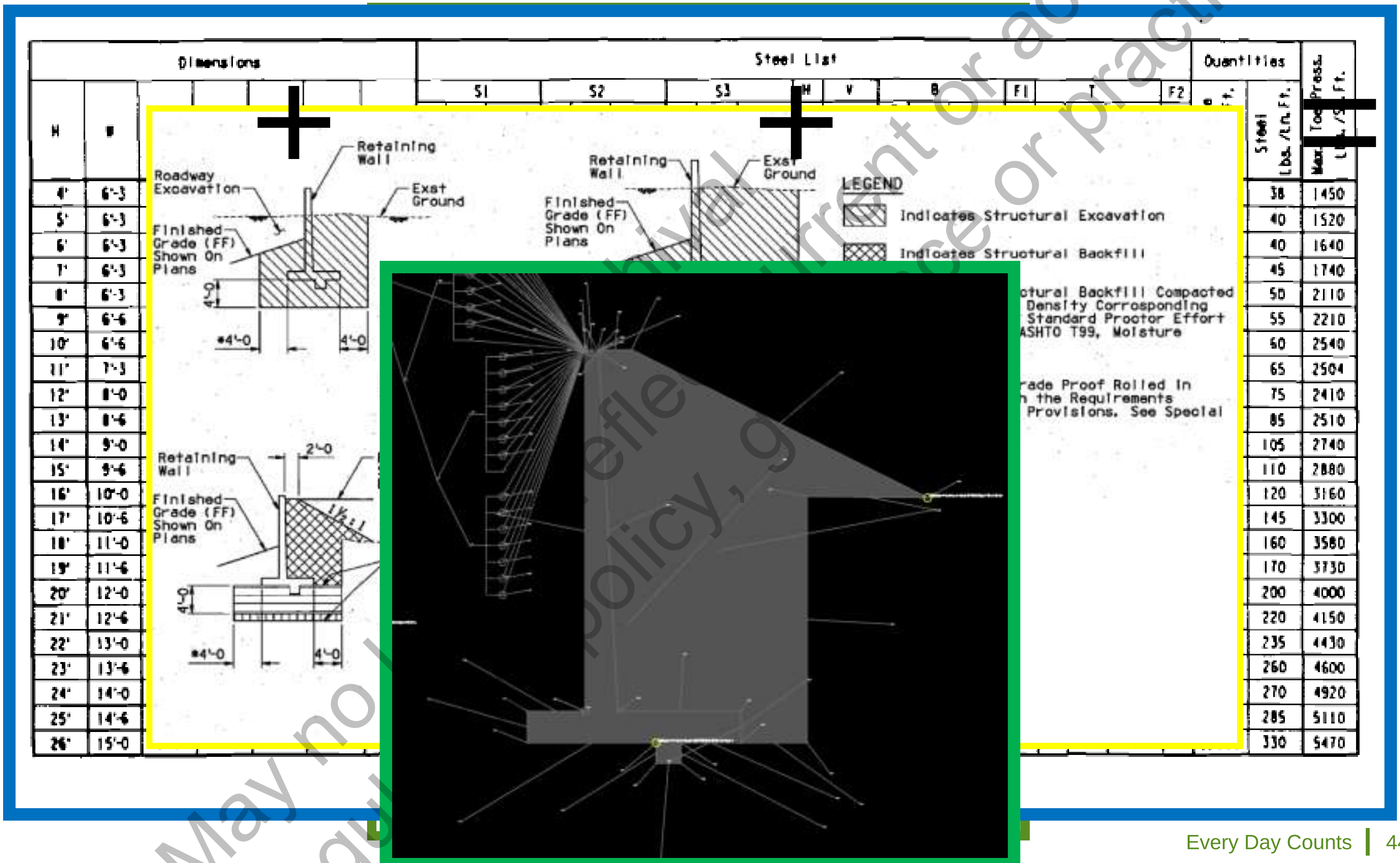
Eric Cylwik
Sundt Construction

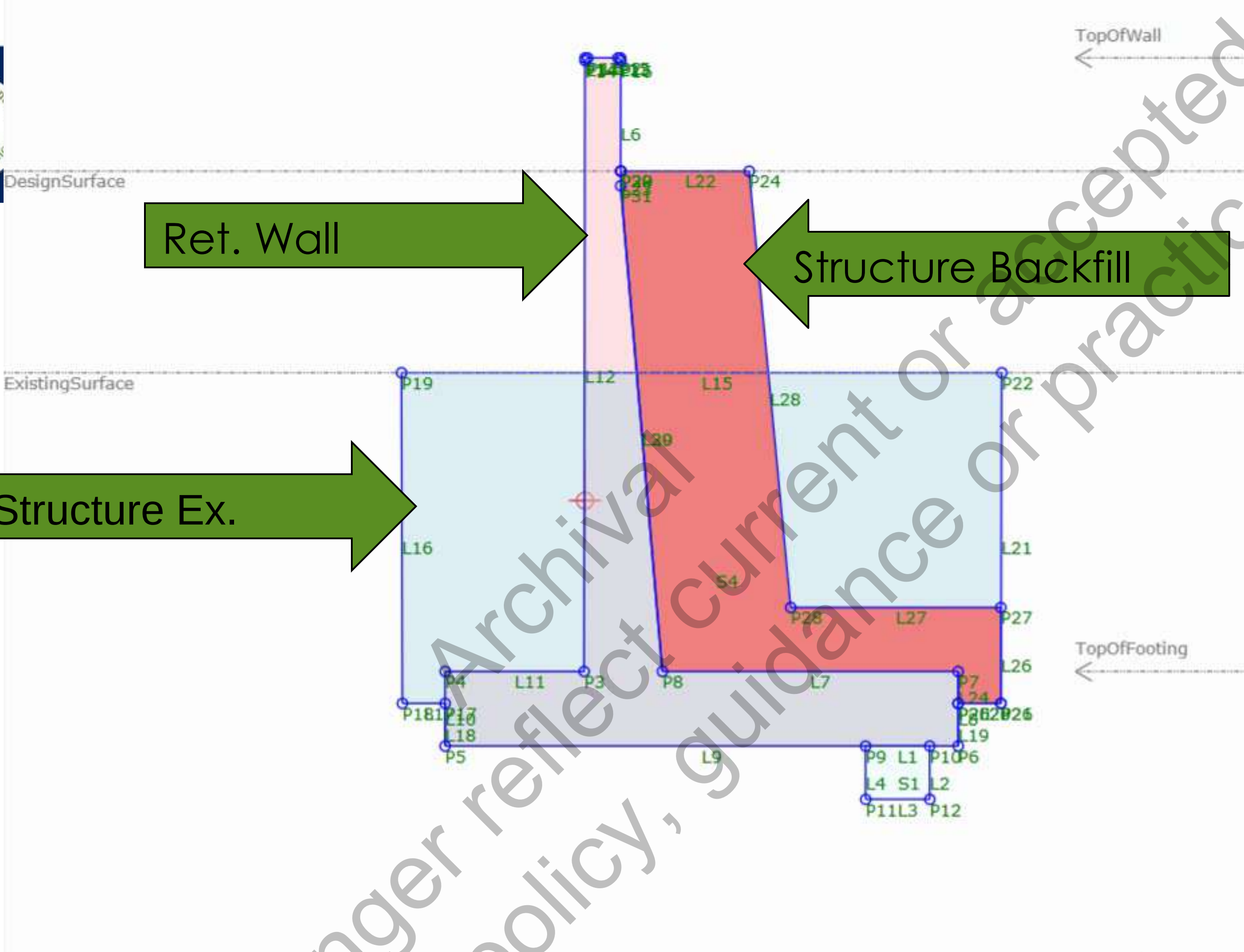
U.S. Department of Transportation
Federal Highway Administration

Developing Models

U.S. Department of Transportation
Federal Highway Administration

Developing Models - Parametric



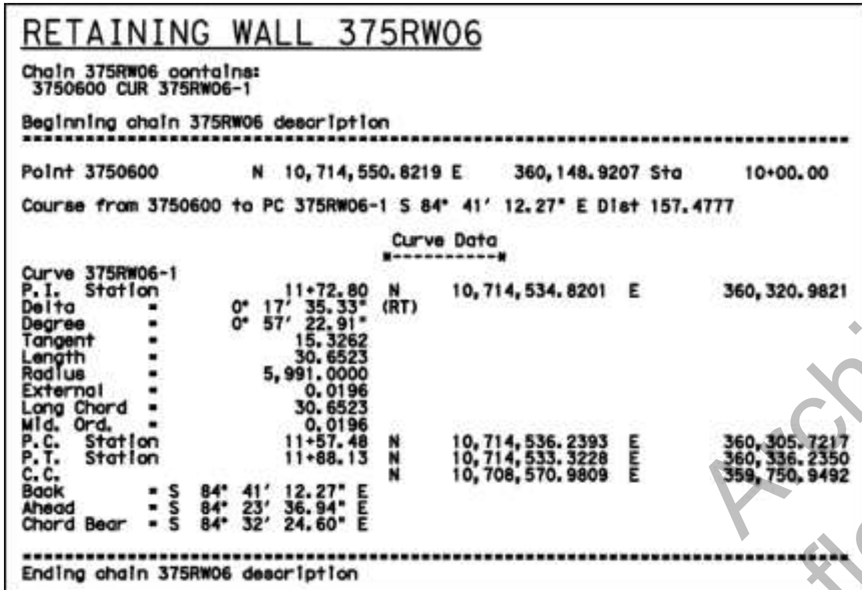


Target Parameters

Name	Type	Preview Value	DisplayName
TopOfWall	Elevation	10.385	
TopOfFooting	Elevation	-4.009	
H_Value	Elevation	20	
ExistingSurface	Surface	3	
DesignSurface	Surface	7.729	

SUNDT

From Construction Documents



RETAINING WALL 375RW06

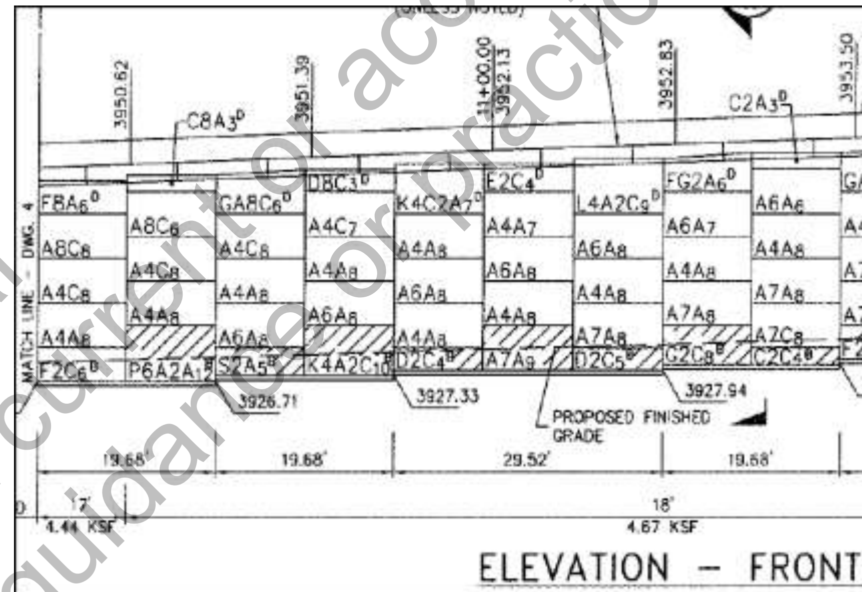
Chain 375RW06 contains:
 3750600 CUR 375RW06-1

Beginning chain 375RW06 description

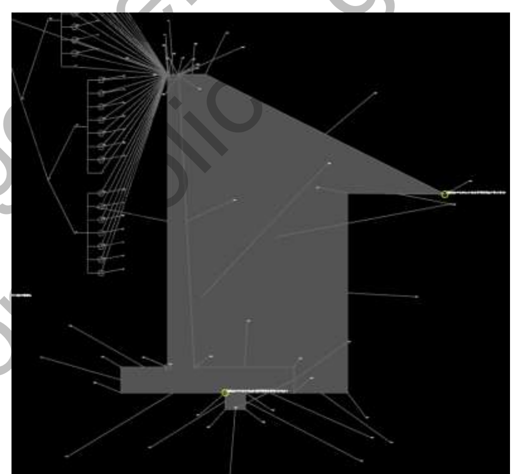
```
Point 3750600        N  10,714,550.8219 E     360,148.9207 Sta      10+00.00

Course from 3750600 to PC 375RW06-1 S 84° 41' 12.27" E Dist 157.4777

                                   Curve Data
                                 *----------*
Curve 375RW06-1
P.I.  Station            11+72.80   N    10,714,534.8201  E      360,320.9821
Delta         =      0° 17' 35.33"  (RT)
Degree        =      0° 57' 22.91"
Tangent       =            15.3262
Length        =            30.6523
Radius        =         5,991.0000
External      =             0.0196
Long Chord    =            30.6523
Mid. Ord.     =             0.0196
P.C.  Station            11+57.48   N    10,714,536.2393  E      360,305.7217
P.T.  Station            11+88.13   N    10,714,533.3228  E      360,336.2350
C.C.                                N    10,708,570.9809  E      359,750.9492
Back          = S  84° 41' 12.27" E
Ahead         = S  84° 23' 36.94" E
Chord Bear    = S  84° 32' 24.60" E
```

Ending chain 375RW06 description

Alignment Data



Profile Data



Standard Detail

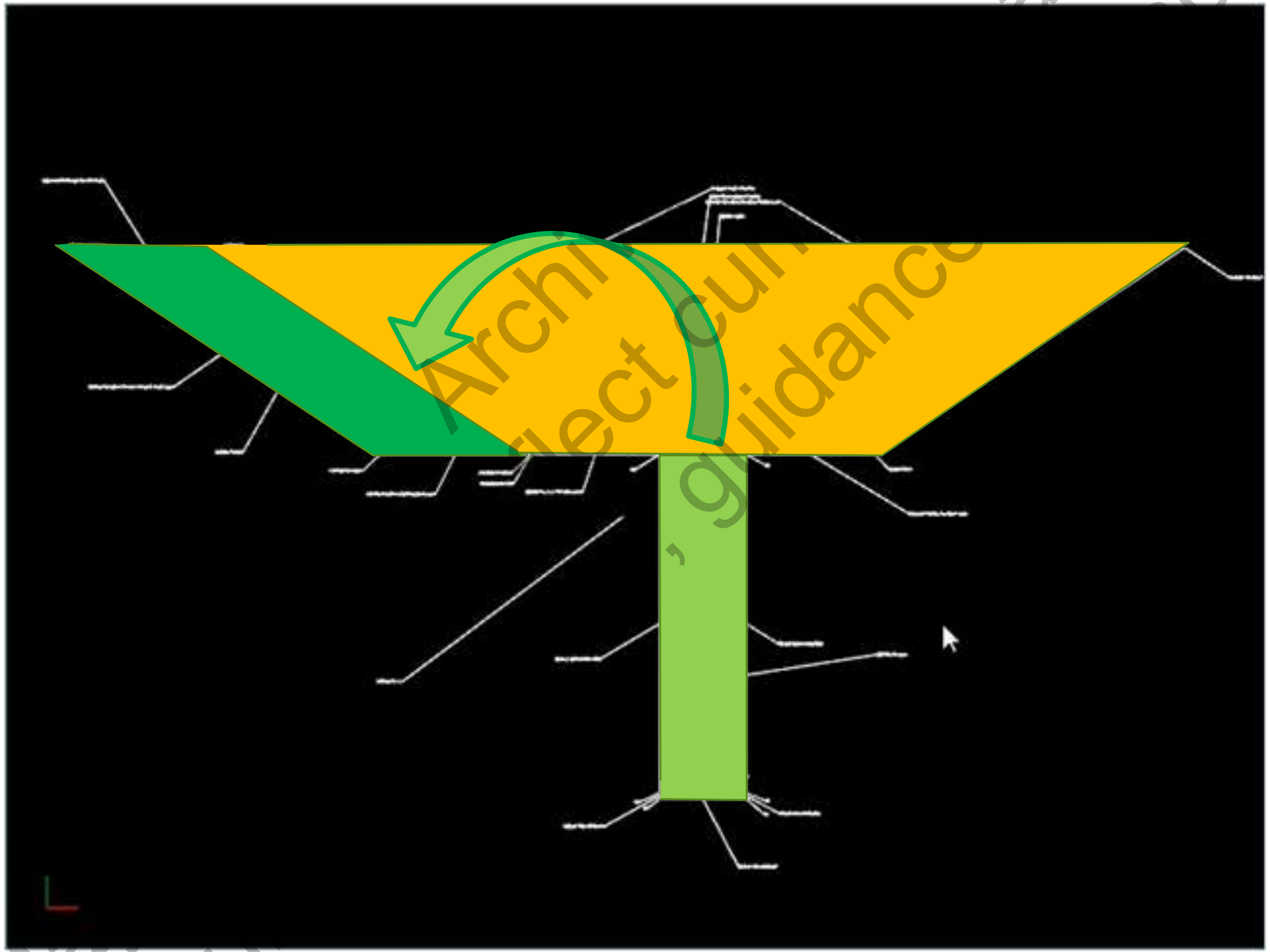
From Model

- Import Surface Data
  - LandXML, DTM, Etc…
- Import Alignment Data
  - LandXML, CSV
- Import Line Work Data
  - DGN, DWG, DXF

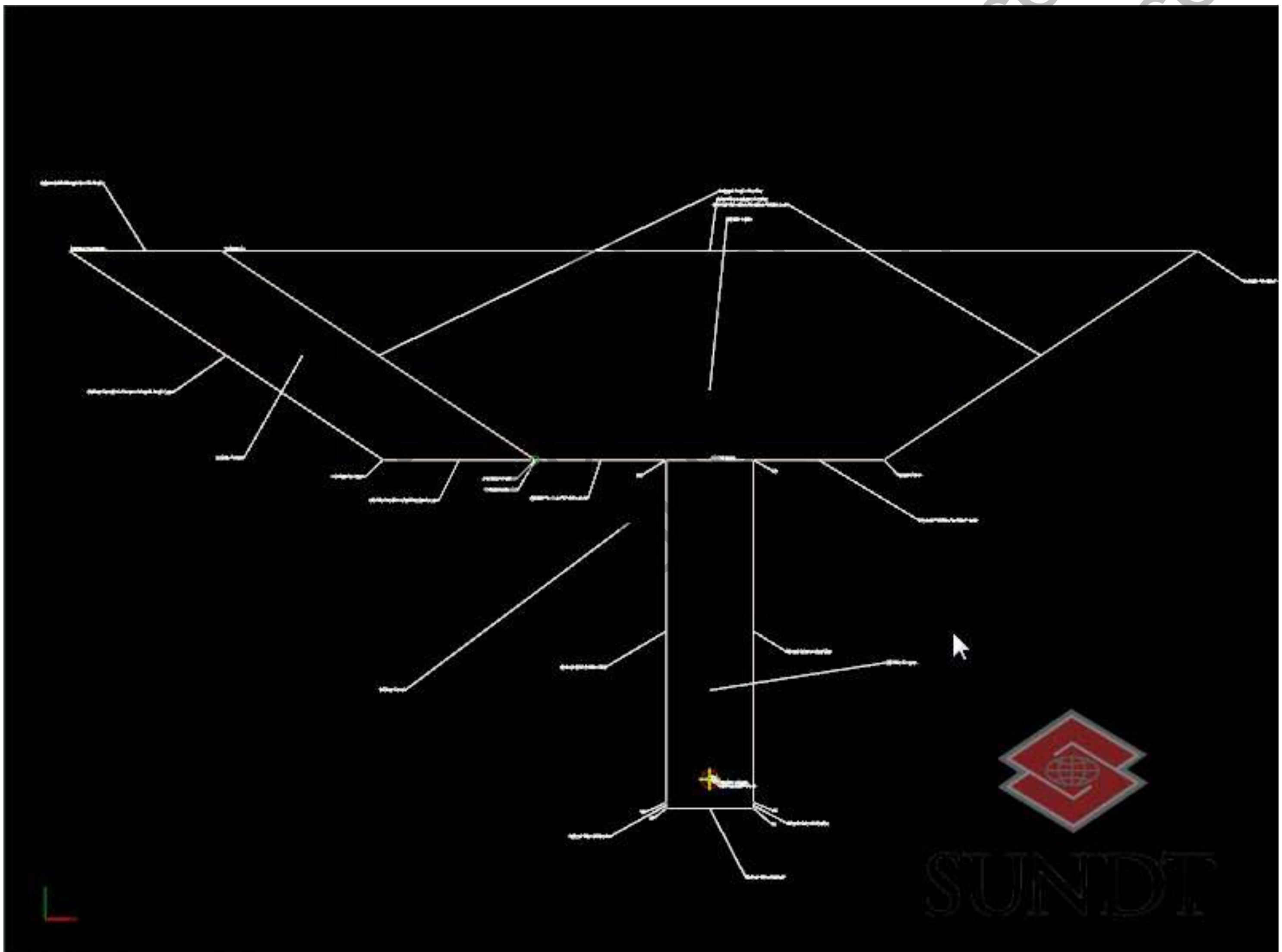
Using Models for Bidding

U.S. Department of Transportation
Federal Highway Administration

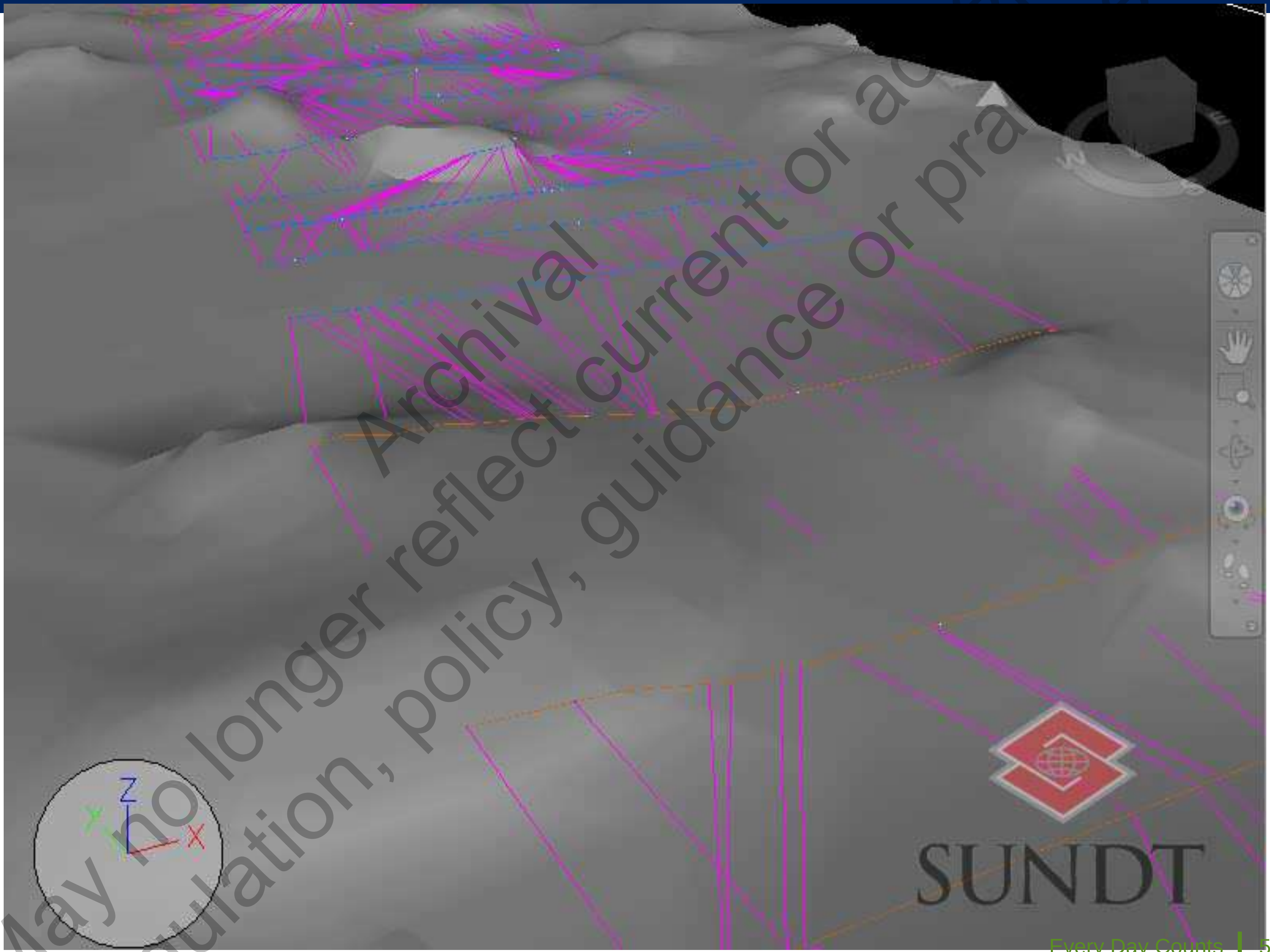
Use in Bidding – Means and Methods



Use in Bidding – Means and Methods



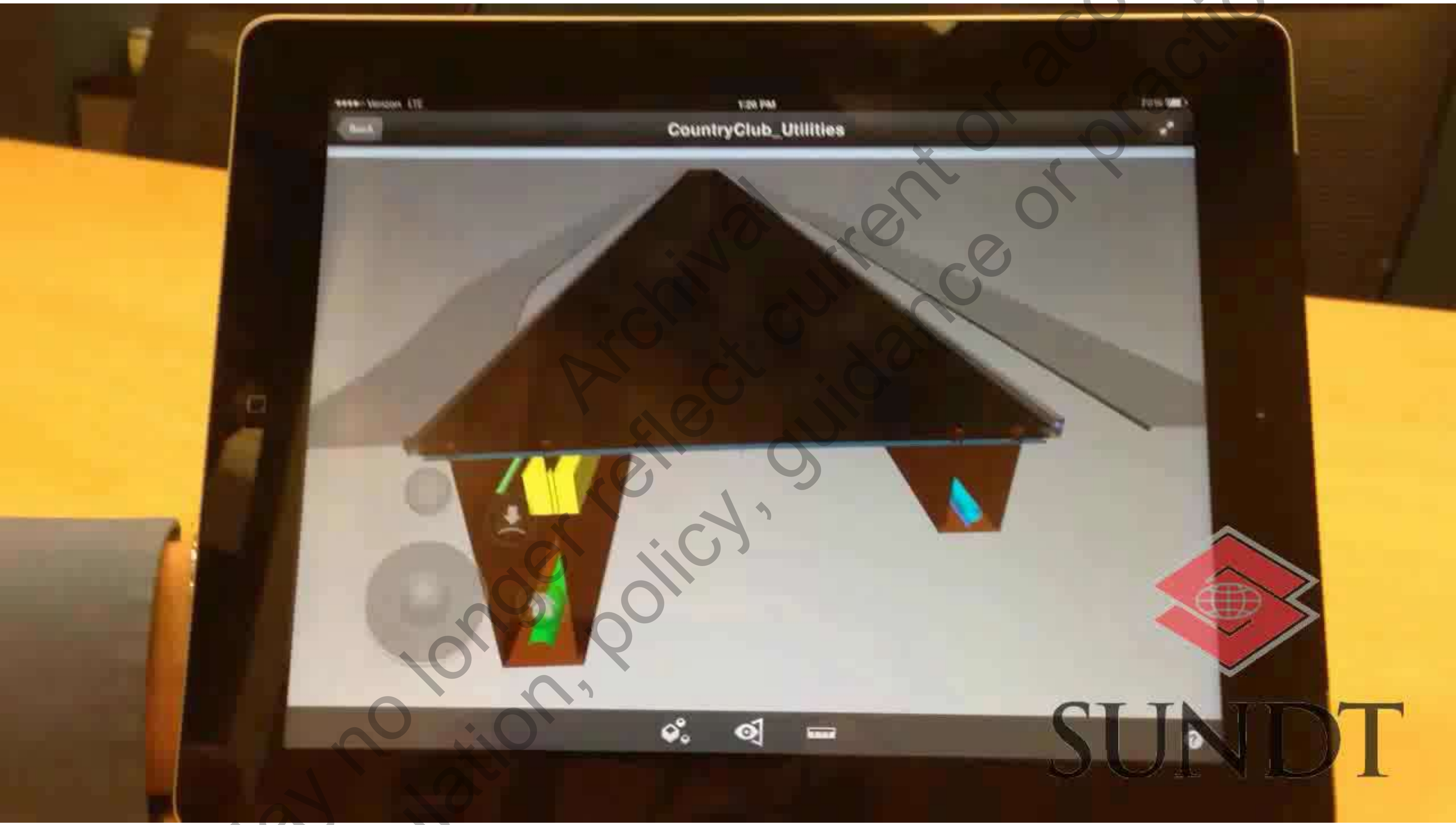
Use In Bidding – Means and Methods



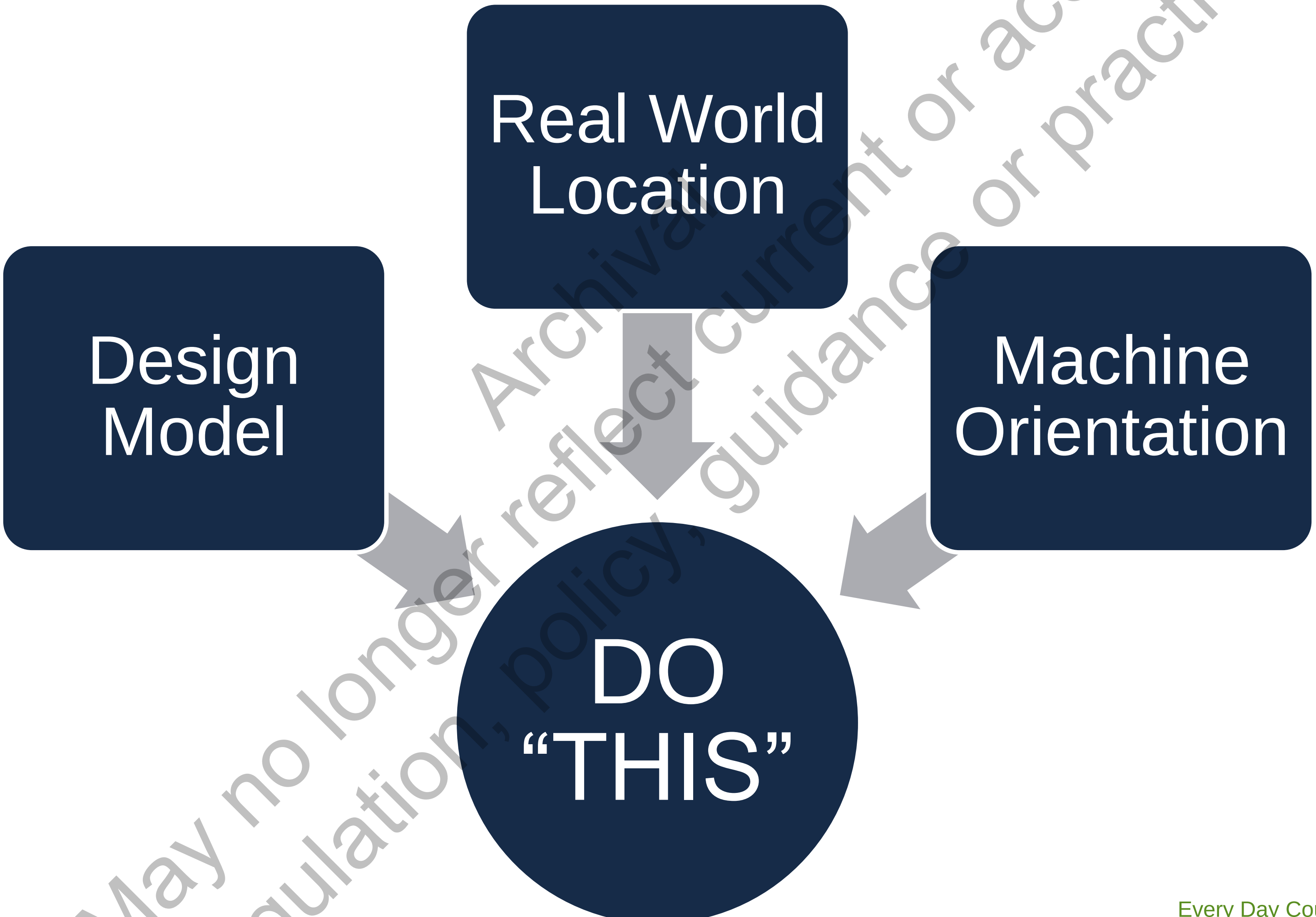
Using Models during Construction

U.S. Department of Transportation
Federal Highway Administration

Use During Construction



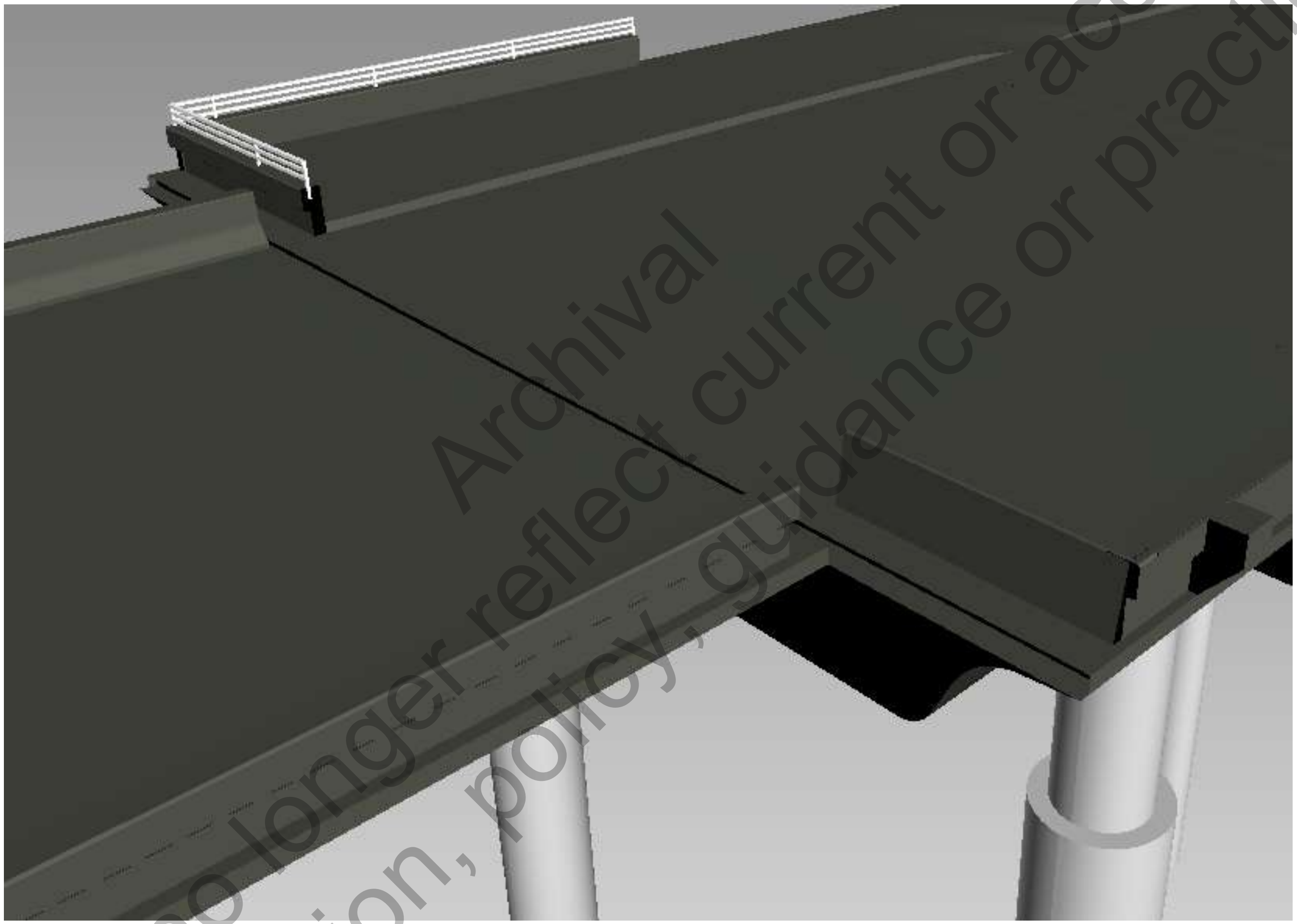
Use in Construction




SUNDT
CATERPILLAR
SUNDT

Bits to Atoms

Bits to Atoms



Bits to Atoms

Bits to Atoms

Bits to Atoms

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

3D Engineered Models for Construction Webinars

Douglas Townes, P.E.
FHWA Resource Center

Every Day Counts — innovation, ingenuity, invention, imagination

U.S. Department of Transportation
Federal Highway Administration

Webinar Topics

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

February19, 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

4. Applications of 3D Models on the Construction Site

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

5. Managing and Sharing 3D Models for Construction

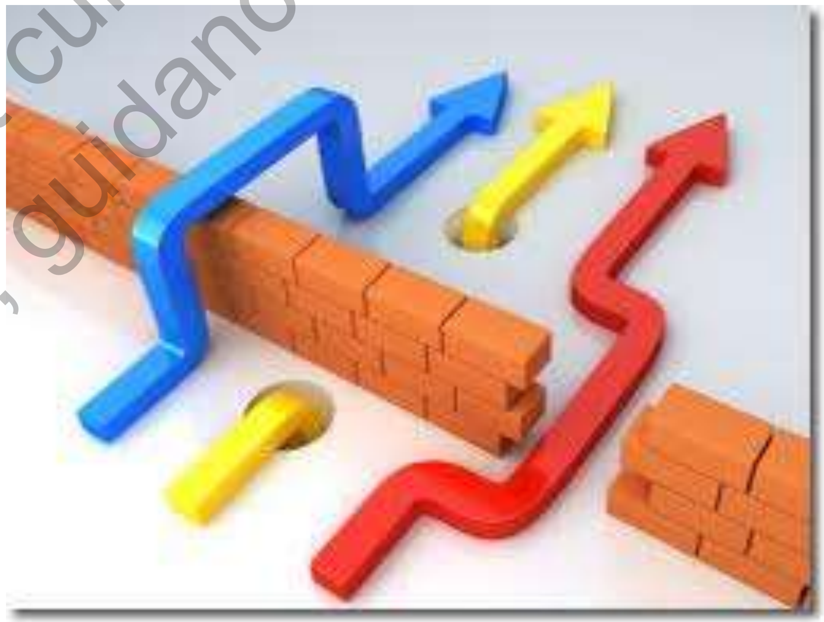
May 7, 2014, 1:00 – 2:30 pm

- 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

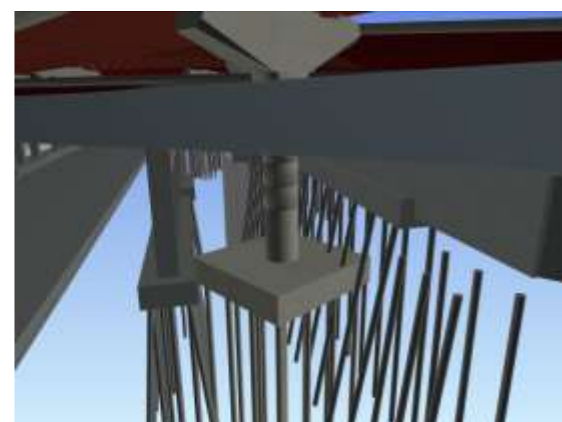
Participant Interaction

Francesca Maier, P.E.
Parsons Brinckerhoff

U.S. Department of Transportation
Federal Highway Administration

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

Webinar Series

Overview of 3D Engineered Models for Construction	Today
Creating 3D Engineered Models	January 8, 2014
Applications of 3D Models in the Construction Office	February 19, 2014
Applications of 3D Models on the Construction Site	April 2, 2014
Managing and Sharing 3D Models for Construction	May 7, 2014
Overcoming Impediments to Using 3D Engineered Models for Construction	September 10, 2014
Steps to Requiring 3D Engineered Models for Construction	October 15, 2014
The Future: Adding Time, Cost and Other Information to 3D Models	November 19, 2014

Contact: Douglas Townes, Phone 404-562-3914, douglas.townes@dot.gov
http://www.fhwa.dot.gov/everydaycounts/edctwo/2012/3d.cfm