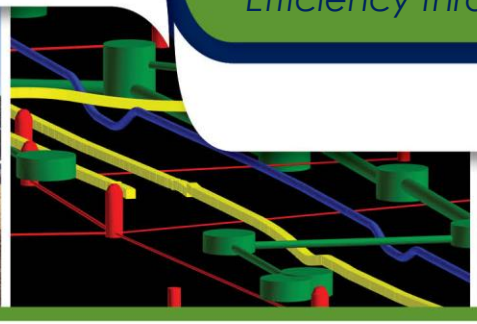
National Perspective: 3D Engineered Models Implementation & Digital Project Delivery

Efficiency through technology and collaboration



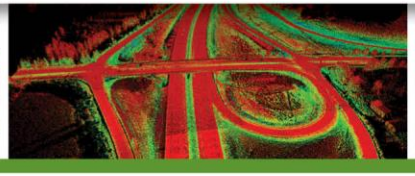


Photo credits (L to R): banner- FHWA, Parsons Brinckerhoff, NCHRP, Caltrans

Every Day Counts
innovation ingenuity invention imagination

U.S. Department of Transportation
Federal Highway Administration

Today's Presentation

- Introduction – MAP-21 & The Big Picture 'CIM'
- EDC2 '3D Engineered Models for Construction'
- EDC3 '3D Engineered Models: Schedule, Cost & Post-Construction'
- Other work to help define the future
- Resources/Contacts

Thanks to Bryan Cawley, Chris Schneider, Romeo Garcia, Katherine Petros, Richard Duval, Brian Kozy and Francesca Maier for supplying info/slides.

Key Takeaways:

- USDOT/FHWA is tasked by MAP-21 to provide national leadership with 'advanced modeling technologies'
- The U.S. Highway Industry is reaching a tipping point with digital project delivery
- Gaps still exist in project delivery implementation procedures and technology, which are rapidly being addressed
- With CIM we are moving beyond project delivery to programmatic asset management applications
- Federal funding is available to advance this type of innovation

MAP-21 – 23 USC 106 (j)
Use of Advanced Modeling Technologies

(2) **Program.—** … the Secretary shall encourage the use of advanced modeling technologies during environmental, planning, financial management, design, simulation, and construction processes of the projects.

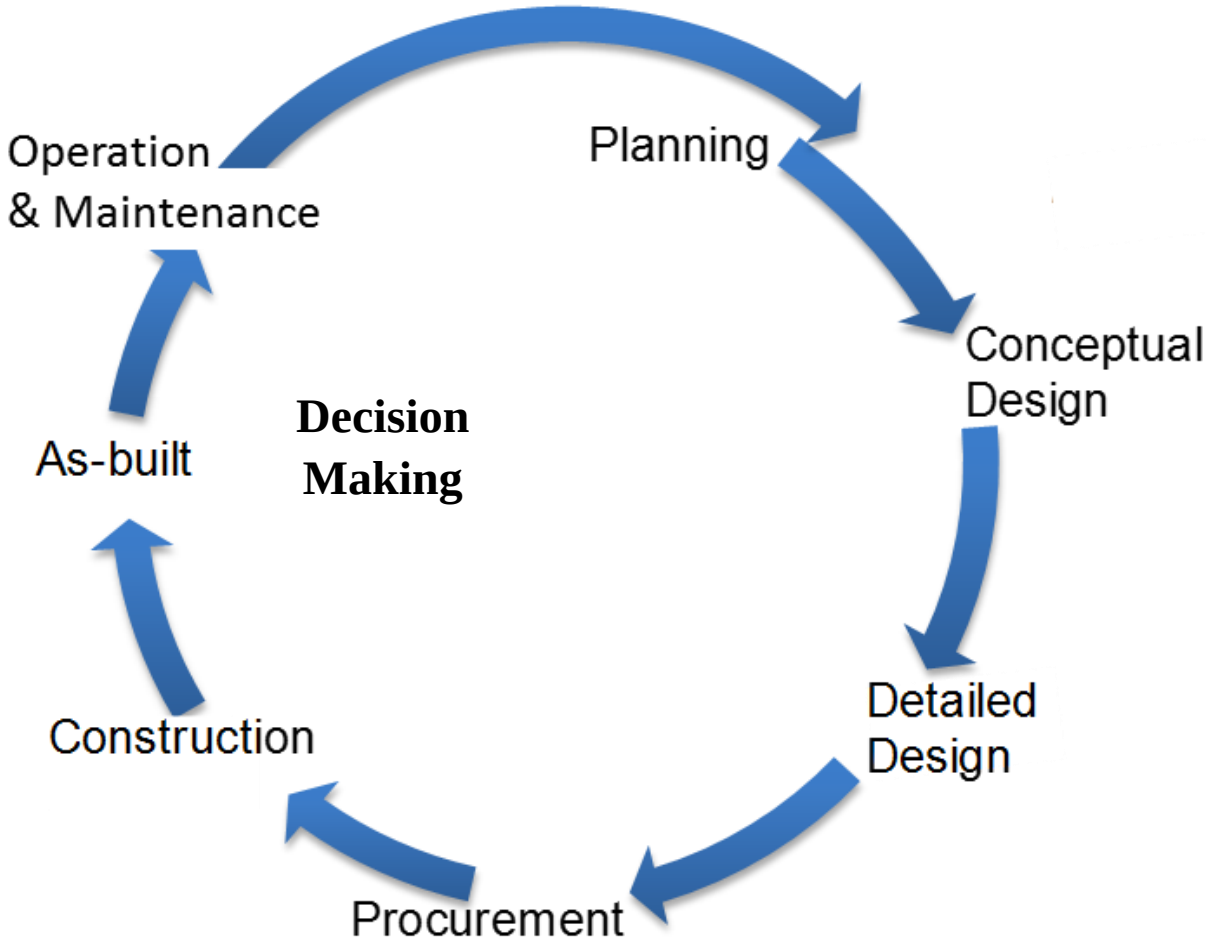
(3) **Activities. —** … the Secretary shall … compile information/best practices … disseminate … and promote use

(4) **Comprehensive plan.—** … the Secretary shall develop and publish on the public website … a detailed and comprehensive plan for the implementation of paragraph (2).

Civil Integrated Management (CIM)

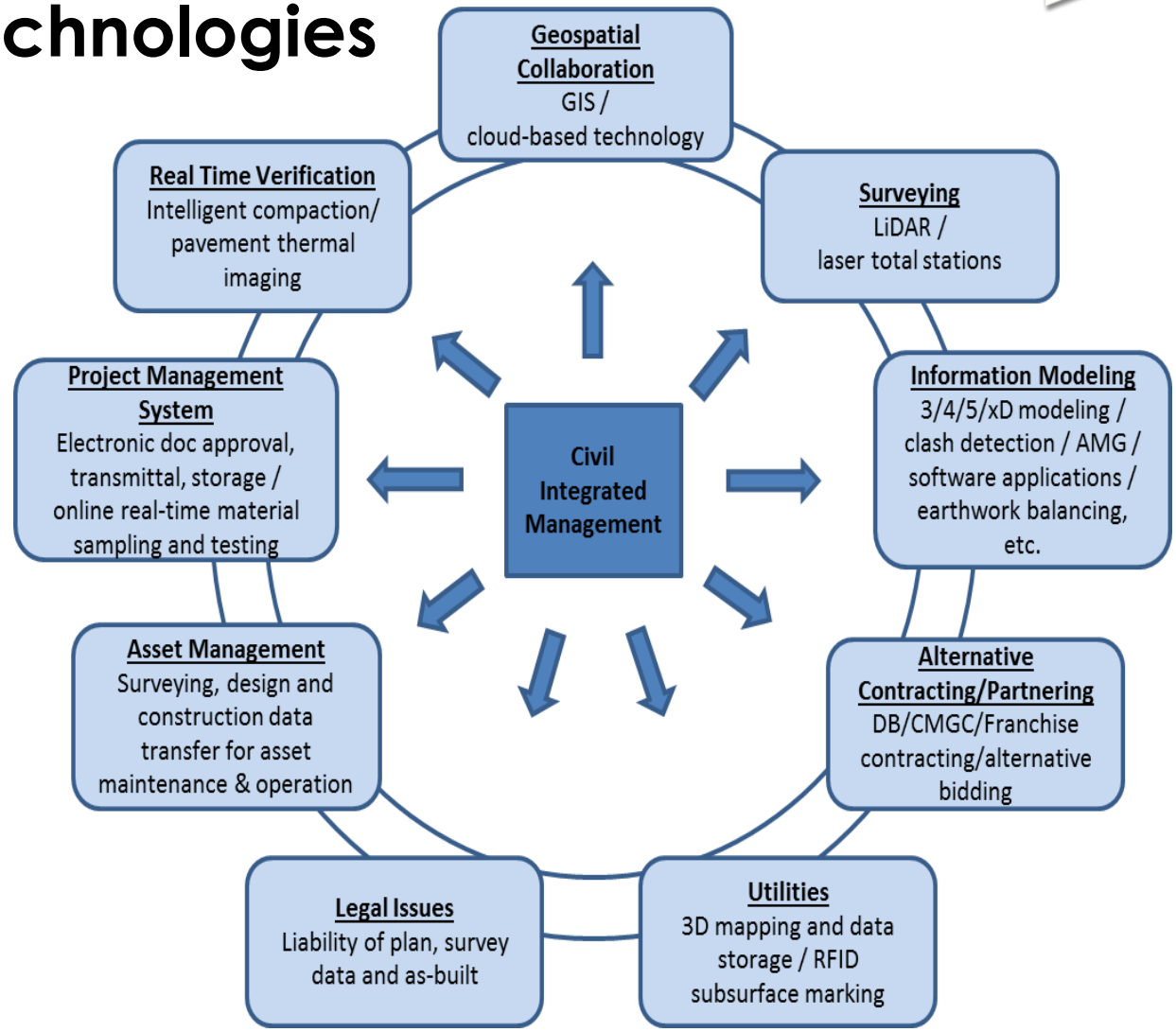
- History: BIM, BRIM, CIM[1], and now CIM[2]
- Civil Integrated Management (CIM) is the **collection, organization, managed accessibility, and the use of accurate data and information throughout the life cycle of a transportation asset**.
- The concept may be used by all affected parties for a wide range of purposes, including planning, environmental assessment, surveying, construction, maintenance, asset management, and risk assessment.

CIM and the Circle of Life



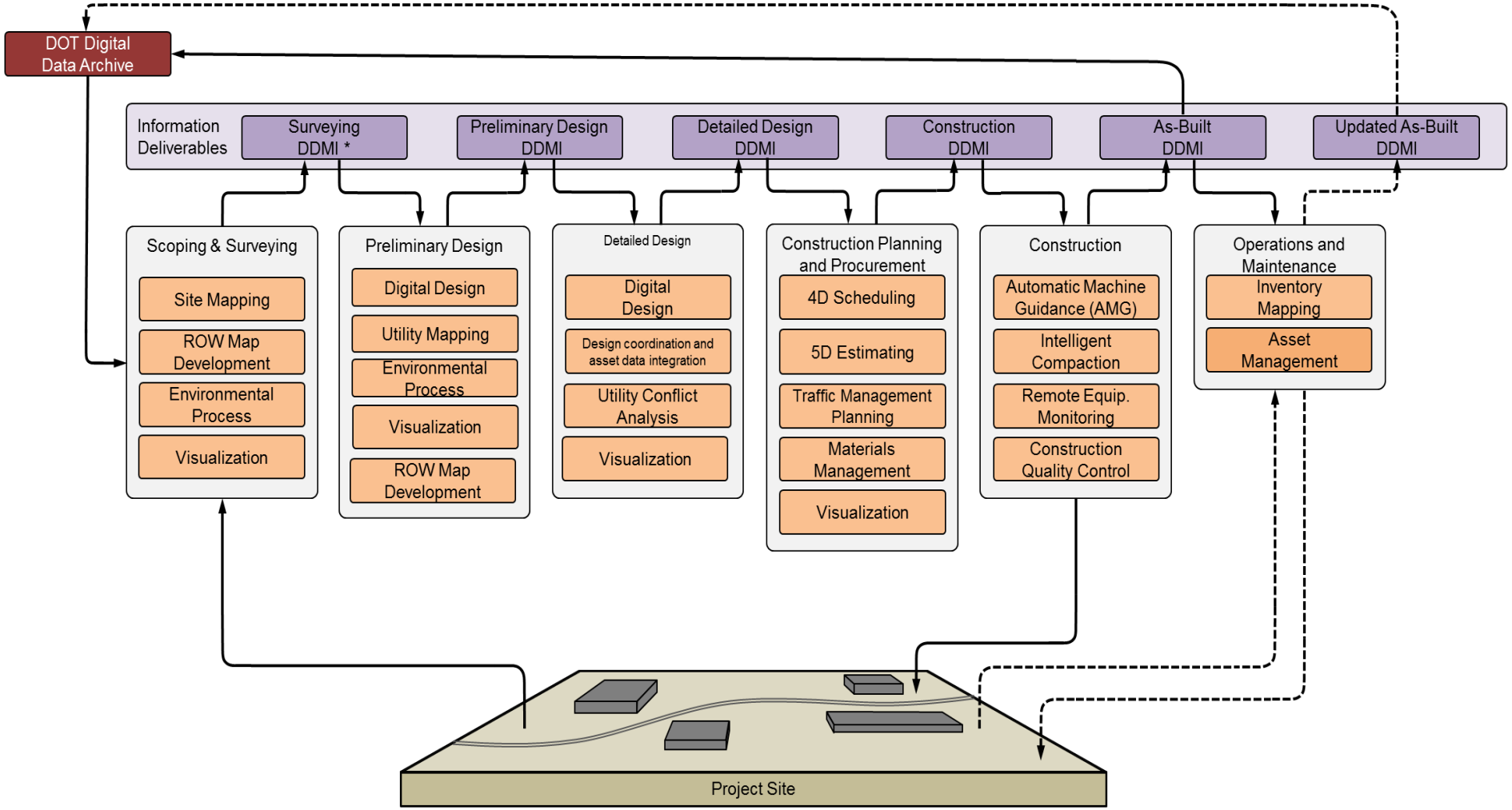
Source: Domestic Scan: Scan 13-02 or NCHRP 20-68A

CIM and Technologies



Source: Domestic Scan: Scan 13-02 or NCHRP 20-68A

CIM and the Data



* DDMI = Document-, Data- and Model-based Information

Project Information Management

Asset Information Management

Source: NCHRP 10-96

Summary of EDC-2 3D Modeling Effort

Survey

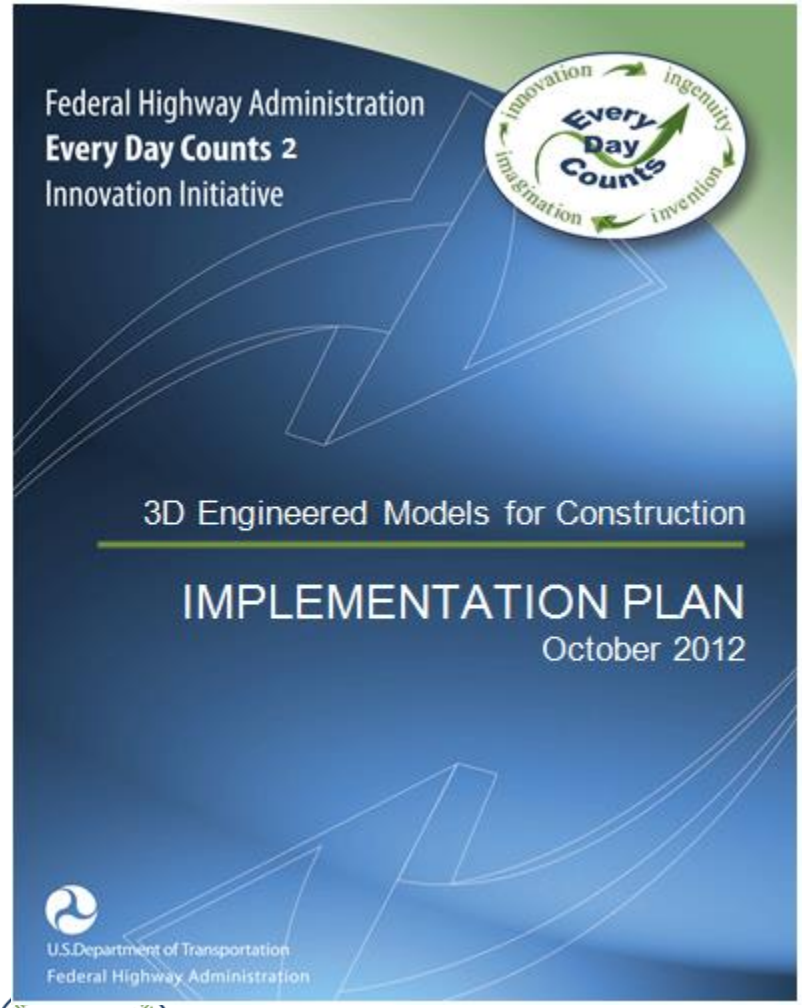
Project Phases

Planning

Design

Construction

EDC2 – 3D Implementation

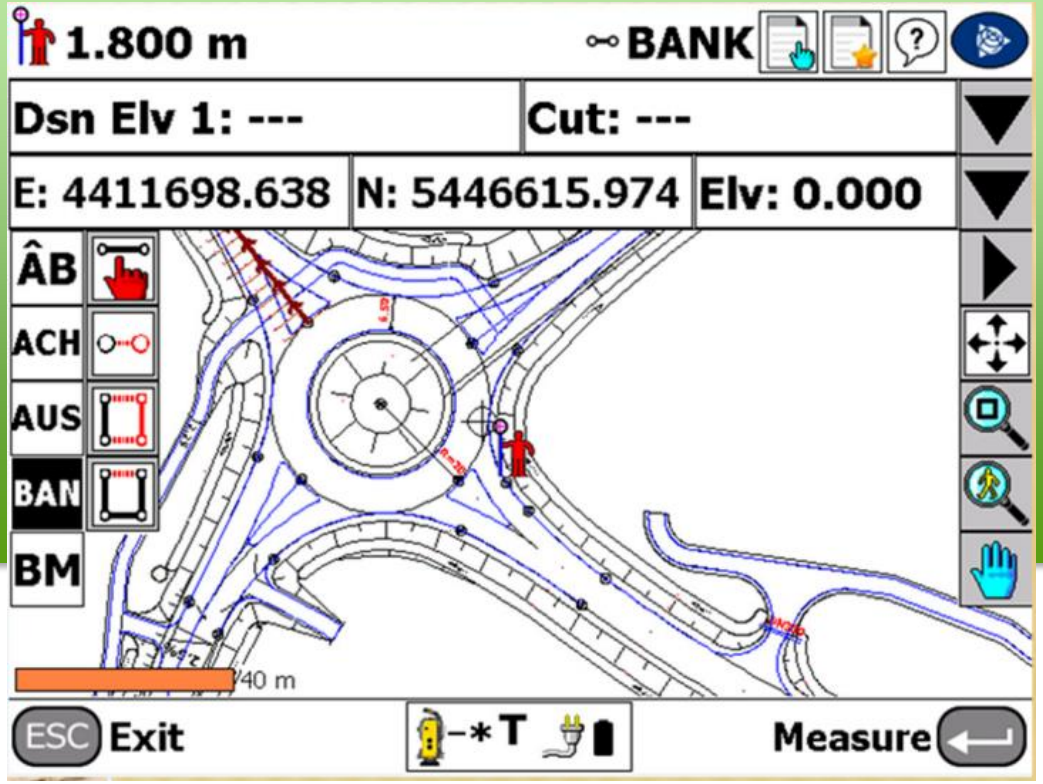


- **FHWA VISION:**
Mainstream the use of the 3D model so construction projects are delivered faster, more efficiently, accurately, and safely.

- **MISSION STATEMENT:**
Promote technology transfer and project implementation of the 3D model for benefit to users such as **more accurate earthwork computations, clash detection, string-less paving and milling, automated machine guidance, and automated machine control.**

Using the Model in the Field: Layout

Source: Iowa State University

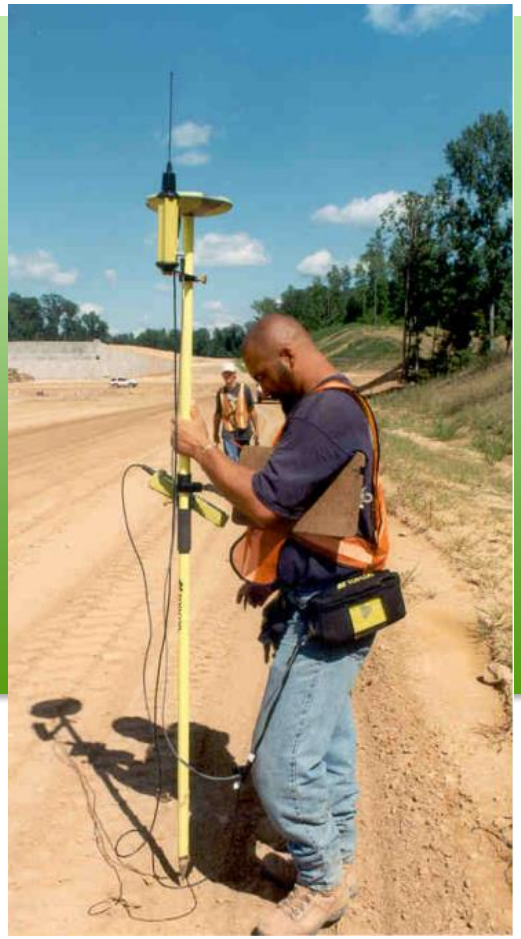


Using the Model in the Field: AMG

Source: FHWA

Using the Model in the Field: Quality Assurance

Source: North Carolina DOT



Other Functions 3D Models Support

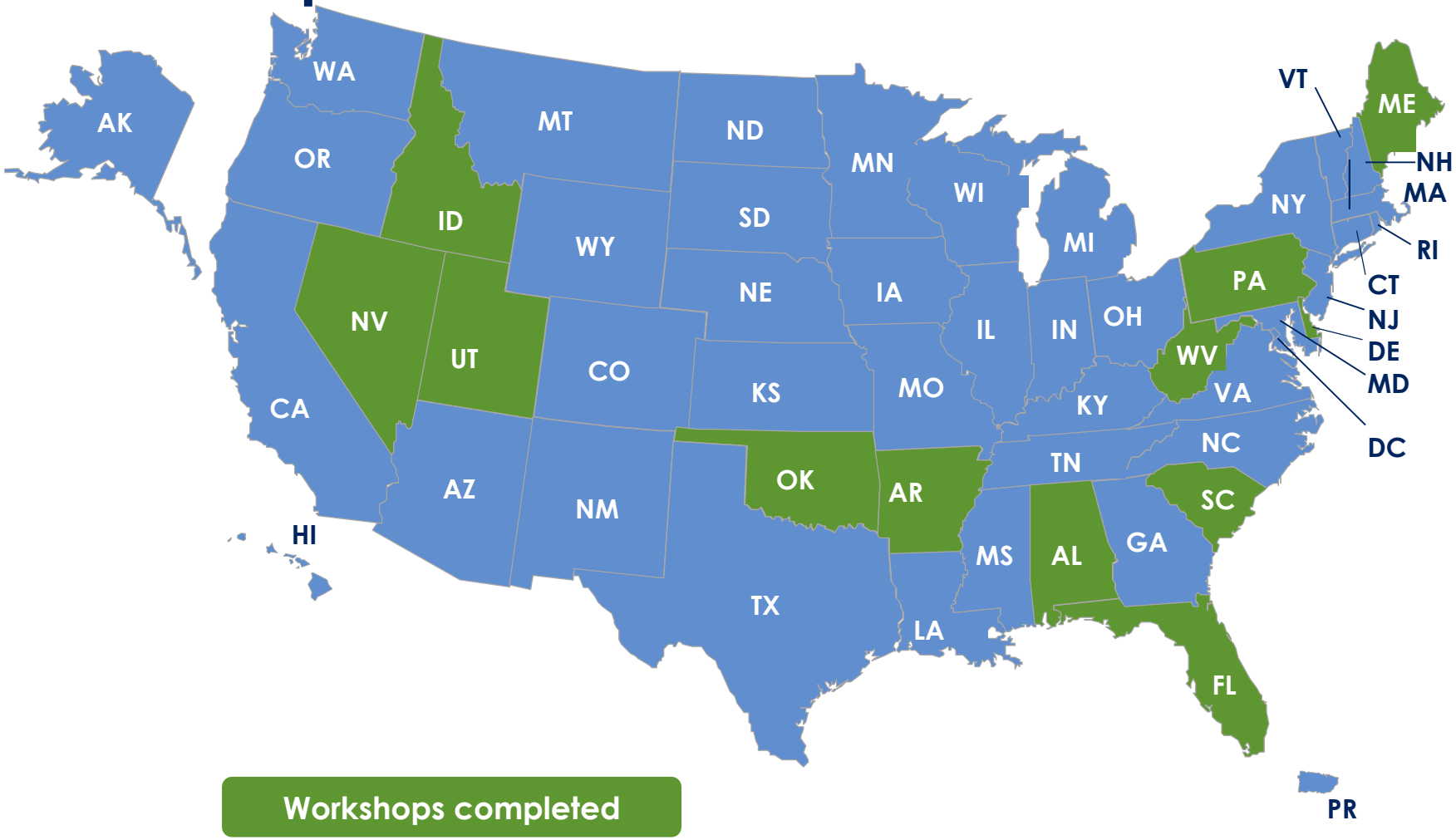
- Public outreach / marketing for projects
- Utilities – coordination and early issue identification
- Clash detection
- Quantity computations

EDC2 - 3D Engineered Models for Construction Webinars

1. *Overview of 3D Engineered Models for Construction.*
2. *Creating 3D Engineered Models.*
3. *Applications of 3D Models in the Construction Office.*
4. *Applications of 3D Models on the Construction Site.*
5. *Managing and Sharing 3D Models for Construction.*
6. *Overcoming Impediments to Using 3D Engineered Models for Construction.*
7. *Steps to Requiring 3D Engineered Models for Construction.*
8. **The Future Adding Time, Cost, and Other Information to 3D Models**

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

3D Workshops

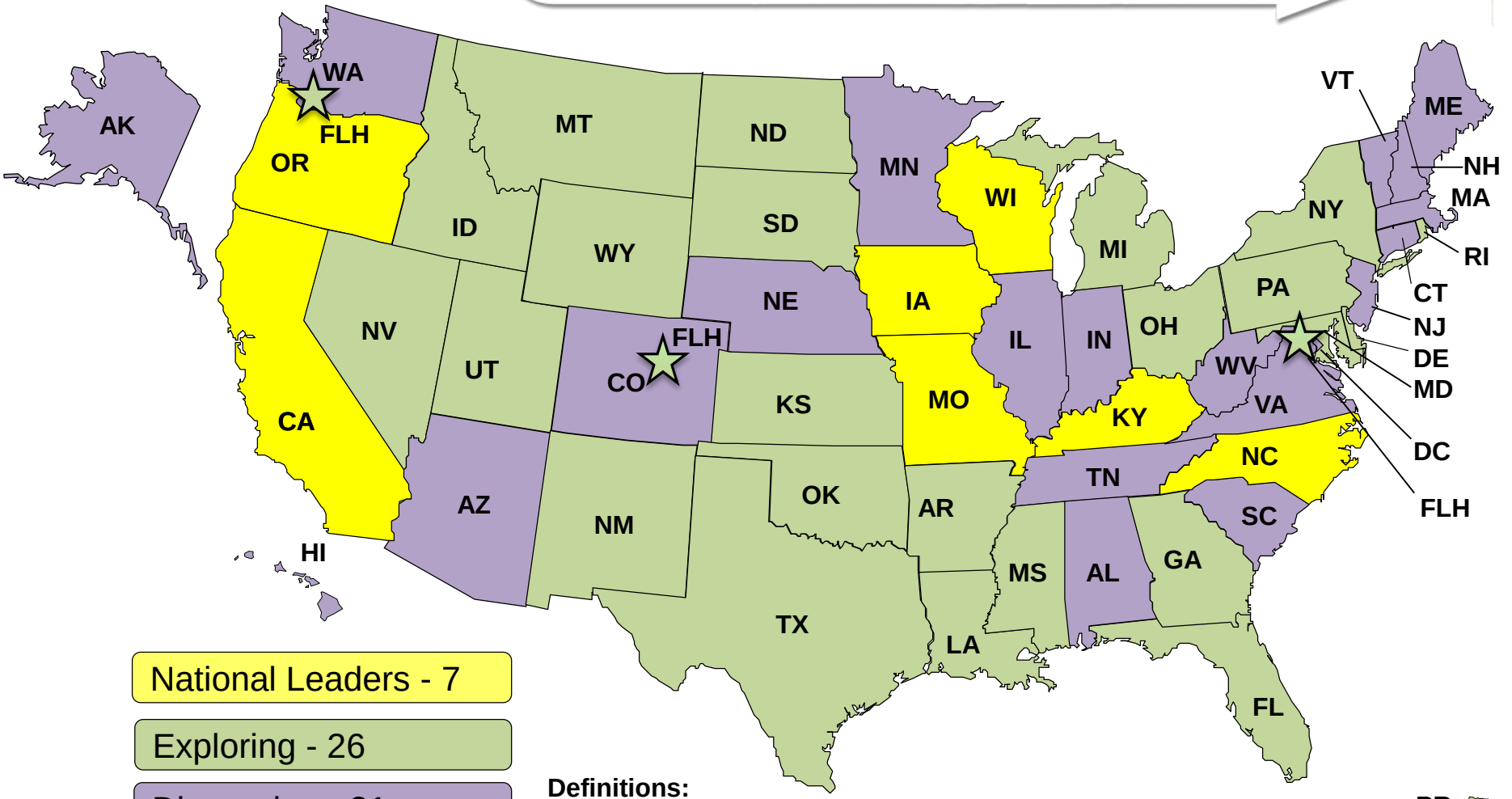


David Unkefer: 404-562-3669, or David.Unkefer@dot.gov

3D Engineered Models

for Construction

EDC-2 Deployment



National Leaders - 7

Exploring - 26

Discussing - 21

Definitions:

National Leader – Has constructed 2 or more projects using 3D technology

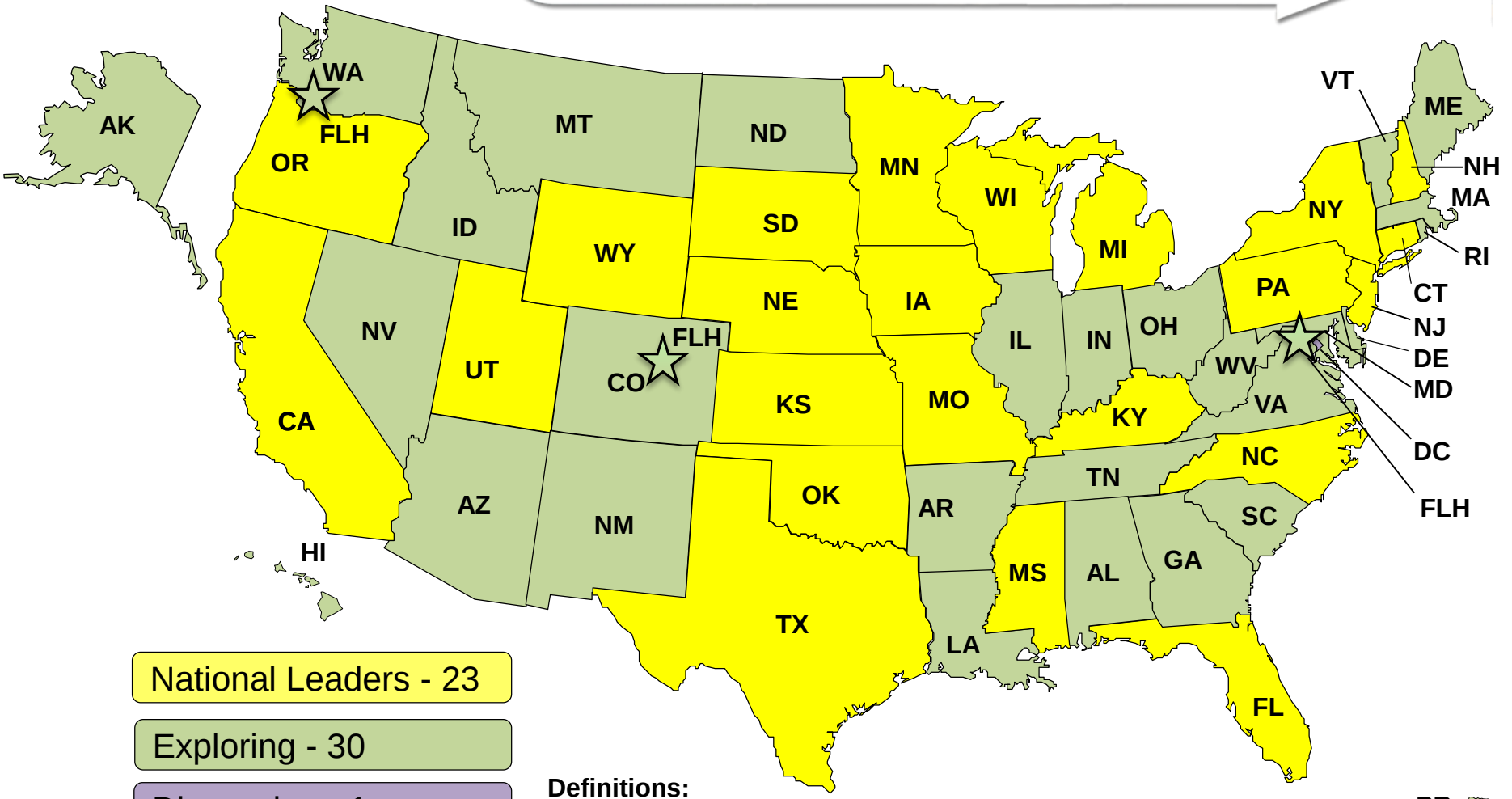
Exploring – Investigating and/or piloting 3D technology

Discussing – Not taking part in national EDC technology initiative

January 1, 2013

3D Engineered Models
for Construction

EDC-2 Deployment



National Leaders - 23

Exploring - 30

Discussing - 1

Definitions:
National Leader – Has constructed 2 or more projects using 3D technology
Exploring – Investigating and/or piloting 3D technology
Discussing – Not taking part in national EDC technology initiative

December 31, 2014

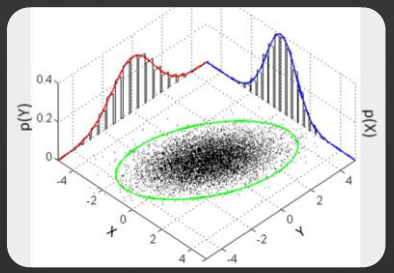
Widespread Successful Practices

- Collection of existing conditions using LiDAR
- Development/use of 3D models as norm in design
- Provision of 3D models to contractors post award
- Contractors development and use of 3D models – AMG and beyond

Gaps in Implementation

- **Overall implementation planning/change management**
- **Training –** Designers and Inspectors
- **Survey** - Pre-design survey standards that consider downstream/lifecycle needs and accuracy requirements
- **Design** - More effective model development and uses during planning and design. Clarifying design model deliverables. Model QA.
- **Bidding/Contracting** - Effective data exchange with contractors during bidding – 'hand-off package'. Digital sign and seal of 3D models and use of the model as the contract document. Clarifying legal liabilities in providing model data to contractor.
- **Construction** - Development of good construction specifications. Owners ability to perform construction QA. Contractors provision of as-built data, especially for utilities.

Implementation Phases



Forming

Storming

Norming

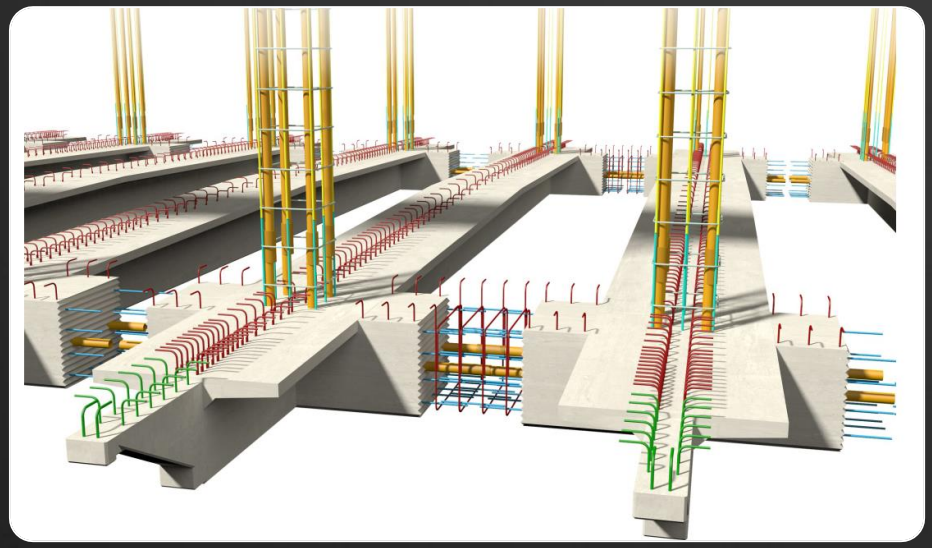
Performing

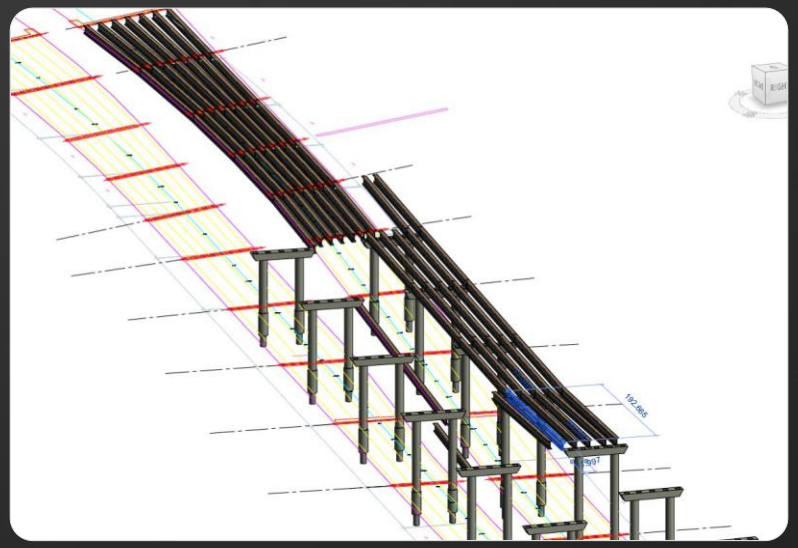
Tuckman's stages of group development

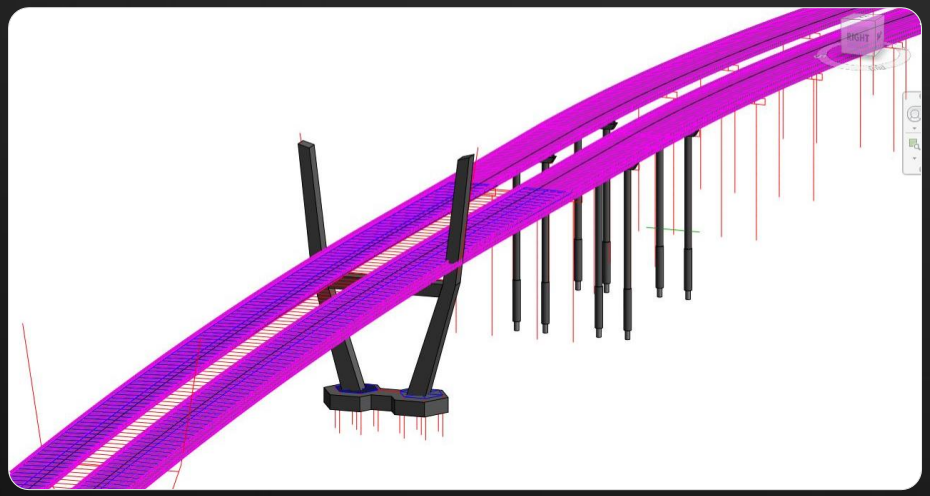
Areas where the Industry is still Forming

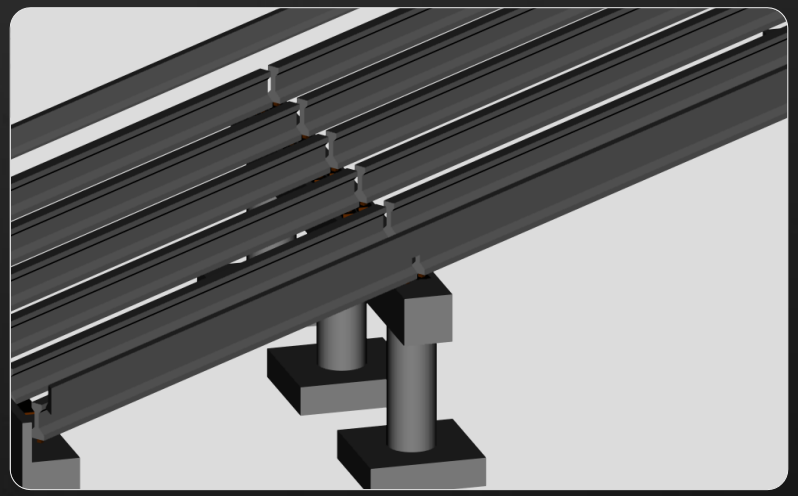
- 4D and 5D Models (construction simulations)
- Post-construction use of design and construction data
- 3D models for bridges

Forming: 3D Models for Bridges







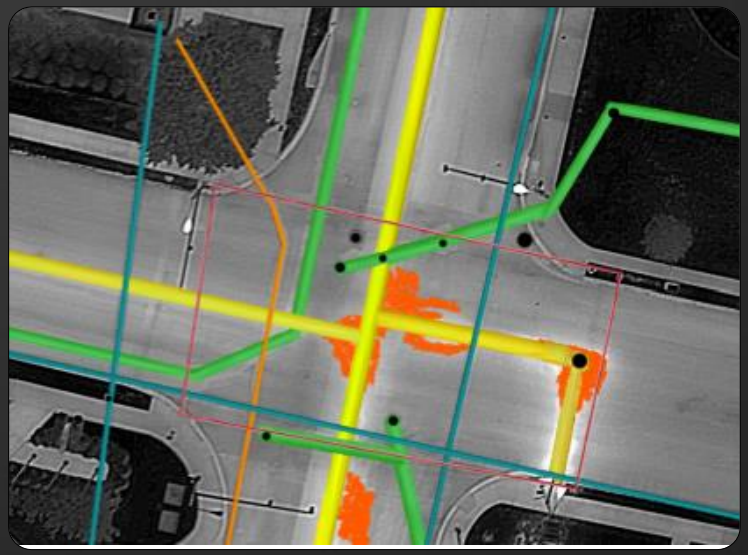


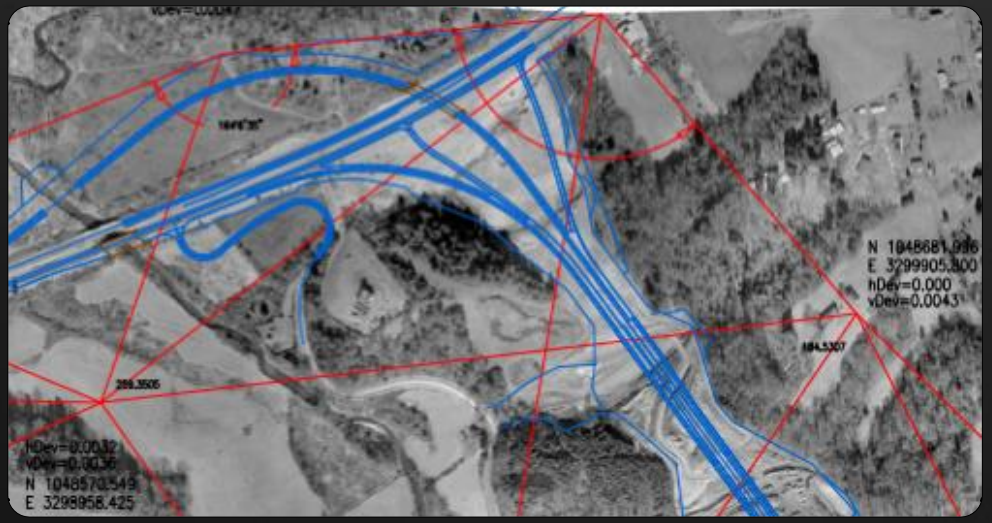
TRB TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

Areas where the Industry is still Storming

- Pre-design survey standards
- 3D model Reviews
- 3D models as Contract Documents
- Use of 3D models in owner's quality assurance

Storming: Pre-design Survey Standards





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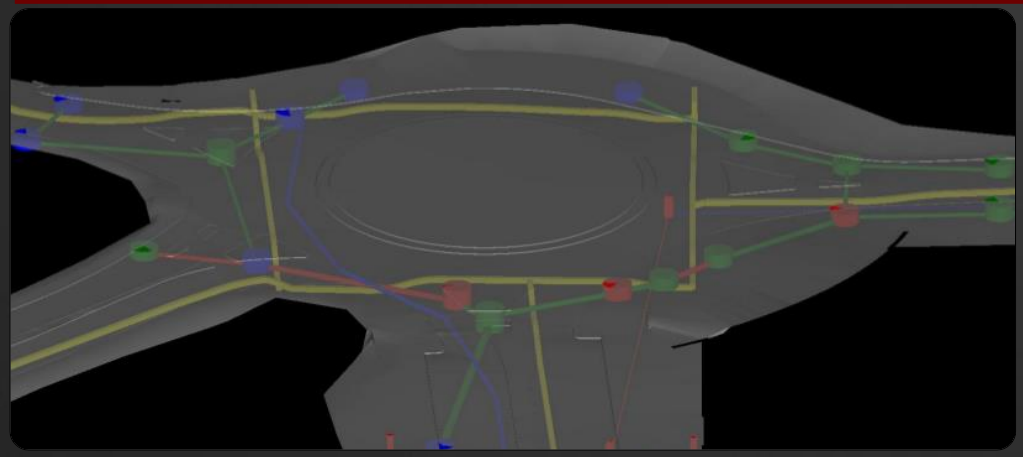
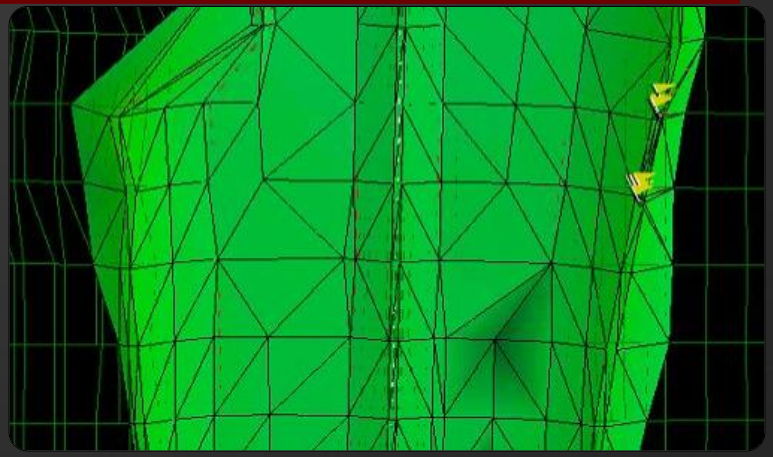
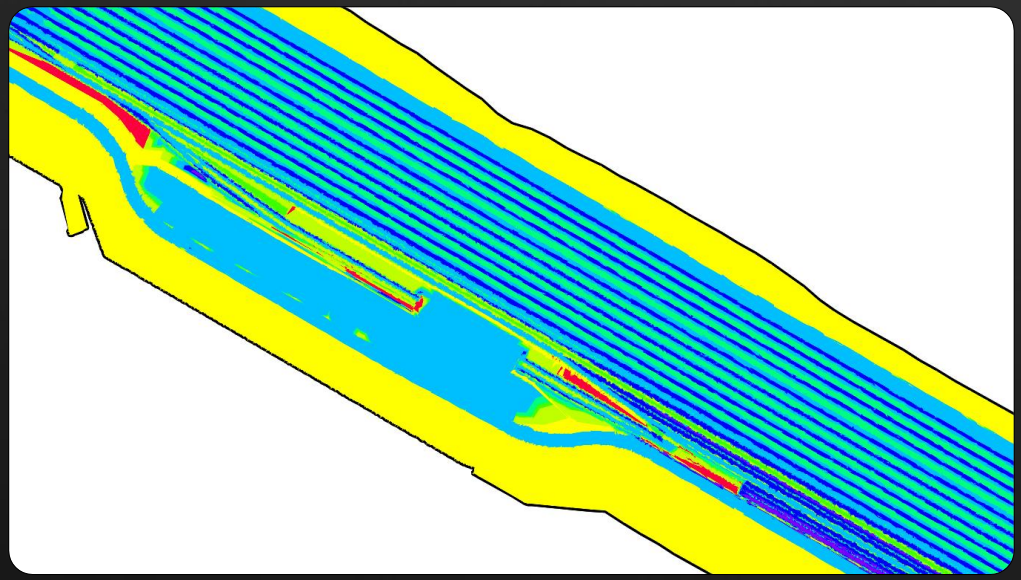
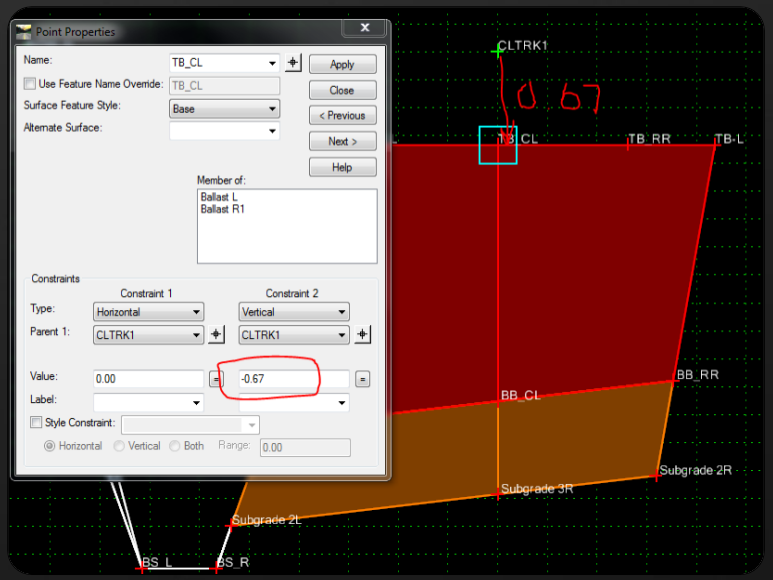
Storming: 3D Model Reviews









Is it correct? How accurate is it? What can it be used for?

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Storming: 3D Models as Contract Documents

March 2013

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Legal Research Digest 58

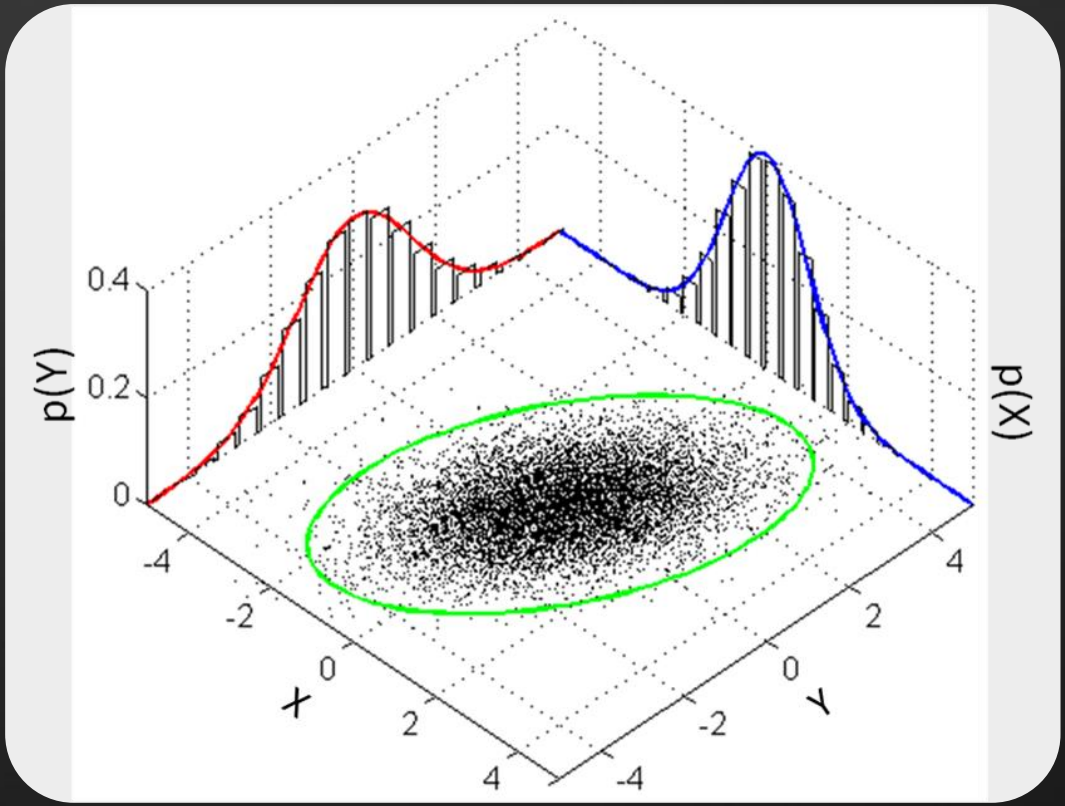
LEGAL ISSUES SURROUNDING THE USE OF DIGITAL INTELLECTUAL PROPERTY ON DESIGN AND CONSTRUCTION PROJECTS

http://www.trb.org/Publications/Blurbs/168710.aspx

- Ownership of models, including joint ownership
- Creation of derivative models
- Freedom of Information Act implications
- Usage agreements
- Challenge of signing & sealing models

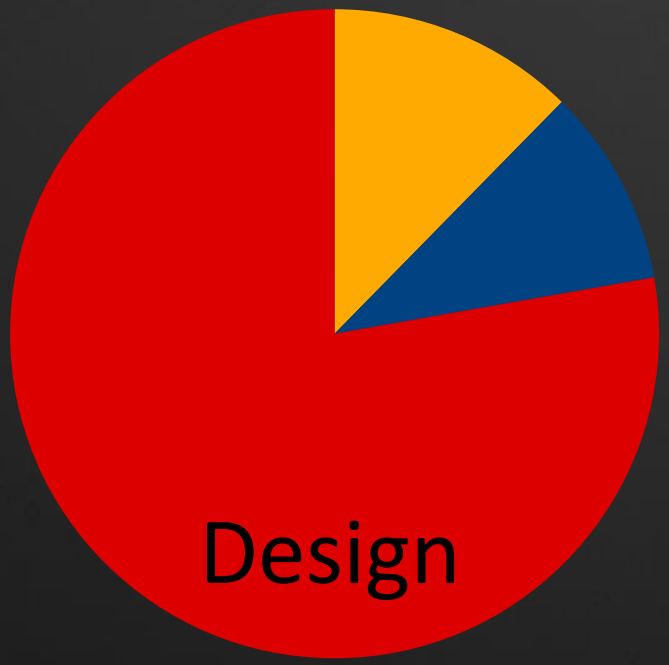
Areas where the Industry is now Norming

- Understanding of how 3D modeling affects cost
- Formats and timing for data transfer
- Use of disclaimers
- Adoption of Specifications to manage AMG



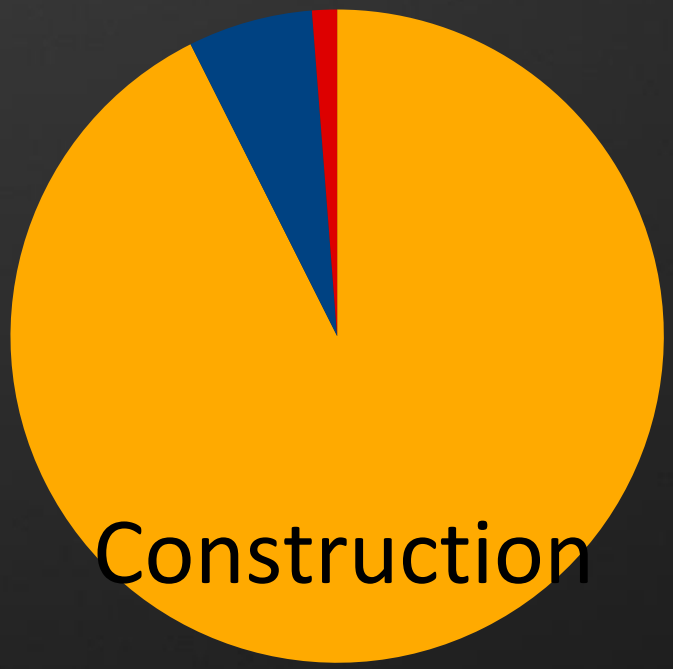
Norming: Understanding of cost impacts

How does 3D modeling affect the cost of…



- Reduces
- Stays the same
- Increases

EDC-2 Webinar 10/15/14 multiple choice, 81 unique responses



- Reduces
- Stays the same
- Increases

EDC-2 Webinar 10/15/14 multiple choice, 81 unique responses

Norming: Timing & Format of Data Transfer

Currently, the Department provides the successful bidder on projects certain files such as CADD (InRoads or MicroStation), Hydrology and Hydraulics (H&H) Environmental, Geotechnical, Permitting, Bridge and Utility files **after** the Award process. The Risk Allocation Committee discussed this and we agreed to share these files with potential bidders during the project Advertisement time period. The intent of providing these files earlier is to allow bidders to submit a more accurate, comprehensive and competitive bid to the Department based on detailed design information. This philosophy will be reflected in Publication 51, Contracts Proposal Preparation Guide.

3) Make LandXML translations of the following data sets when practical and relevant as determined by the ADE-Design:

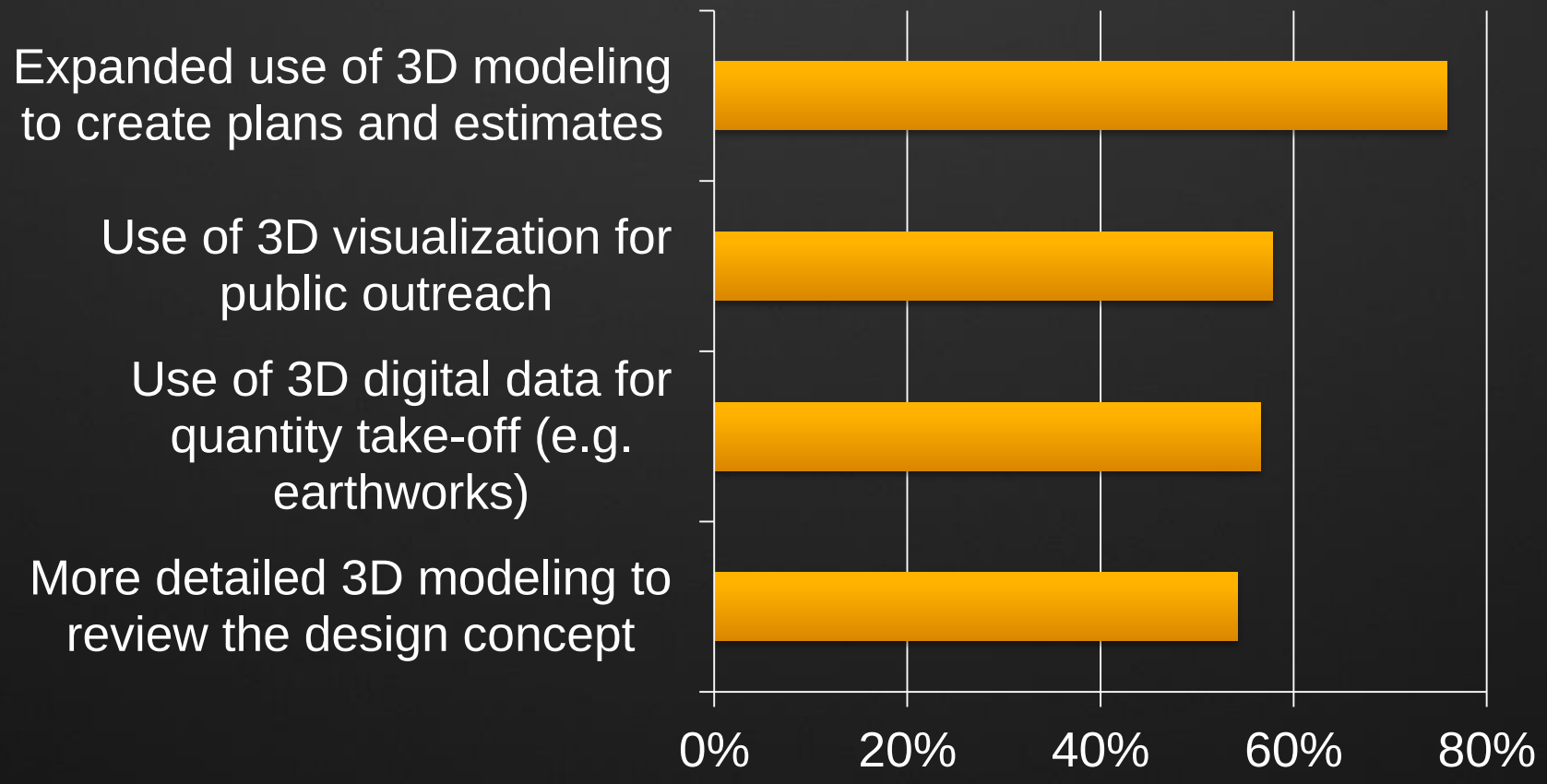
   a. **Existing or surveyed surface** - the surface as it exists prior to construction or a construction stage when a project is multi-staged.
   b. **Final project geometry -** the horizontal and vertical alignment data for each design corridor or cross section set represented in the final design. Temporary road(s) geometry for staged construction should be saved in separate LandXML data files.
   c. **Final design surface** - the proposed design surface complete in all its parts. It may be contained in a single merged surface or in several component surfaces. The final design surface must be checked for accuracy before translation to LandXML.

Samples from Pennsylvania DOT Strike-Off Letters issued in 2013

Many other DOTs have implemented or are implementing similar policies.

Norming: Pre-construction Uses of 3D Models

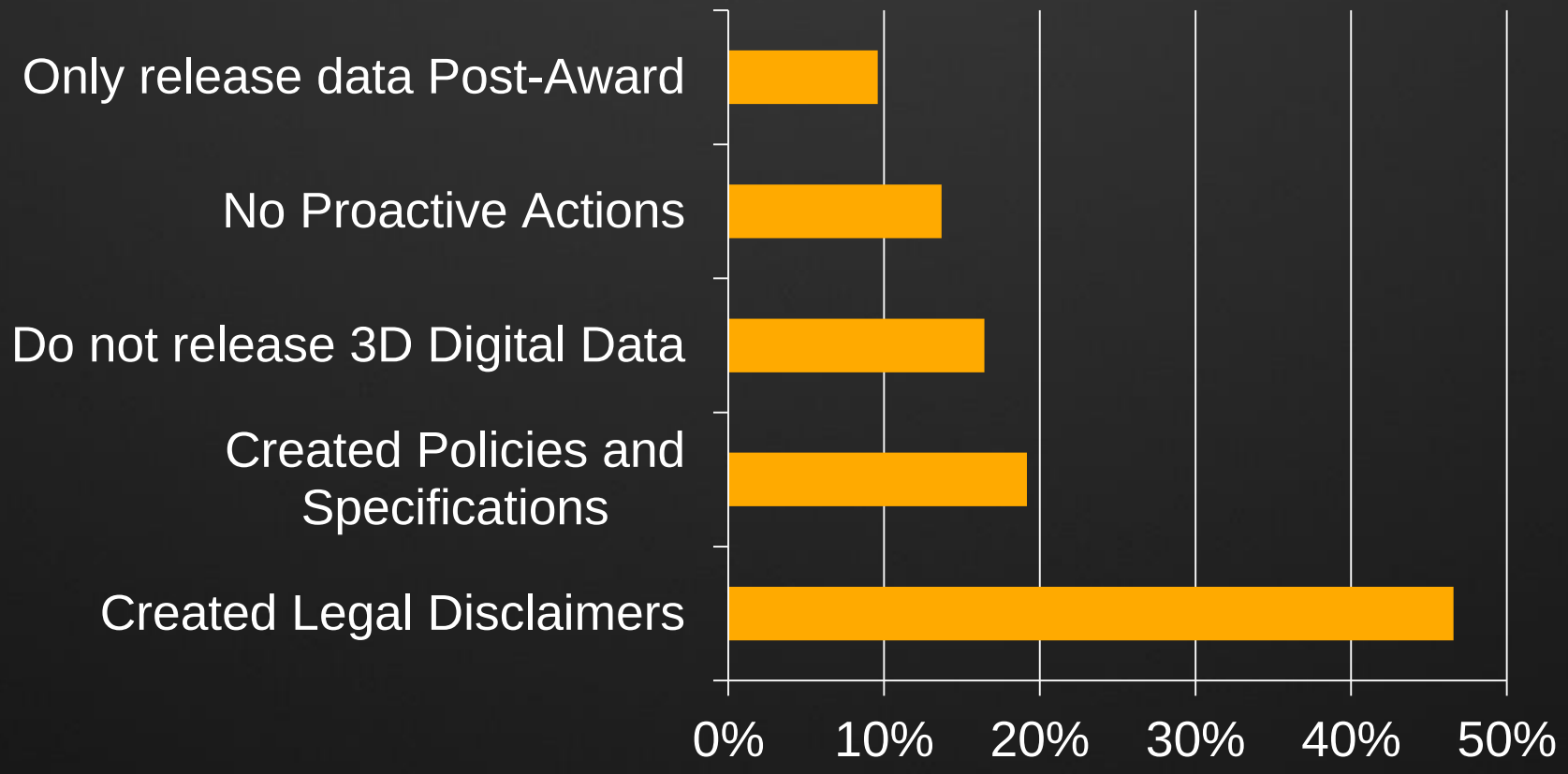
Which capabilities are you pursuing to implement 3D Engineered Models for Construction?



EDC-2 Webinar 9/10/14 Multi-answer, 83 unique respondents

Norming: Use of Disclaimers

What has your organization done to manage risks associated with releasing 3D digital data for Construction?

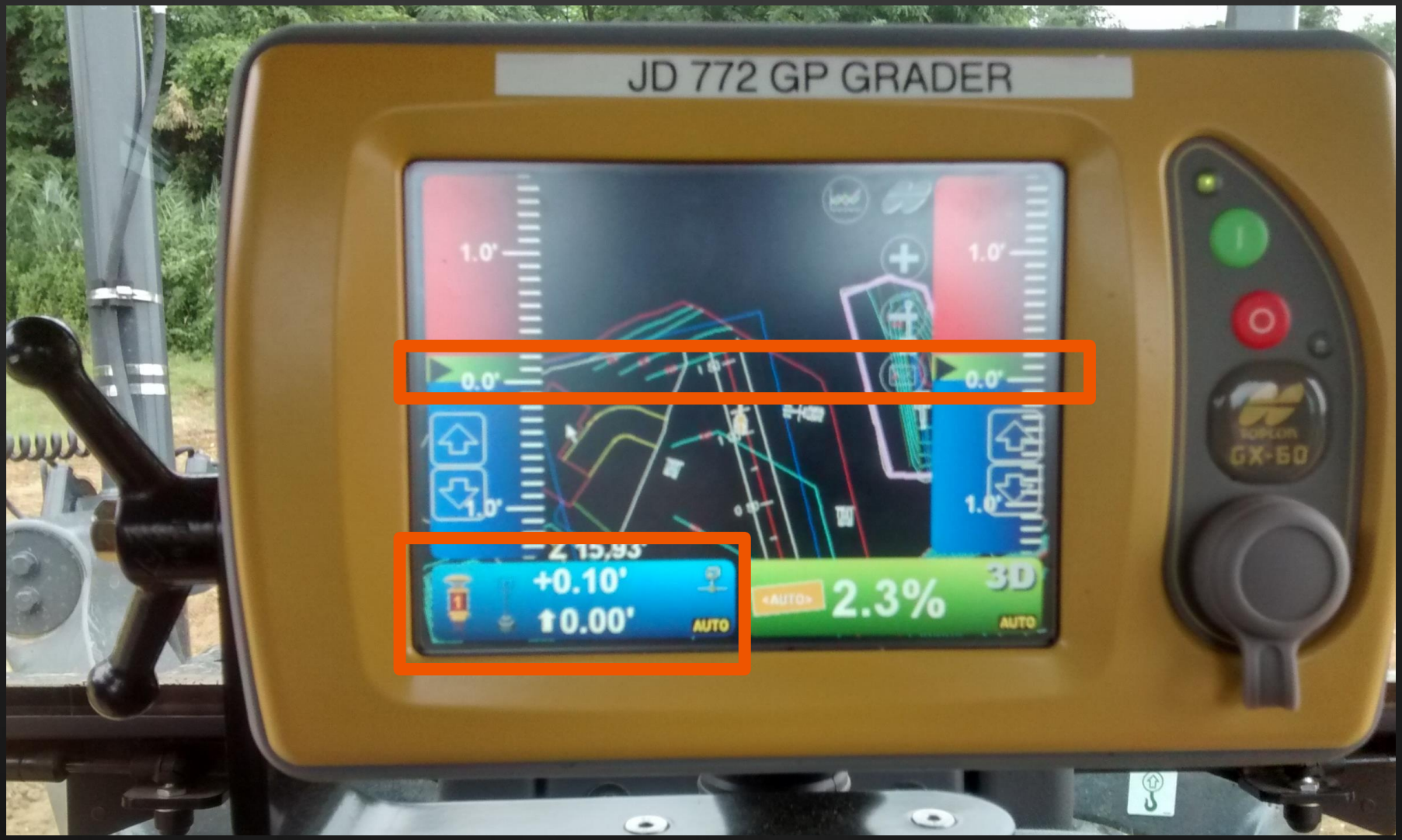


EDC-2 Webinar 10/15/14 Multi-answer, 73 unique respondents

Areas where the Industry is Performing

- Use of 3D digital data in design
- Use of 3D data in construction at the project level
- Contractors' use of 3D data

Performing: Contractors' Use of 3D Models



Summary of EDC-3 3D Technologies

… for digital project delivery

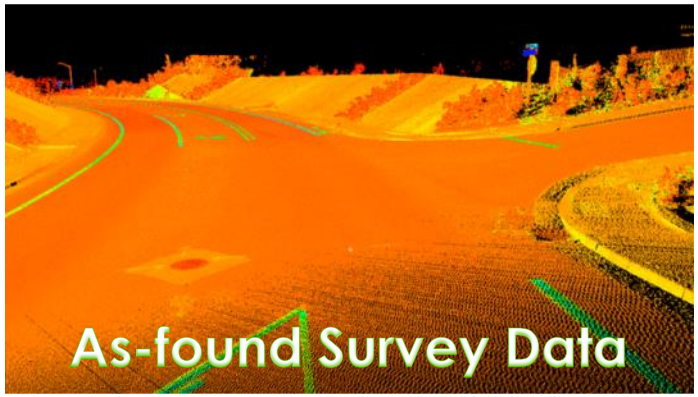
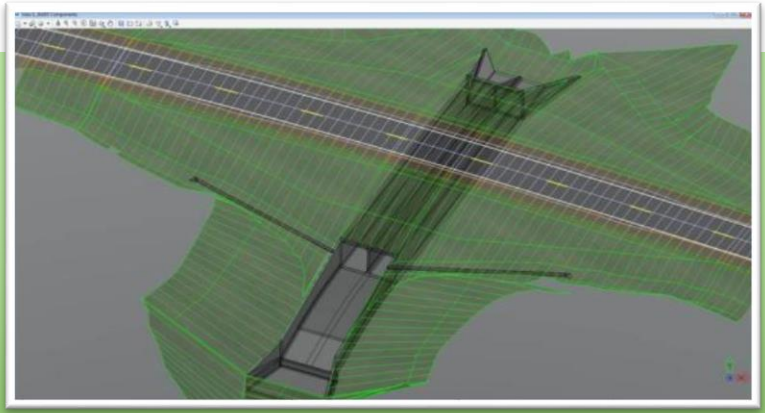


Image Sources: Walsh, Caltrans, FHWA

4D and 5D Modeling



Task Name	Duration	Start
Project	**19.47 days**	**5/6/2011**
Start	0 day	5/6/2011
Task A	4 days	5/6/2011
Task B	5.3 days	5/6/2011
Task C	5.15 days	5/12/2011
Task D	6.32 days	5/12/2011
Task E	5.15 days	5/19/2011
Task F	4.5 days	5/20/2011
Task G	5.15 days	5/26/2011
Finish	0 day	6/2/2011

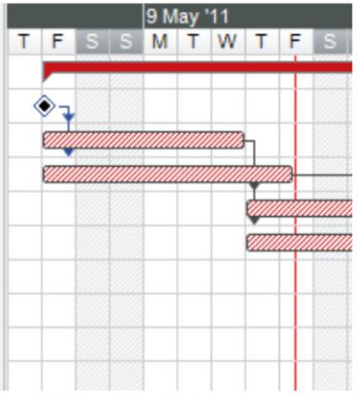
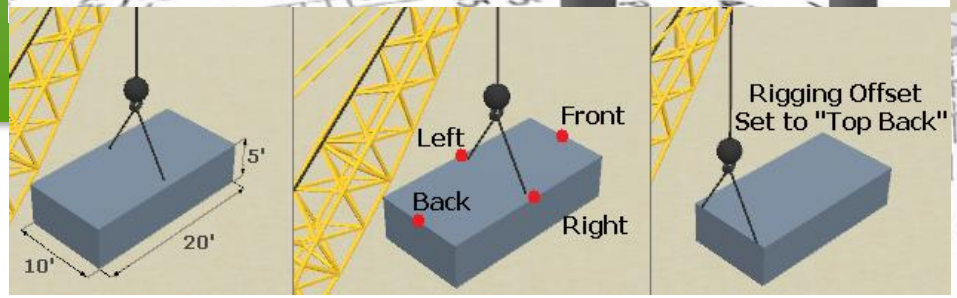
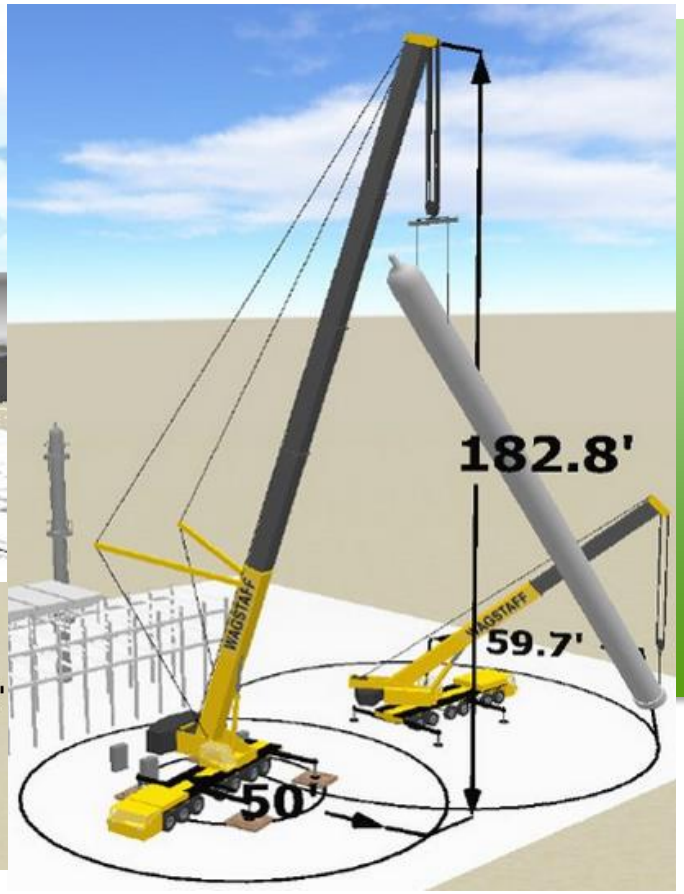


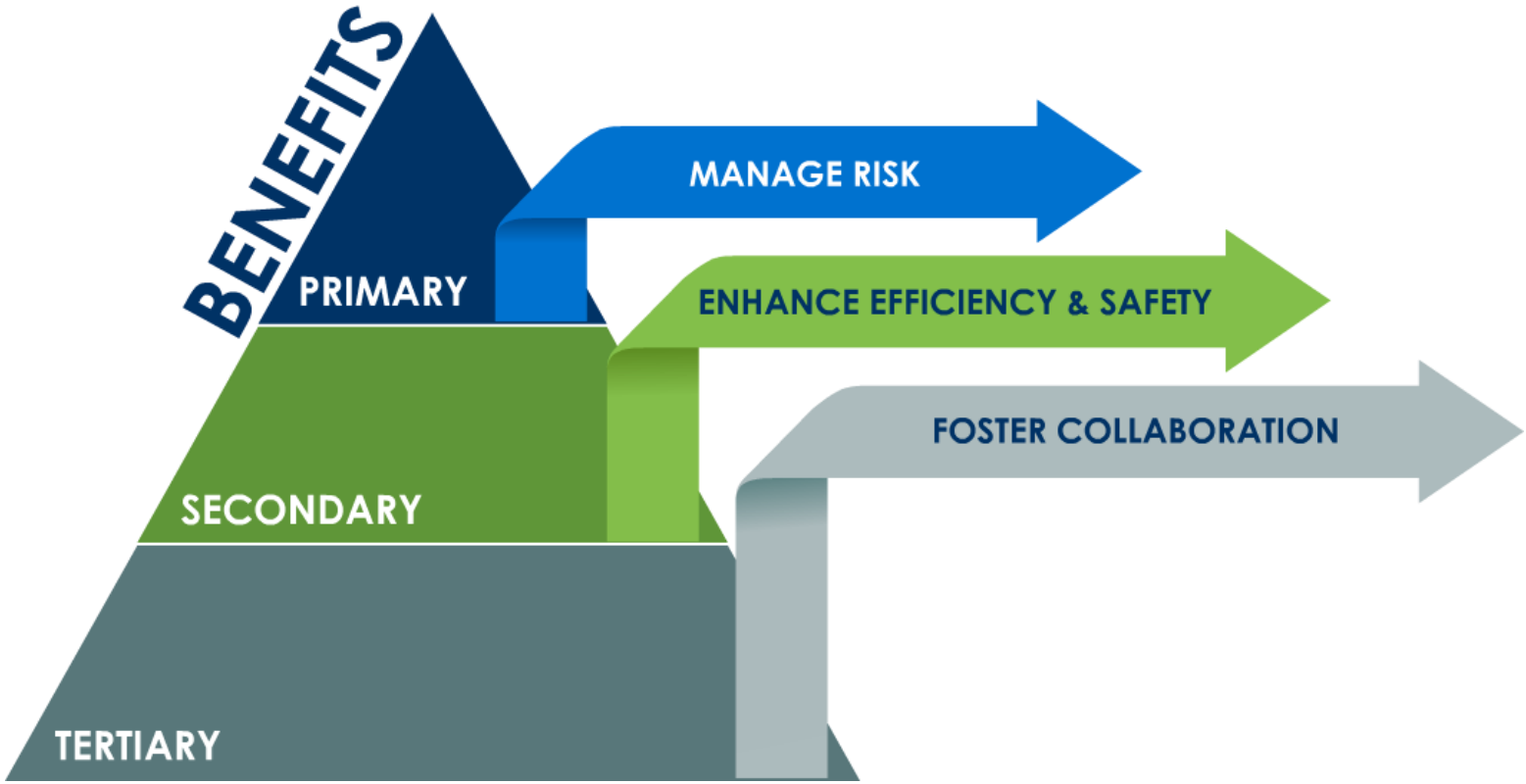
Image Sources: Iowa DOT, Wikimedia Commons, Caltrans

Planning Complex Activities





Benefits of 4D Modeling and 5D Modeling



Creating Digital As-Built Records

Construction is the most cost-effective time to capture position information

Image Source: FHWA

Subsurface Utility Engineering

Image Source: Cardno

Benefits of Digital As-Built Records

- More portable data format
- No manual data entry
- No need to manage paper
- Less effort to translate
- Projection and datum information can be embedded

As-found Survey Data *for…*

Street Sign Inventories

- Locate assets
- Evaluate asset condition
- Determine most economic replacement strategy
- Monitor sign readability for safety

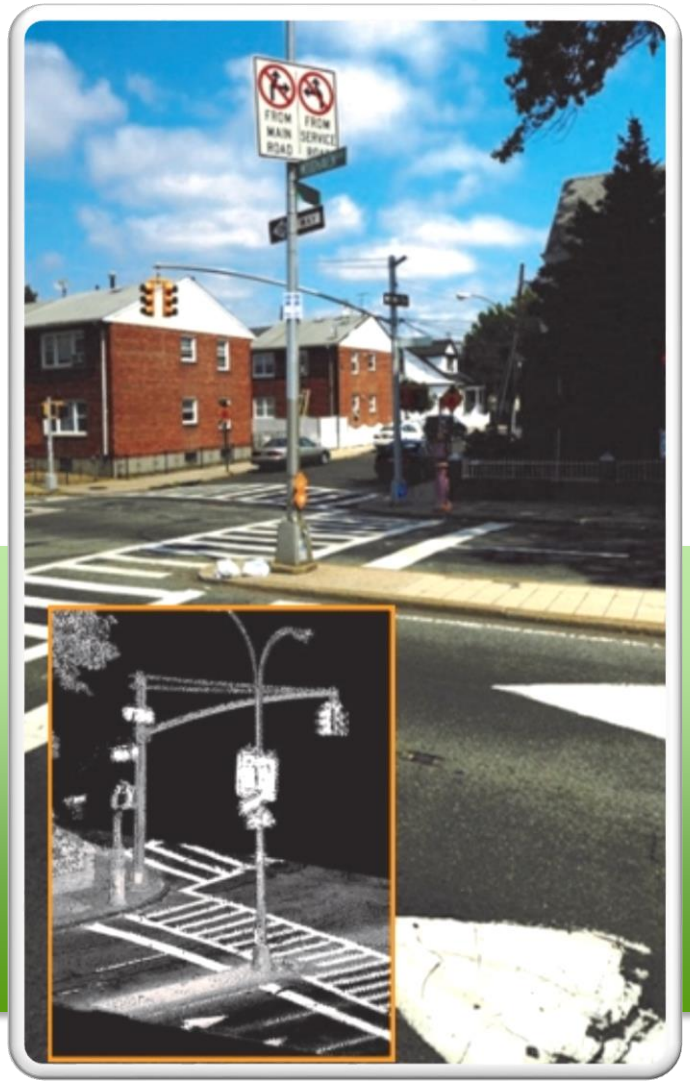
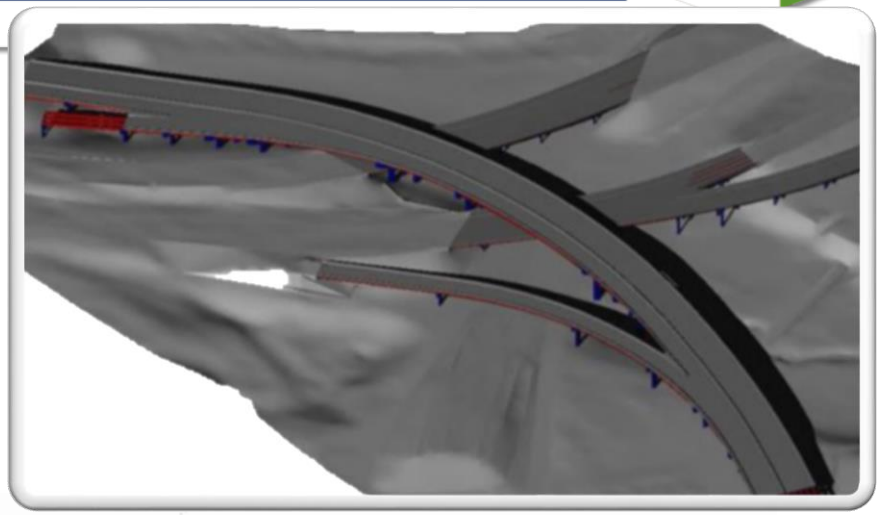


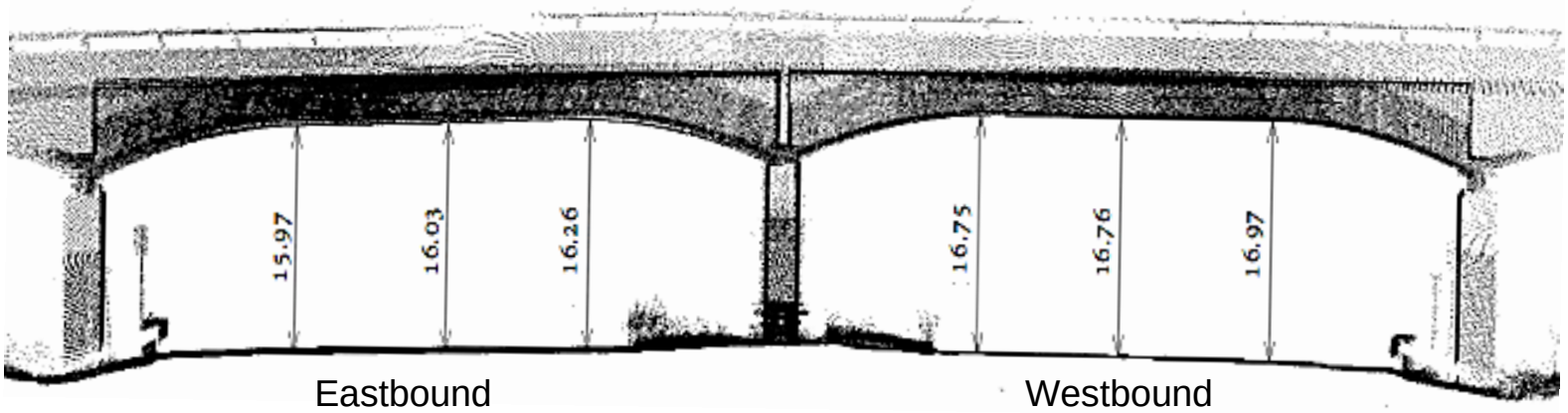
Image Sources: NCHRP, ACA

As-found Survey Data

Bridge Inventories

- Design
- Clearances
- Condition assessments





Route: KY-222
Structure ID: 047XXXXX
Design Construction: Tie-beam
Length: 62.8 m

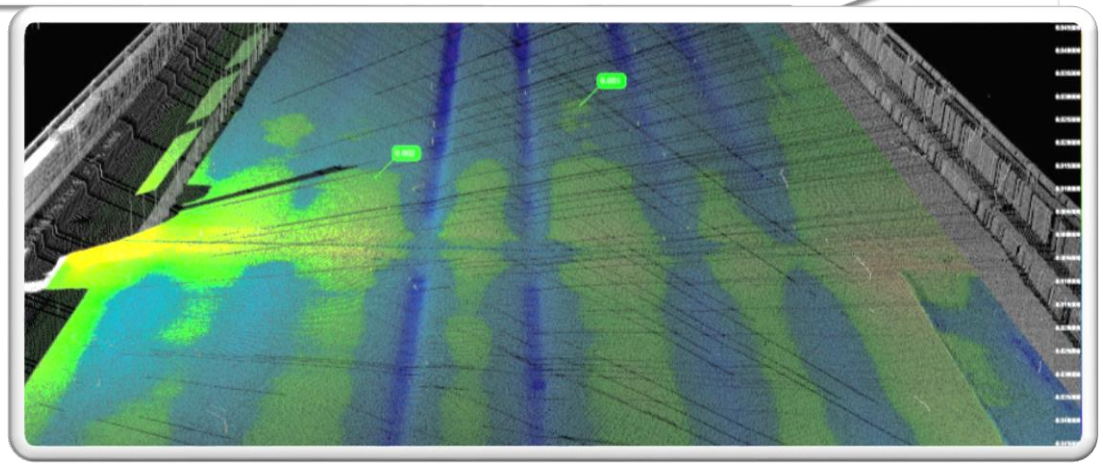
Milepoint: 129
Year Built: 1962
Material Design: Concrete Continuous
Scan date: 6/19/2013

Image Sources: Woolpert, Kentucky Transportation Cabinet

As-found Survey Data

Pavement Condition

- Cracking
- Rutting
- Distress
- Potholes



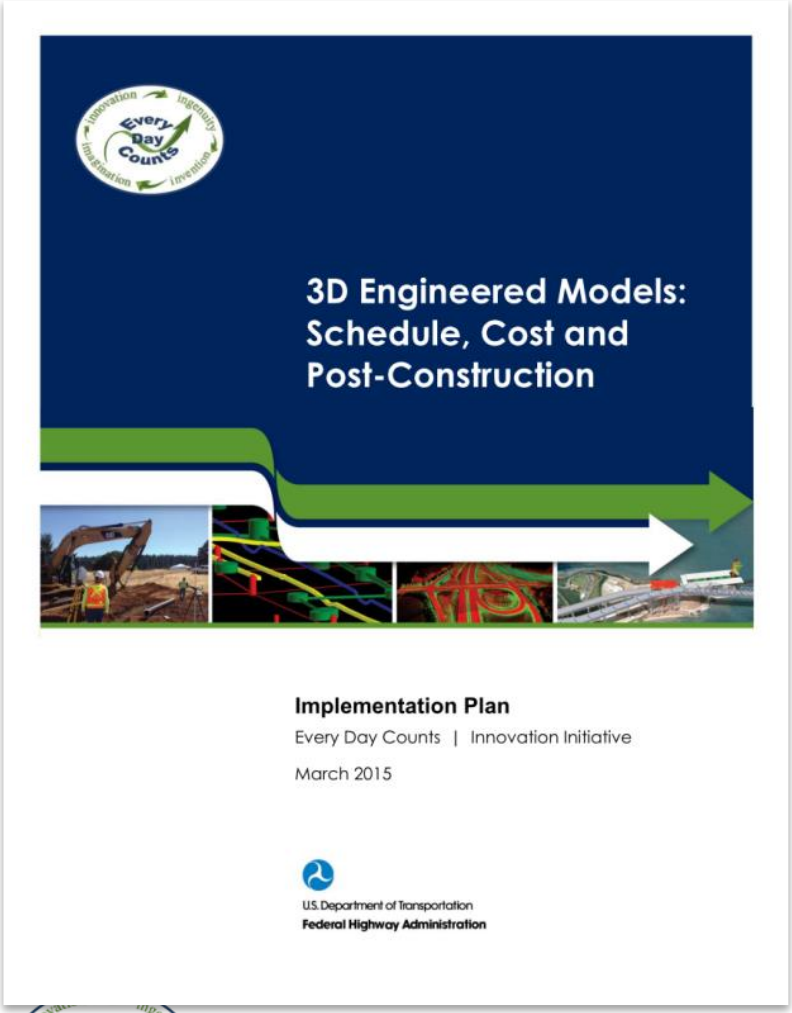
Low Severity
Area/Linear distress

Medium Severity
Area/Linear distress

High Severity
Area/Linear distress

Image Sources: Washington DOT, Jason Amadori

EDC-3 3D Implementation Plan



FHWA VISION

Mainstream the use of 3D engineered models and data in the creation, commissioning, maintenance and renewal of highway transportation assets to support effective resource allocation that enhances safety, efficiency, and reliability of the national highway system.

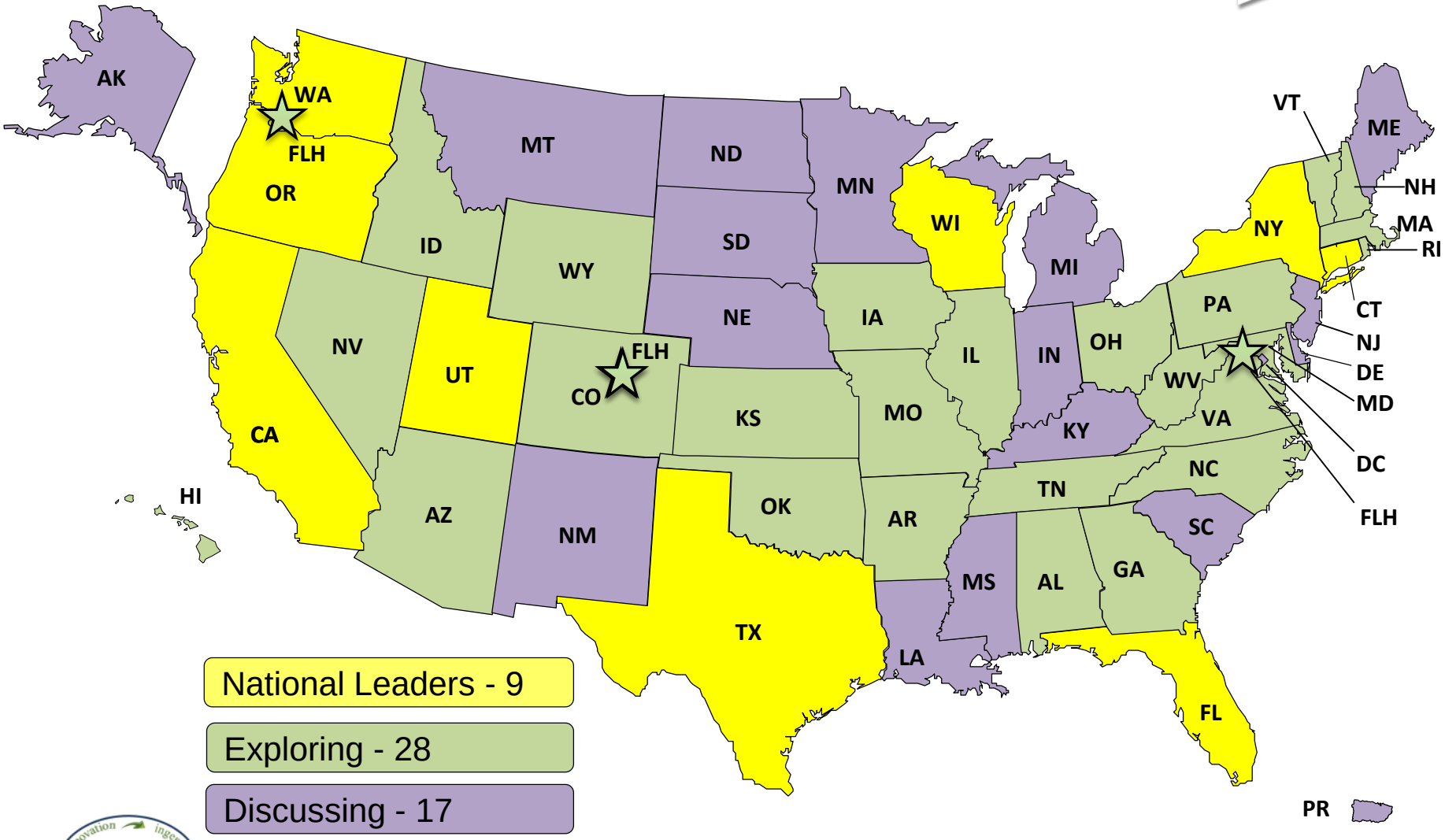
MISSION STATEMENT

Promote technology transfer and appropriate program or project-level implementation of 3D engineered models and data for the benefit of using the technology in all phases of the project delivery cycle including (1) construction schedules and cost data applications, (2) digital asset as-built record creation including subsurface utilities and (3) roadway inventory and asset management functions.

3D Engineered Models:

Schedule, Cost and Post-Construction

EDC-3 Deployment

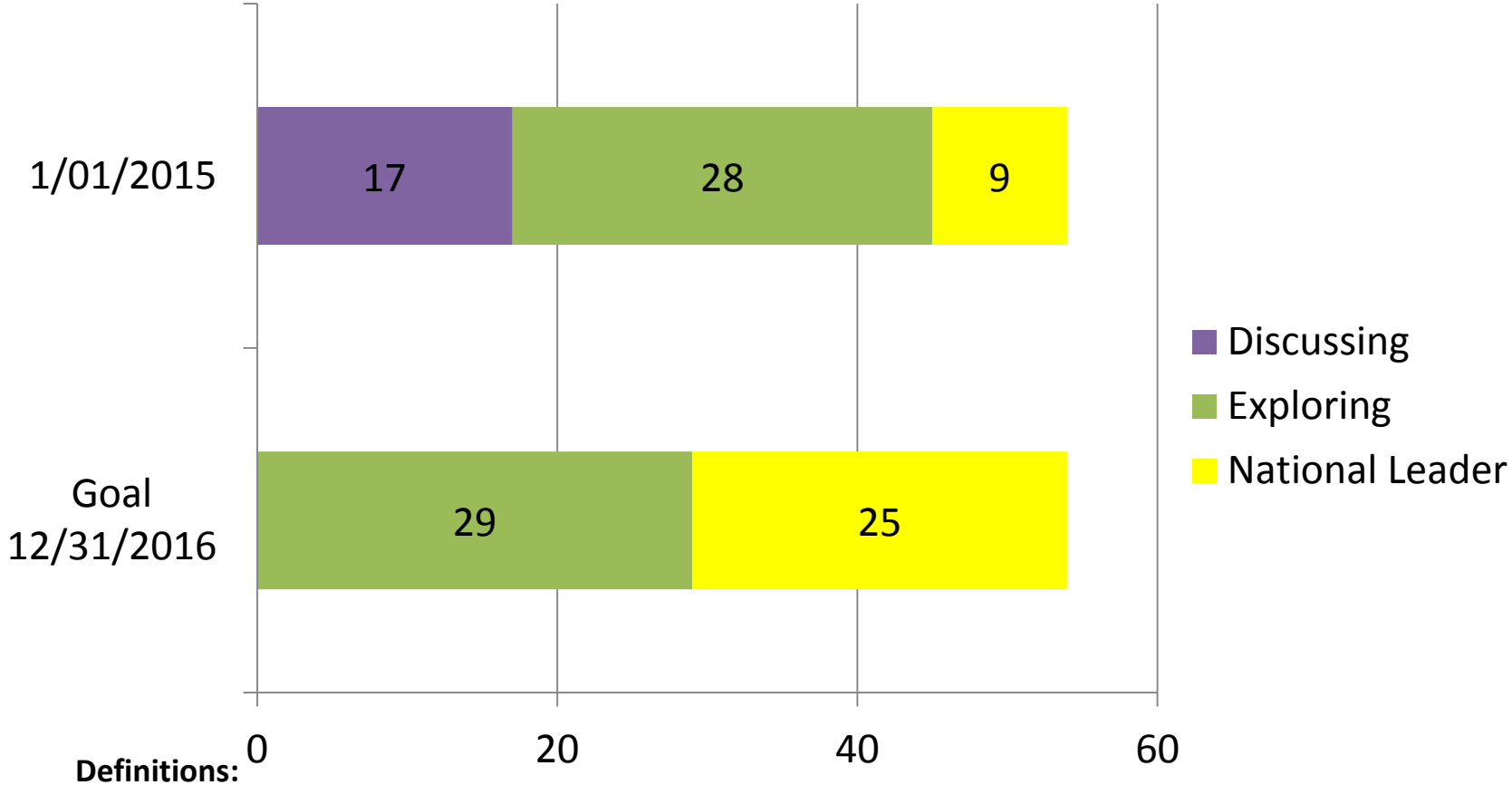


January 1, 2015

3D Engineered Models:

Schedule, Cost and Post-Construction

EDC-3 Deployment

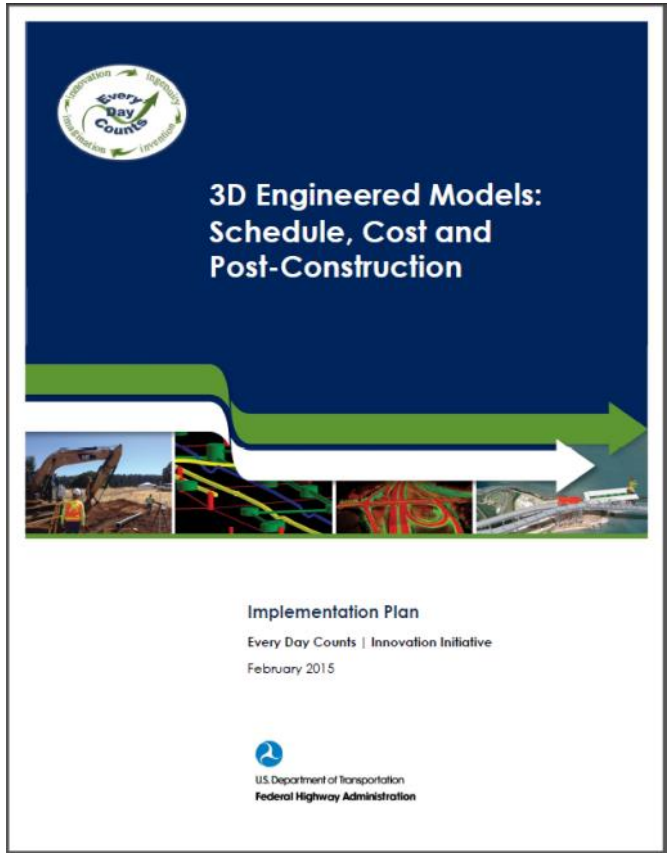


Definitions:

- National Leader – Has implemented at least one practice area programmatically or has implemented at least two practice areas at the project level on two or more instances.
- Exploring – Investigating and/or piloting the EDC-3 technology practice areas. Has successfully conducted at least one pilot or demonstration project.
- Discussing – Not taking part in the national EDC-3 technology initiative

Implementation Plan Activities

- Workshops & Peer Exchanges & eTS Conferences
- Webinar Series
- Case Studies
- Guidance Manuals & Specifications
- Demonstration & Pilot Projects
- Web-based Training



EDC-3 Webinars

Number	Webinar Title	Date
1	Introduction to 3D, 4D, 5D Schedule, Cost and Post-Construction	Tues 9/01/15
2	Using 3D Digital Data for Construction Engineering & Inspection	Tues 10/06/15
3	Creating and Using 3D Models of Highway Structures	Tues 11/10/15
4	Uses of 4D and 5D Models in Highways	Tues 1/05/16
5	Getting Started with 4D and 5D Modeling	Tues 2/09/16
6	Collection and Use of 3D Digital As-built Records	Tues 3/22/16
7	Use of 3D Digital Data for Asset Management	Tues 4/26/16

Case Studies

- Caltrans Virtual Geomatics Workflows for Roadway Feature Extraction
- UDOT uPLAN: BIM concepts in Highway Asset Management
- 4D Modeling—Resource Optimization
- 4D Modeling—Risk Mitigation
- Northern Virginia Subsurface Utility Engineering Practices (SUE)
- Oregon Geospatial Coordinates for Low distortion projections

‘How to’ guidance briefs

- Lidar data collection and management
- Standards based data collection and exchange based on business requirements
- Updating or maintaining 4D models as schedules evolve
- Project selection guidance for 4D modeling by usage case
- Guide specifications for capturing digital as-builts for subsurface utilities.
- Dealing with legacy survey data in the design, construction, and asset management phases
- Framework for digital asset management
- Estimating return-on-investment for technology implementation at the project and program level

EDC-3 Workshop Modules

- Applications of 3D Engineered Models Across the Highway Asset Lifecycle
- Survey Fundamentals for 3D Engineered Models
- Designing 3D Engineered Models for Roadway and Bridge Construction
- Managing 3D Engineered Models Across Asset Lifecycle Phases
- Using 3D Engineered Models for Construction Engineering and Quality Assurance
- Implementation Planning Breakout Session
- Post-construction Survey for 3D Digital As-built Records
- Uses of 4D and 5D Engineered Models by Owners and Contractors
- Capturing and Storing 3D Data for Asset Management

Implementation Self-Assessment Tool Identify Baseline/Goals

Planning Element	Level of Maturity						Maturity Goals		
Strategy	0 None	1 Initial	2 Managed	3 Defined	4 Managed	5 Optimized	Baseline	Short-term	Ultimate
		for adopting 3D deling	Vision for adop for some						
		ort for feasibility tudy	Managemen feasibility st further						
		dentified but no countability	Champio incorporated						
		nittee established	First draft Imp						
		1 itial	Ma						
		:ORS	Statewide CO asset/GI						
		uters	All staff ha con						
		d Office	CADD desig designers a						
		nents s for 2D	CADD Manual requiremen						
			es posted or for unmana						
			igital signatu on PDF documents	documents	electronic documents	with digital sign & seal			
			eld offices have computers, but limited network access	Field offices have computers and full network access	Field offices have networked computers and some mobile tablets	Networked computers and mobile tablets on all construction sites			
			Some access to Construction software	Desktop Construction software is available	The latest Desktop Construction software is available	Desktop and Mobile Construction software is available			
RTK GNSS Receivers (Rovers)	None	Specification allows using the contractor's Rovers	Specification requires contractor to furnish Rovers and training	Limited agency-owned Rovers	Agency-owned Rovers available to all Construction sites	All Construction staff have Rovers and are trained to use them.			

Planning Element

Strategy

Enabling Infrastructure

Applications of 3D Models

Implementation Goals

Baseline

Short-term

Ultimate

Overview Module: Applications of 3D Models Across the Highway Asset Lifecycle

Learning Outcomes

- Describe an enterprise strategy for 3D asset data within the context of Civil Integrated Management
- Describe the state-of-the-practice for key aspects of using 3D Models in the highway lifecycle
- Describe the benefits of using 3D Models across the highway lifecycle
- Identify the constituent parts of an Implementation Plan

Terminology

RTK GNSS Rover

4D Model

3D Geospatial Data

Post-Construction Surveying

Roadway Inventory

Subsurface Utility Engineering

Asset Management

Mobile LiDAR

Terrestrial LiDAR

Point Cloud

Acceptance

5D Model

Remote Sensing

GIS

Real-time Verification

Civil Integrated Management (CIM)

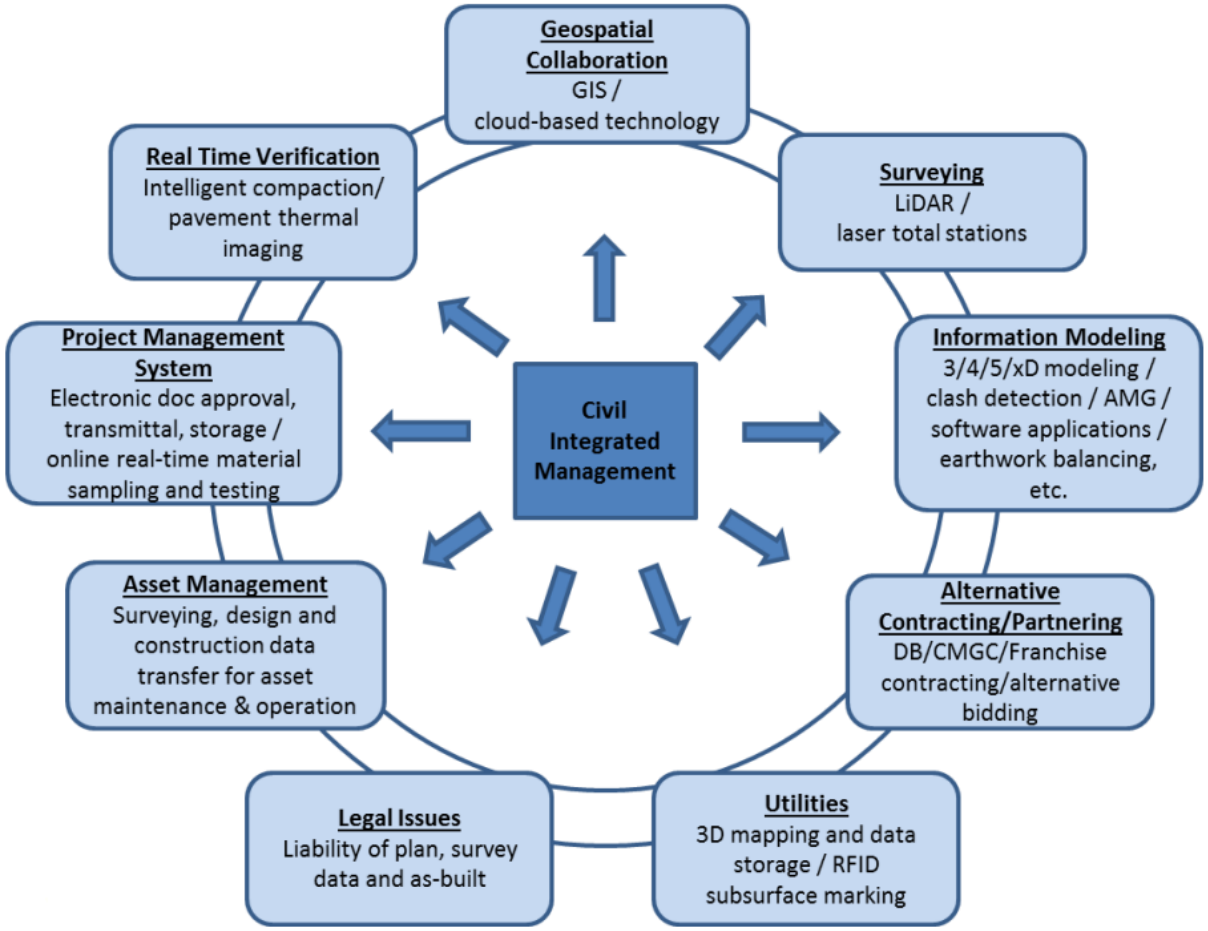


Image source: NCHRP 20-68A

Use of 3D Models throughout the Lifecycle

- Pre-design Survey
- Design Development
- Constructability Review
- Construction Automation
- Owner's use in Construction
- Subsurface Utility As-built Records
- Asset Inventory & Condition Assessment

Pre-Design Survey

Actual current practice?	State-of-Practice	State-of-the-Art
Uniform Accuracy	**Multiple Collection Methods**	**Construction Ready**
• Single data collection • No need to consolidate datasets	• Accurate control and tie-ins • Rapid topographic data acquisition	• Control at high order accuracy • Tie-ins and constraint features at high accuracy

Challenges

Technological: *devices, hardware, software, training, and support*

Procedural: *creating 3D Models, signatures and specifications*

Change Management: *Change is a dynamic process – benefits must be proven*

Exercise: *Use the note card provided to jot down one or two perceived challenges. These will be addressed during the modules.*

CIM Related Research

- FHWA's Ongoing Projects:
  - 3D Model Usage Case Study
  - E-construction
  - Digital As-builts and O&M Plans
  - Impact of AMG on Meeting Smoothness Specs
  - Use of Geospatial Data in Construction (including drones/UAVs and documenting the legal issues)
- NCHRP 10-96, Guide for CIM in DOTs

Utilizing 3D Digital Design Data in Highway Construction: A Case Study

- Project Start Date: September 2014
- Project #: DTFH61-14-C-00039

Objective: Conduct a comprehensive case study of how 3D digital design data was successfully used by both the owner agency and the construction contractor during highway construction.

Emphasis: Data integration/transfer

Integrating 3D Digital Models into Asset Management

- Project Start: September 2014
- Project #: DTFH61-14-C-00043

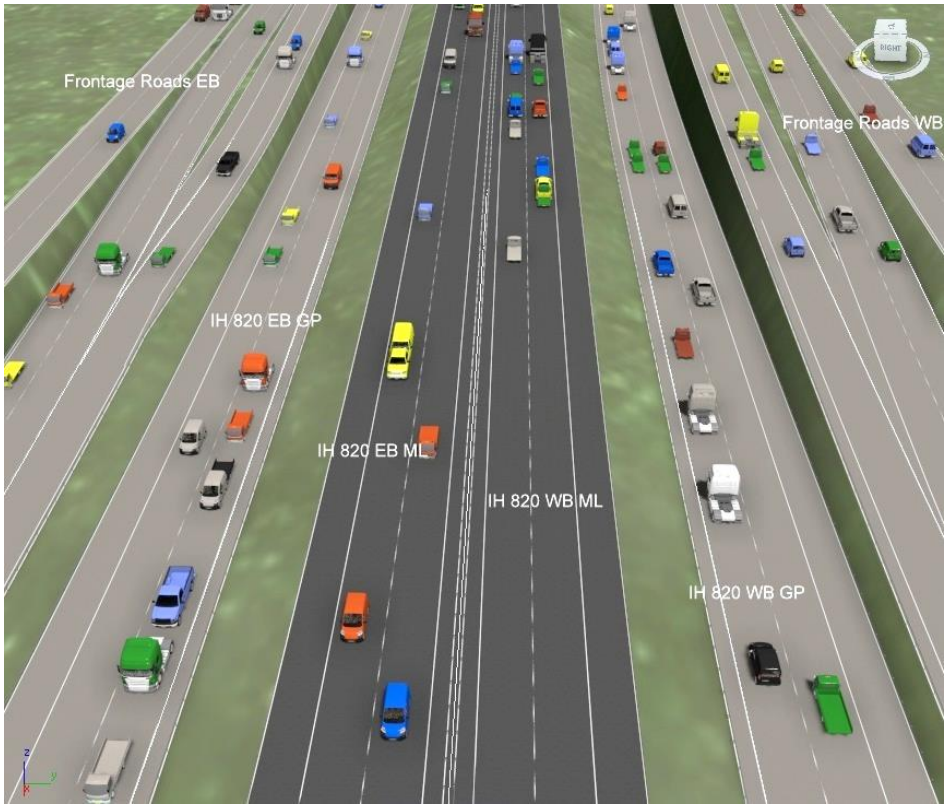
Objective: Determine the state of the practice for using 3D digital modeling in asset management and develop best practice recommendations.

Emphasis: Best Practices and Guidance

Implementation Guide for CIM in DOTs

- Project #: NCHRP 10-96

Objective: Investigate the wide spectrum of CIM technologies and practices being deployed by DOTs on their projects and develop an implementation guide



Contact: Katherine Petros, TFHRC

NCHRP Project Team

- The University of Texas at Austin
  - Bill O'Brien – Principal Investigator
  - Fernanda Liete – Co-Principal Investigator
  - Nabeel Khwaja – Co-Principal Investigator
  - Bharathwaj Sankaran – Graduate Student

THE UNIVERSITY OF TEXAS AT AUSTIN
CENTER FOR TRANSPORTATION RESEARCH

- The University of Colorado at Boulder
  - Paul Goodrum – Co-Principal Investigator
  - Keith Molenaar –Co-Principal Investigator
  - Guillermo Nevett – Graduate Student
  - Joshua Johnson – Graduate Student

University of Colorado
Boulder

Research Objectives

The objective of this research is to develop a guide to CIM that DOT managers can use to

a) Identify which CIM tools and processes to implement;
b) Identify the particular benefits, obstacles, and costs; and
c) Identify practical strategies to assist with implementation.

Agenda

National Surveys

- **What are agencies using?**

Case studies

- **Detailed interview of projects that demonstrated successful utilization of one or more CIM practices**
- **Identify practical strategies, lessons learned, and recommendations**

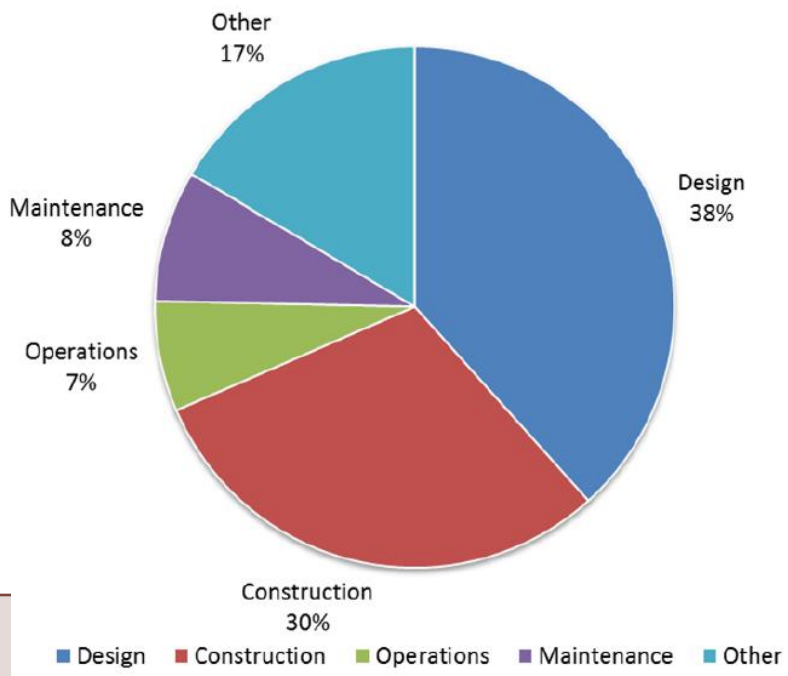
Implementation Guide

- **identify practical strategies for increasing reliance on digital project delivery and asset management.**

Survey participants

- Respondents from Design, Construction, Operations, or Maintenance.
- 40 States involved:

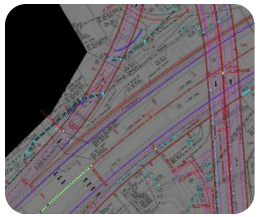
Alaska	Georgia	Maine	North Carolina	Rhode Island
Arizona	Hawaii	Maryland	Nevada	Tennessee
Arkansas	Idaho	Massachusetts	New Hampshire	Texas
California	Indiana	Michigan	New Jersey	Utah
Colorado	Iowa	Minnesota	New York	Virginia
Connecticut	Kansas	Mississippi	Ohio	Washington
Delaware	Kentucky	Missouri	Oregon	West Virginia
Florida	Louisiana	Montana	Pennsylvania	Wyoming



CIM Technology Clusters used for Surveys

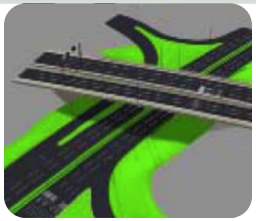
2D

- 2D Plan sets in the field during construction



3D / nD

- 3D Visualization during construction (e.g. isometric drawings, physical models, etc.)
- 3D CADD 4D Modeling Analysis (3D + schedule)
- 5D/nD Modeling Analysis (model-based quantity takeoff/model-based cost estimating)
- Work Packaging Software / Advanced scheduling



Sensing

- 3D Imaging (e.g. LiDAR, photogrammetry)
- Geographical Information Systems (GIS)
- Global Positioning Systems (GPS)
- Intelligent Transportation Systems (ITS)
- Field Sensors (e.g. RFID, ground penetrating radar, ultrasonics)
- Intelligent Compaction
- Automated Machine Guidance and Control (AMG)
- Utility Engineering / Clash Detection / Coordination

Data Management

- Electronic archival and updating of plans
- Digital Asset Management
- Materials Management System (e.g. Spreadsheets and RFIDs)
- Mobile Digital Devices for onsite applications (tablets, smart phones, etc.)
- Data Connectivity Other than Cellular Towers
- Digital Signatures

Case studies

S.No.	Project	Project Delivery Method	Approx. Project Cost ($M)	CIM Topics examined
1	Rotary upgrade to modern roundabout (CTDOT)	D-B-B	1.45	Electronic Engineering Data
2	Kiewit case study on I-70 project (CDOT)	D-B-B	18	3D modeling for visualization
3	Relocation of KY7 in Elliott County (KYTC)	D-B-B	26.5	Contract precedence to 3D models
4	I-96 Livonia construction project (MDOT)	D-B-B	124.1	E-construction initiative
5	Fore River bridge replacement project (MassDOT)	D-B	300	3D modeling for steel bridge
6	Kosciuszko Bridge project (NYSDOT)	D-B	555	4D/5D modeling for project monitoring and control
7	Crossrail Ltd. (UK)	Various	42,000	CIM Lifecycle integration practices

Agency interviews

1. Oregon DOT's CIM Practices (3-D design models for AMG)
   Ron Singh (Ranvir.SINGH@odot.state.or.us)
2. Wisconsin DOT CIM Practices (Integrated Surveying for 3-D design)
   Lance Parve (Lance.Parve@dot.wi.gov)

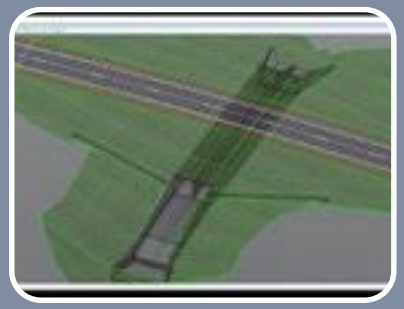
Lessons learned– Organizational

- **Technology implementation planning for CIM vital at organizational level (phased and detailed)**
  - Vision and mission statement
  - Leads and responsibilities
  - Funding and regulations / other constraints
  - Plan to involve relevant stakeholders (vendors, utility companies)
  - Executive management buy-in
  - 3-D Design and construction (QA/QC) training requirements for agencies

A few Examples

- WisDOT's 3-D Technologies Implementation Plan (TIP, 2013)
- Utah DOT's 3-D TIP (2014)
- Oregon DOT's Engineering Automation Plan (2008)
- UK Government's BIM strategy (Crossrail)
- Singapore's e-BIM submission system (regulations)

Lessons learned– CIM and work processes

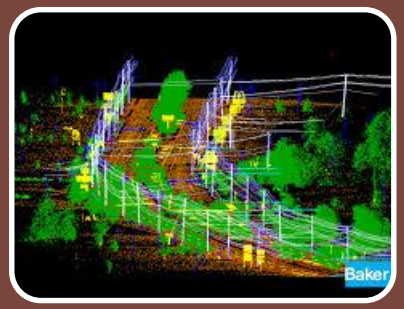


3D **design**

- **Common for roadway design (terrain models) over structures**
- Integrated surveying important for collecting data (LiDAR/Robotic TS/Aerial imagery/Photogrammetry)
- Major issues: **LOD**, pilot projects, training, managing design changes, Electronic Engineering Data (EED) specifications

4D/5D

- **Complex interchanges, bridges, staged construction**
- **LOD** model vs schedule (consistency), **linking**(automation)
- *5D - emerging application; few reported instances in practice (NYSDOT's Kosciuszko Bridge project*)



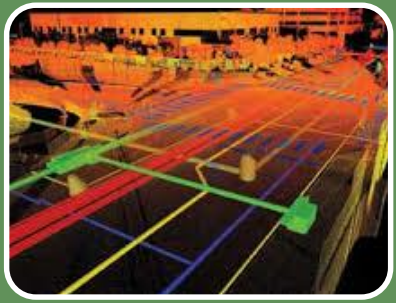
Advanced Surveying Methods(LiDAR/UAVs)

- **Rapid data collection for assisting 3-D design**
- High initial investment (Mobile / Airborne) – greater returns on a "system" perspective
- DOTs of Wisconsin, Oregon, CalTrans, Washington (Examples)

Lessons learned– CIM and work processes

Automated Machine Guidance (Machine controls)

- **Used for grading/excavation, emerging application for finished surface (asphalt/concrete);** Specs of Iowa, Michigan, Wisconsin and NYSDOT
- Increased productivity and safety on site;
- Contract clauses – explicitly mentioning AMG-related activities
- **"Information only" models**, QA/QC checks using rovers/RTS



Utility **engineering**

- **Risks/uncertainties have to justify investments**
- **Issues: Initial investment (GPR/GPS/EMI/Rovers), skilled labor-force**
- Clash detection with other design entities – major application
- Extending current standards (UCMs) to accommodate 3D Geospatial data
- Request as-built utility data from contractors (specs.)

Data/Information management

- **e-bidding and submittals, electronic document management (common)**
- ProjectWise, AASHTO Project Suite, Microsoft SharePoint (software tools)
- Workflow mainly document-based (challenges for model-based workflow)
- Different variants of data for O&M – 2D as-builts (pdfs, electronic), 3D CAD, 3D point clouds (challenge)

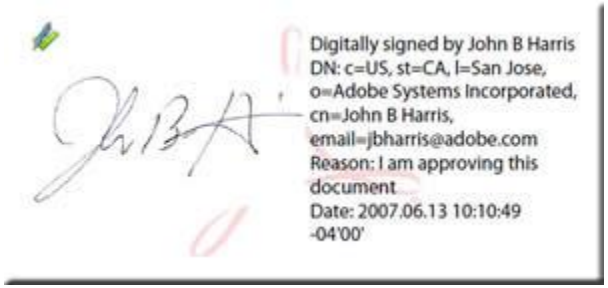
Lessons learned – ROI analysis

Organization	Focal point for analysis	Brief description
Michigan DOT	e-document management systems (ProjectWise) (Farr 2013).	Agency-wide implementation of electronic document management systems and digital signatures – Monetary benefits through paper-less work process and efficiency improvements ***(APPROX. $185,000 SAVINGS IN LATSON ROAD PROJECT ($32M))***
Wisconsin DOT	3D design (Clash detection) (Parve 2012).	clash detection processes on its SE Freeways Mitchell Interchange projects --Reported considerable reduction in RFIs, Change orders, and design issues ***(7% RFI REDUCTION IN $ 298 MILLION MITCHELL INTERCHANGE PROJECT)***
CalTrans, and Washington DOT	Mobile LiDAR (Yen et al. 2014).	examined different strategies of deploying a mobile LiDAR for agencies' -- Purchasing and operating surveying grade mobile LiDAR emerged as least cost option ***($ 6.1 MILLION DOLLARS LESS FOR 6 YEARS LIFECYCLE)***
TxDOT	3D design and ProjectWise (TxDOT 2014).	TxDOT conducted a preliminary NPV analysis for agency-wider implementation of 3D design on its projects and ProjectWise to support the 3D workflow. -- ***(ESTIMATED TO BE $ 70-95 MILLION DOLLARS OVER 5 YEARS.)***
Oregon DOT	Information Technology Benefit-Cost Evaluation report (Hagar 2011).	ODOT evaluated the benefits and costs of nine IT systems that included GIS infrastructure, environmental analysis tools, electronic document management systems, engineering tools, work zone analysis tools, among others -- Reported time savings (converted to labor-costs through hours saved), workflow and efficiency improvements in information management ***(B/C RATIO ESTIMATED TO BE 2.1)***

Lessons learned – Contracts and governance

- Contractual Issues
  - 2D plans governing documents (Plans, Specifications, Estimates)
  - "Information only" clauses on models- risk and liability issues (AMG)

- Legal
  - Statutory laws and agency rules yet to evolve to support model-based delivery (signatures and seals primarily on documents)
  - Lack of clarity in professional guidelines for Digital signatures (e.g. states' Engineering Practice Acts)



10-96 CIM Implementation Guide – Layout

1. **Overview of CIM tools and functions**
2. **Impact of CIM on project delivery**
   - Maturity model
3. **Implementation framework for CIM**
   - Planning from current practices – Stage I (Input from surveys)
   - Assessment of future capabilities – Stage II (Input from survey/case studies)
   - Implementation Considerations – Stage III (input from case studies)
4. **Supplemental resources**
   - Literature review – Summary
   - Current state of practice – Survey results
   - Case studies – Lessons learned
5. **References**
6. **Appendix**
   - Catalog of resources for CIM tools and functions

ADDRESSING CHALLENGES IN AUTOMATION IN HIGHWAY CONSTRUCTION

DTFH61-13-C-00026

Contact: Richard Duval, TFHRC

3D Structures Activities & Products

- Workshops
  - Penn DOT 3D Modeling for Structures, October 2014
  - Iowa DOT 3D Design & Modeling for Structures, April 2015
  - Development of Nat'l BrIM Standards – 2 Day workshop- August 2015
  - IBC workshop on BrIM Standards June 2015
- Case Study
  - 3D Design, Fab. & Virtual Assembly of Steel Structures, Summer 2015
- National Webinars
  - FHWA planned 3D Modeling for Structures, Fall/Winter 2015
  - Update on FHWA Development of Nat'l BrIM Standards May 2015

Benefits of 3D Modeling for Structures

- Improves workflow from detailing to fabrication
- Provides one source for data
- Improves the "3C's" among project stakeholders
- Supports fit verification & clash detection
- Reduces errors & eliminates redundant/manual efforts

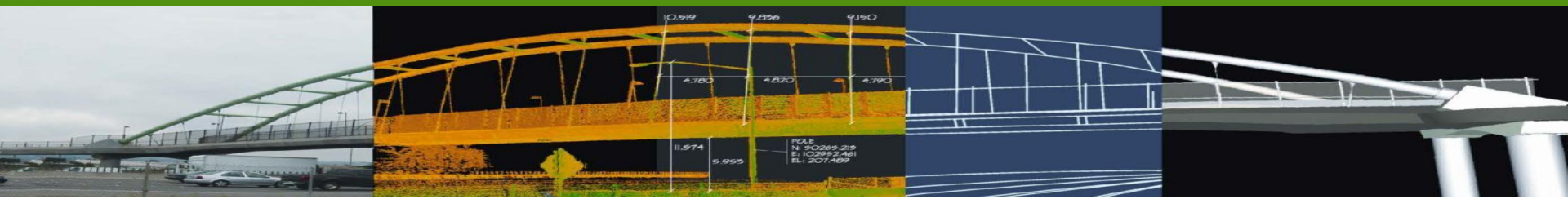


Image Sources: Wisconsin DOT

Bridge Information Modeling (BrIM) Standards Workshop

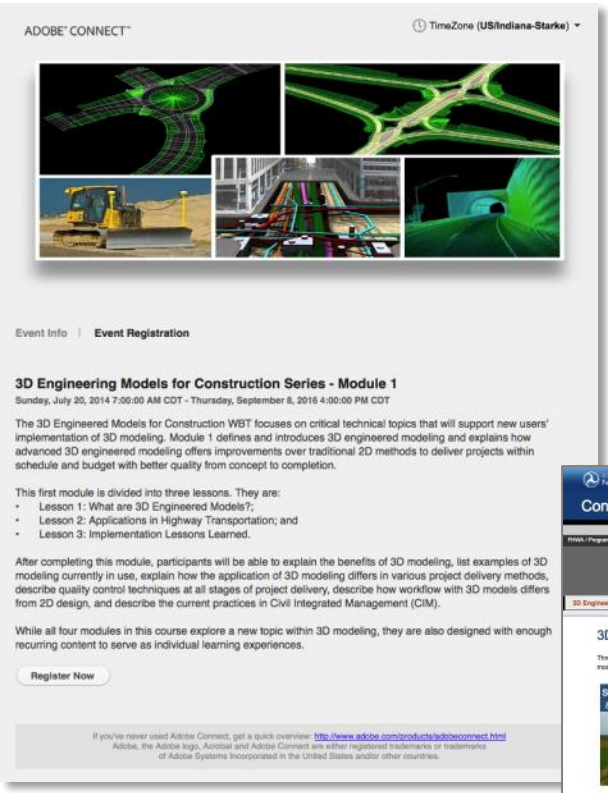
U.S. Department of Transportation
August 25-26, 2015
Washington DC

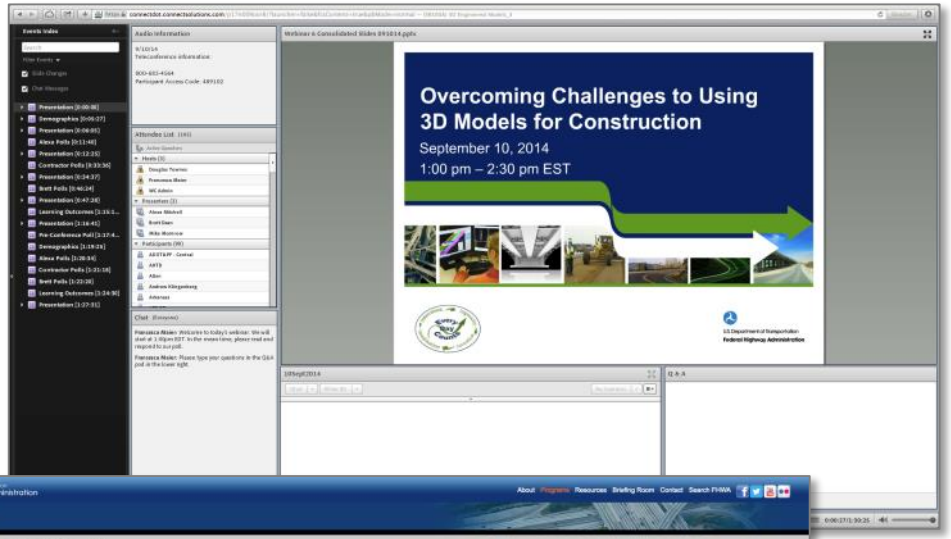
Brian Kozy, PhD P.E.
Principal Bridge Engineer
Federal Highway Administration

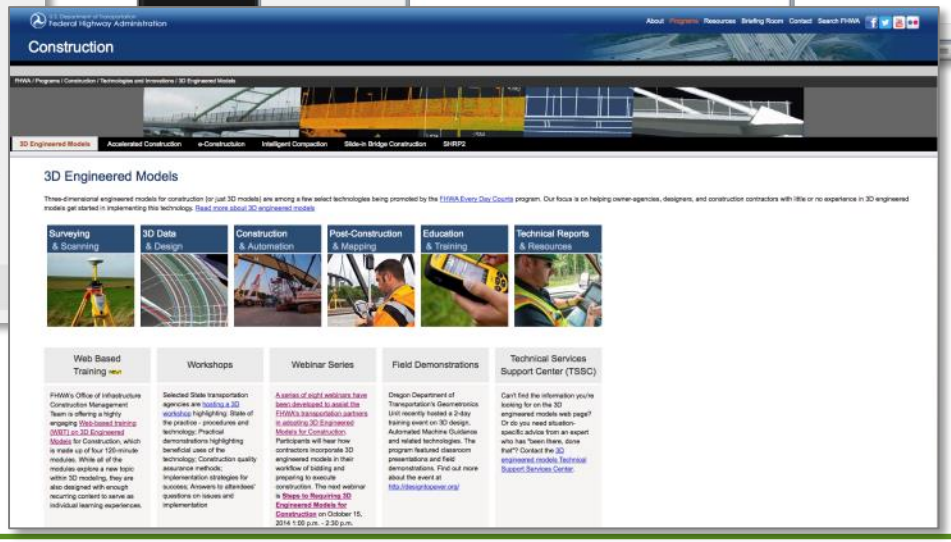
Vision of Future Bridge Engineering

- Practice operates with digital delivery and exchange and storage of bridge information (more than trees)
- Interoperability in engineering software platforms
- Advanced analysis and visualization
- Move away from "book keeping" towards more value-added engineering
- Build the virtual "world" (google earth, drones, the Matrix, Avatar, etc.)

3D Support & Available Tools

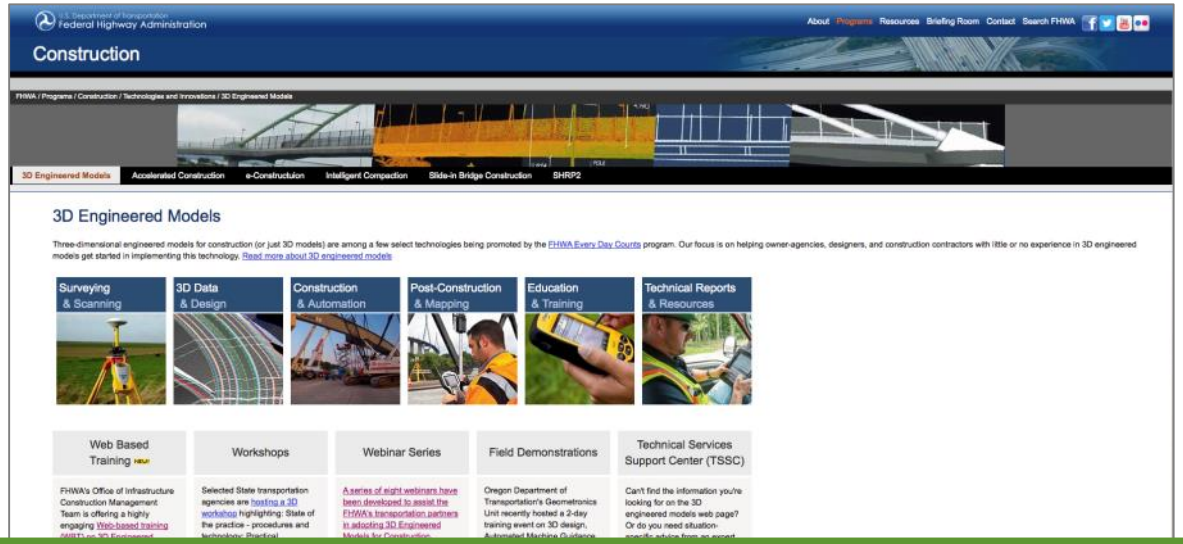






National Website

- New web page
  - Specs, Standards, Details, Tech Briefs, Case Studies, etc.



New web page viewable at www.fhwa.dot.gov/3d (search "fhwa 3D")

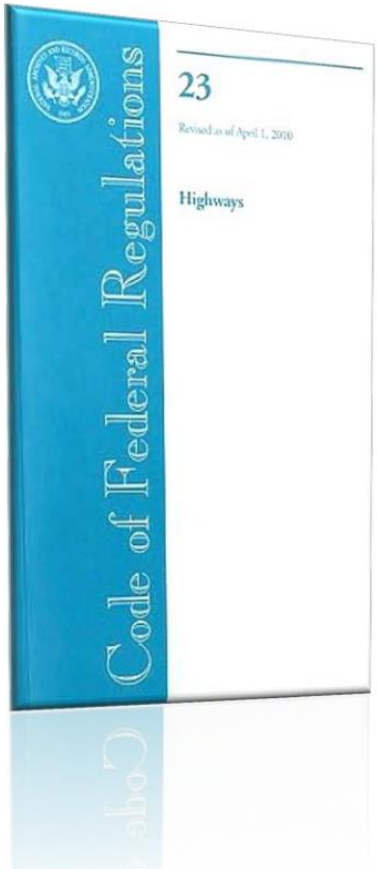
Web-based Training

- Four, 120-minute online modules
- Available 24/7, at users' convenience
- Users can start, stop, and then pick up where they left off
- The focus is on critical topics that support new users' implementation of 3D modeling
- ***AVAILABLE NOW*!**

Accessible at: **www.fhwa.dot.gov/3d**

Available FHWA Innovation Deployment Funding

- Accelerated Innovation Deployment (AID) Funding
  - Up to $1m per award
  - Project initiates within 6 mo
  - http://www.fhwa.dot.gov/accelerating/grants/index.cfm
- State Transportation Innovation Council (STIC) Incentive Funds
  - Up to $100,000 per year
  - contact your FHWA state office and Mary.Huie@dot.gov in the FHWA CAI office
- MAP-21 Section 1304 Innovative Project Delivery Funding
  - Up to 5% increased federal share
  - http://www.fhwa.dot.gov/map21/qandas/qaipd.cfm



EDC-3 Deployment Team

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Thank You!

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Questions?