Applications of 3D Models in the Construction Office

February 19, 2014

1:00 pm – 2:30 pm EST

Every Day Counts

U.S. Department of Transportation
Federal Highway Administration

Welcome & Introductions

Douglas Townes, P.E.

FHWA Resource Center

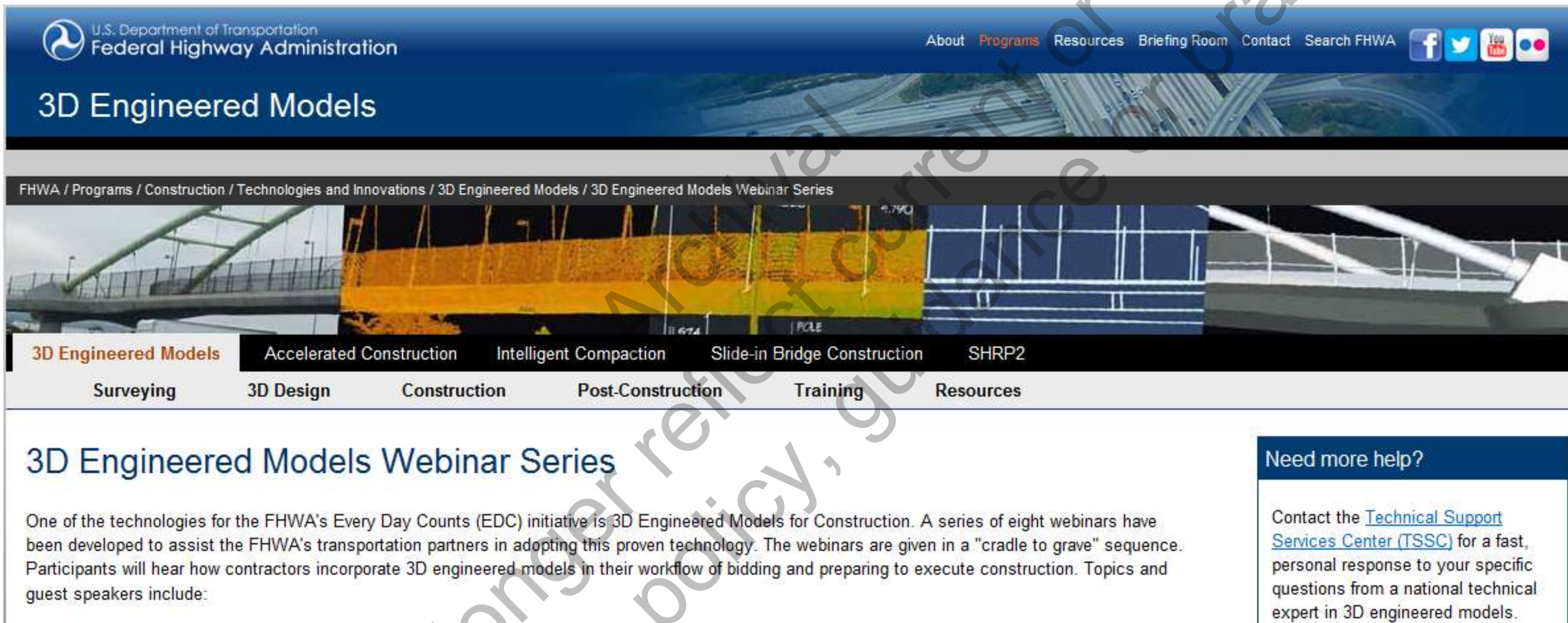
U.S. Department of Transportation
Federal Highway Administration

3D Engineered Models Webinar Series

Webinar 1: Overview of 3D Models for Construction
Webinar 2: Creating 3D Engineered Models
Webinar 3: Applications of 3D Models in the Contractor’s Office
Webinar 4: Applications of 3D Models on the Construction Site
Webinar 5: Managing and Sharing 3D Models for Construction
Webinar 6: Overcoming Challenges to Using 3D Models for Construction
Webinar 7: Steps to Requiring 3D Engineered Models for Construction
Webinar 8: Adding Time, Cost and other Information to 3D Models

Recordings of Previous Webinars

http://www.fhwa.dot.gov/construction/3d/webinars.cfm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3D Engineered Models

FHWA / Programs / Construction / Technologies and Innovations / 3D Engineered Models / 3D Engineered Models Webinar Series

3D Engineered Models | Accelerated Construction | Intelligent Compaction | Slide-in Bridge Construction | SHRP2

Surveying | 3D Design | Construction | Post-Construction | Training | Resources

3D Engineered Models Webinar Series

One of the technologies for the FHWA's Every Day Counts (EDC) initiative is 3D Engineered Models for Construction. A series of eight webinars have been developed to assist the FHWA's transportation partners in adopting this proven technology. The webinars are given in a "cradle to grave" sequence. Participants will hear how contractors incorporate 3D engineered models in their workflow of bidding and preparing to execute construction. Topics and guest speakers include:

Need more help?

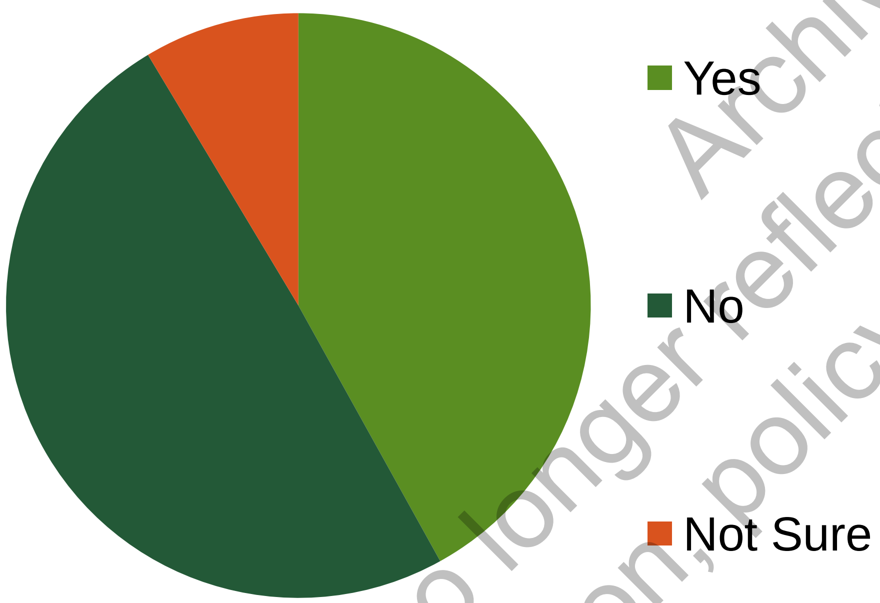
Contact the Technical Support Services Center (TSSC) for a fast, personal response to your specific questions from a national technical expert in 3D engineered models.

Recorded Webinars

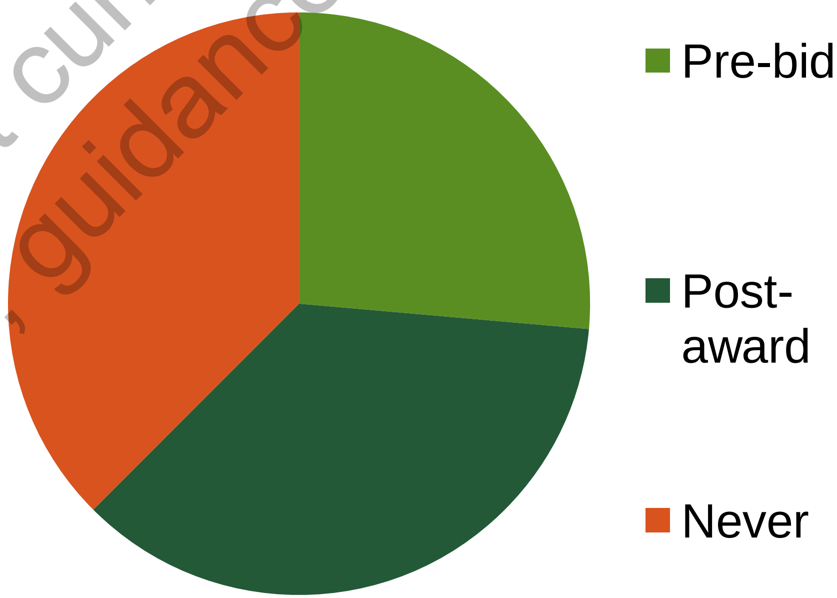
- Overview of 3D Engineered Models for Construction
  November 20, 2013 1:00 p.m. - 2:30 p.m. Eastern
- Creating 3D Engineered Models
  January 8, 2014 1:00 p.m. - 2:30 p.m. Eastern

What you told us: Webinar 1

Does your agency produce 3D deliverables?

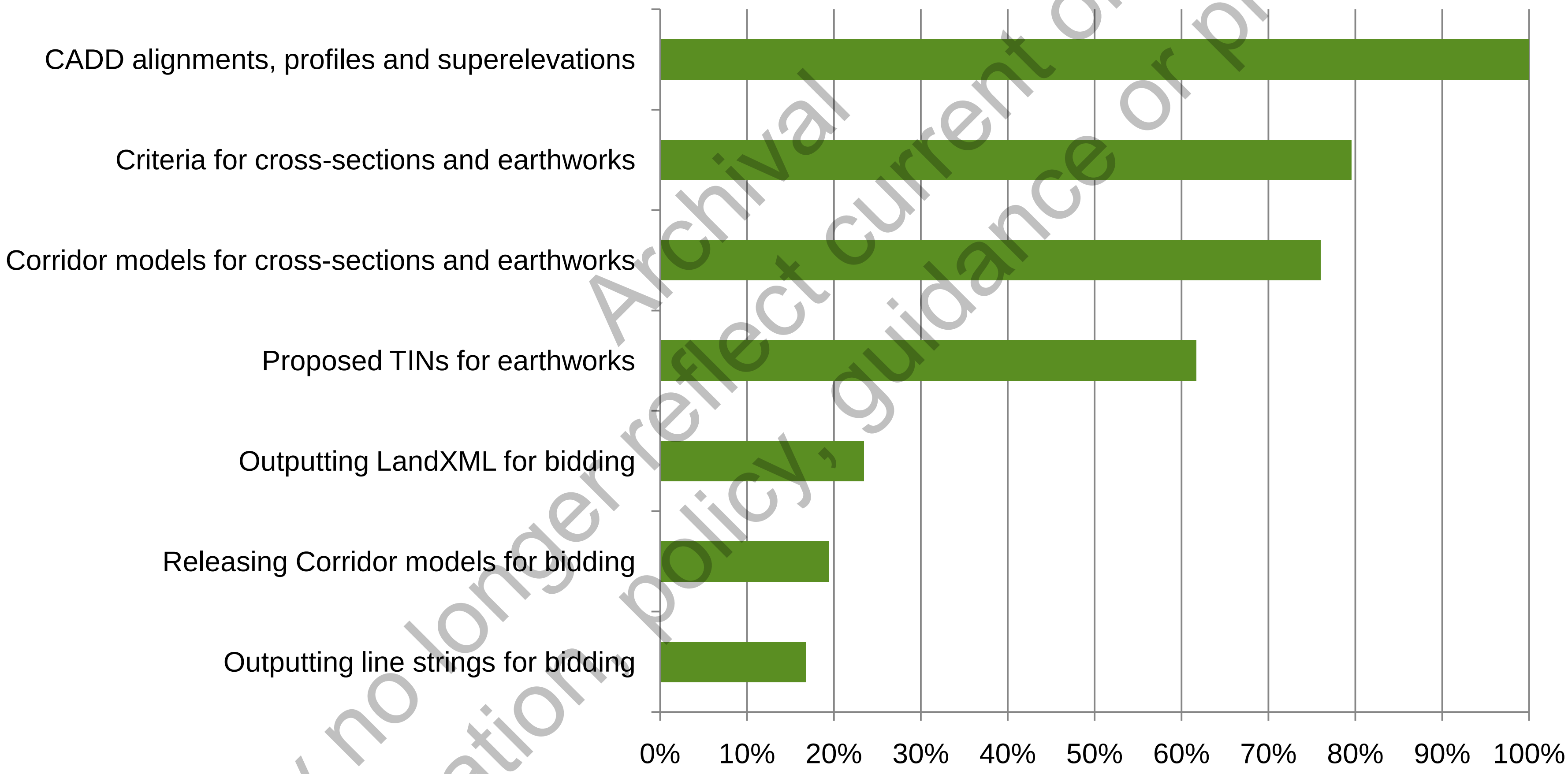


When does your agency provide 3D deliverables to contractors?



What you told us: Webinar 2

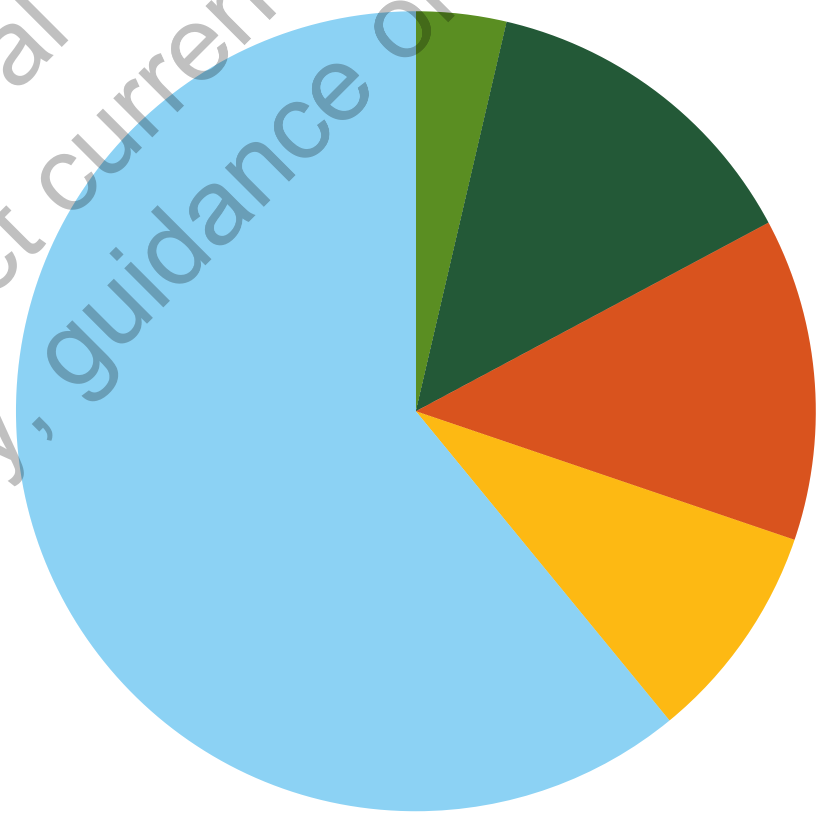
What is in your design workflow?



What you told us: Webinar 2

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 Exisitng Surfaces
- Yes, but I'll release LandXML & 3D line strings
- No, I'd release all data



Today's Speakers

Speaker	Topic
Douglas Townes (FHWA-RC)	Welcome and Introductions
Brian Deery (AGC)	Contractor's Organization Perspective
Brian Smith and Sam Kloes (IMCO Construction)	Using Available Data to Create Construction Models
Karthik "RK" Ramkrishnan (Walsh Construction)	Planning Construction Activities and Clash Detection
Ryan Forrestel (Cold Spring Construction)	Executing Construction with 3D Engineered Models
Douglas Townes (FHWA-RC)	Information on Next Webinar and Close

What type of organization do you represent?

- DOT Construction Division
- DOT Design Division
- DOT Survey Division
- DOT Other Division
- Local Authority
- FHWA Division Office
- FHWA Other Office
- Other Federal Agency
- Contractor
- Consultant
- Vendor
- Industry Representative

Contractor’s Organization Perspective

Brian Deery

Associated General Contractors of America (AGC)

Every Day Counts

U.S. Department of Transportation
Federal Highway Administration

Introduction

- BIM used in vertical industry for years
- AGC created BIM Forum to address 3D needs
- Contractors use 3D for bidding, AMG, means & methods, staging, clash detection, collaboration
- EDC Initiative to help push adoption in horizontal industry

AASHTO-AGC-ARTBA Joint Committee

AASHTO THE VOICE OF TRANSPORTATION

AGC of America
THE ASSOCIATED GENERAL CONTRACTORS OF AMERICA
Quality People. Quality Projects.

ARTBA American Road & Transportation Builders Association

U.S. Department of Transportation
Federal Highway Administration

AASHTO-AGC-ARTBA 2012 Joint Position Statement

Topic: Best practices for electronic data-sharing between state DOTs and contractors

Electronic technology is being used more and more as a tool in the design and construction of highway, bridge and other transportation projects. In particular, more transportation construction projects are being designed using 3D models to help visualize and simulate project ideas before they're ever built.

Using Available Data to Create Construction Models

Brian K. Smith and Sam Kloes
IMCO Construction

U.S. Department of Transportation
Federal Highway Administration

Learning Objectives

- List different ways to create 3D Engineered Models for Construction
- Describe how 3D models can be used for Quantity Take-off

What type of data to you provide/receive pre-bid?

- Raster PDF
- Vector PDF
- 2D CAD Linework
- 3D CAD Linework
- LandXML
- 3D Model
- None

Types of Data Received by Contractors

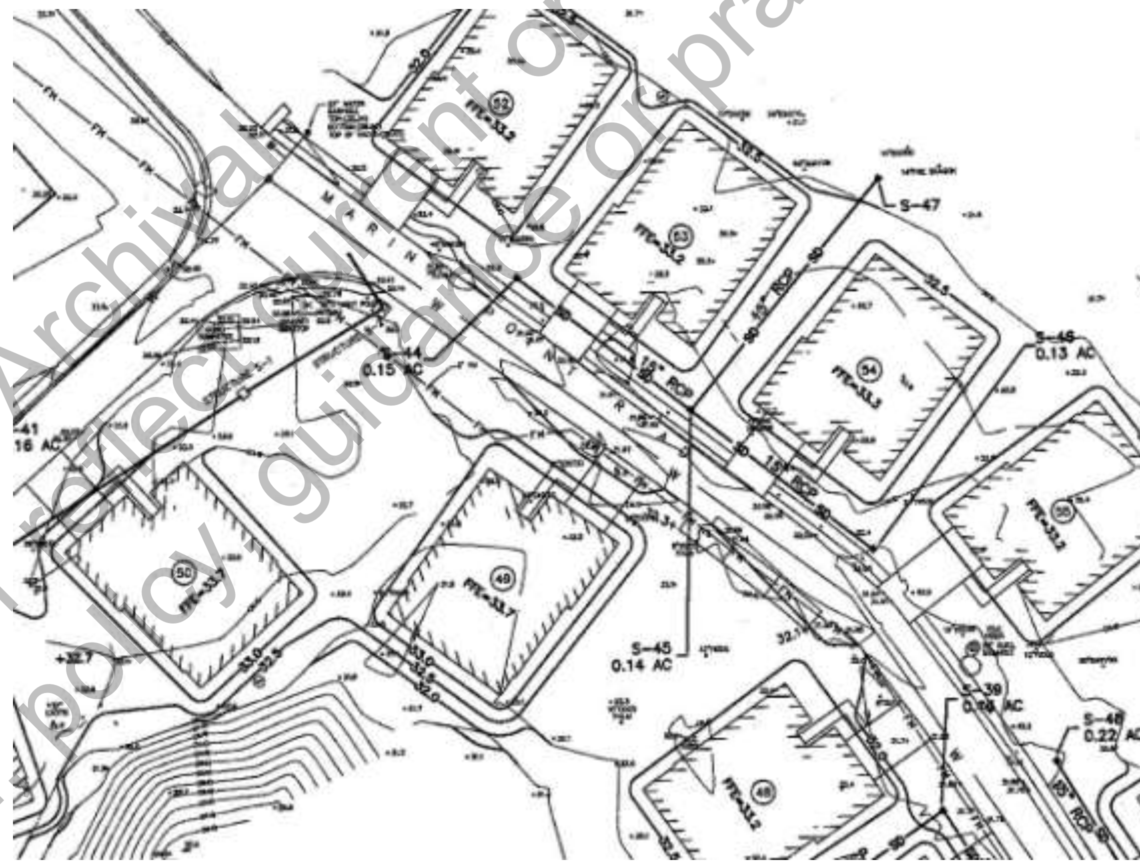
For a General Contractor there are mainly two different types of data received.

- PDF's (Raster and Vectorized)
- Electronic CAD and design files

Types of Data Received by Contractors

Raster Adobe PDF's

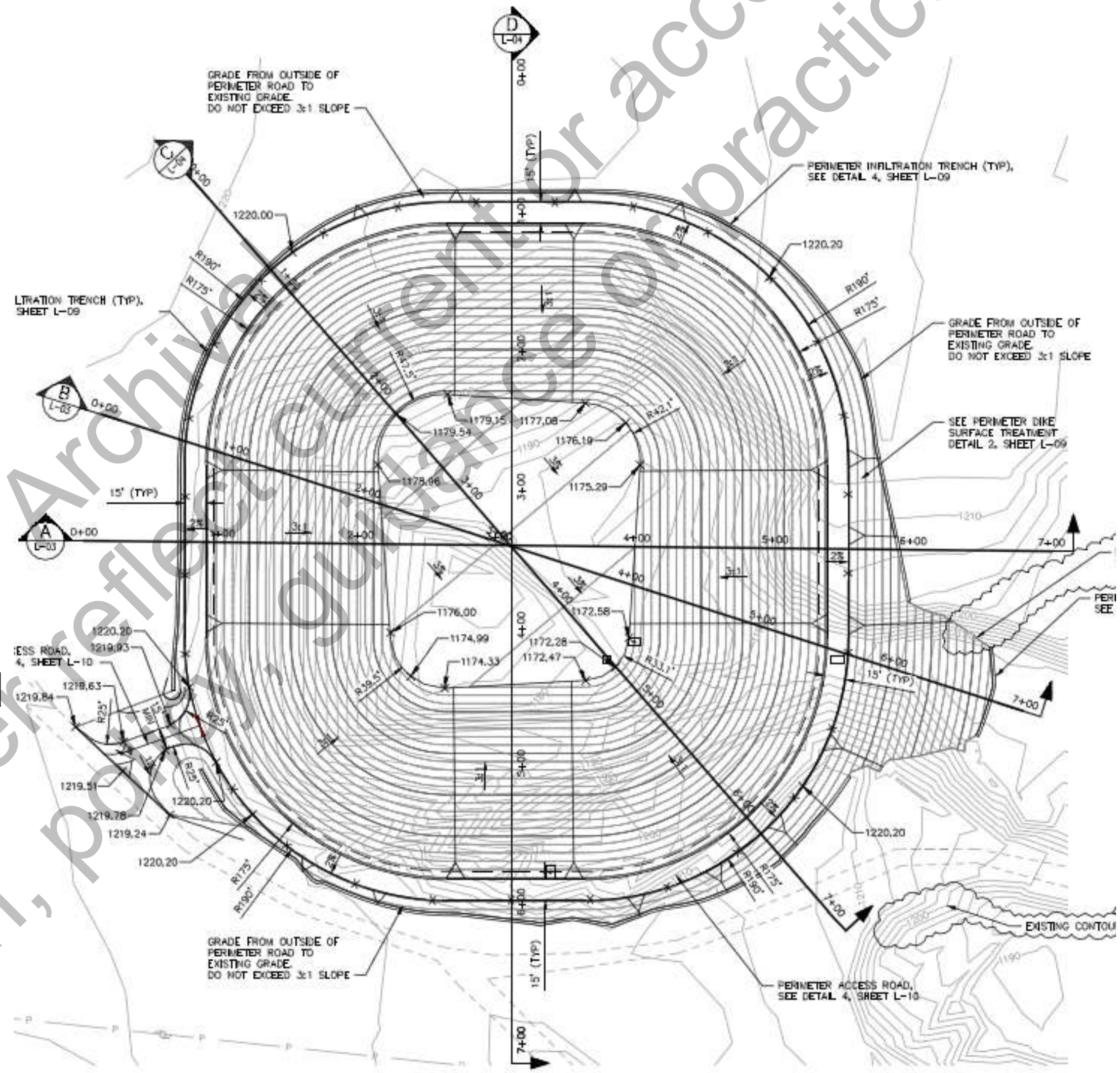
- No tangible electronic data
- Pixelized data
- Must digitize using software to import to CAD
- Lowest quality of data to import
- Typically from scans of plots



Types of Data Received by Contractors

Vectorized Adobe PDF's

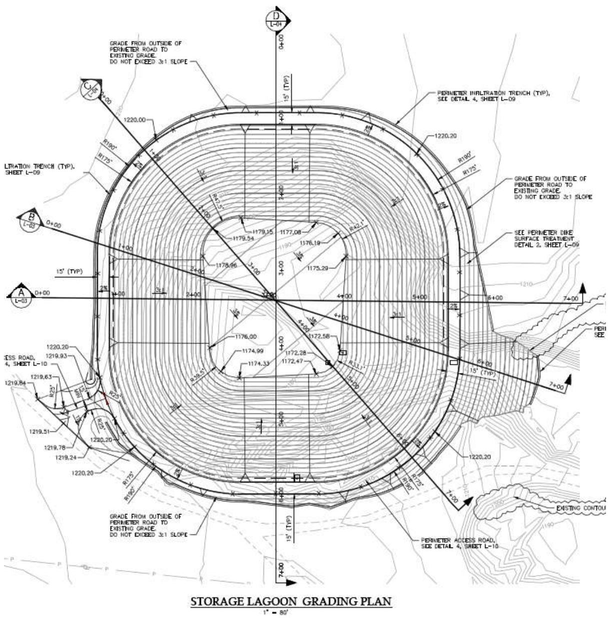
- Contains data with numerical values for lines, curves, etc.
- Direct export from design software
- Requires software to rebuild data for import to CAD
- Best PDF option

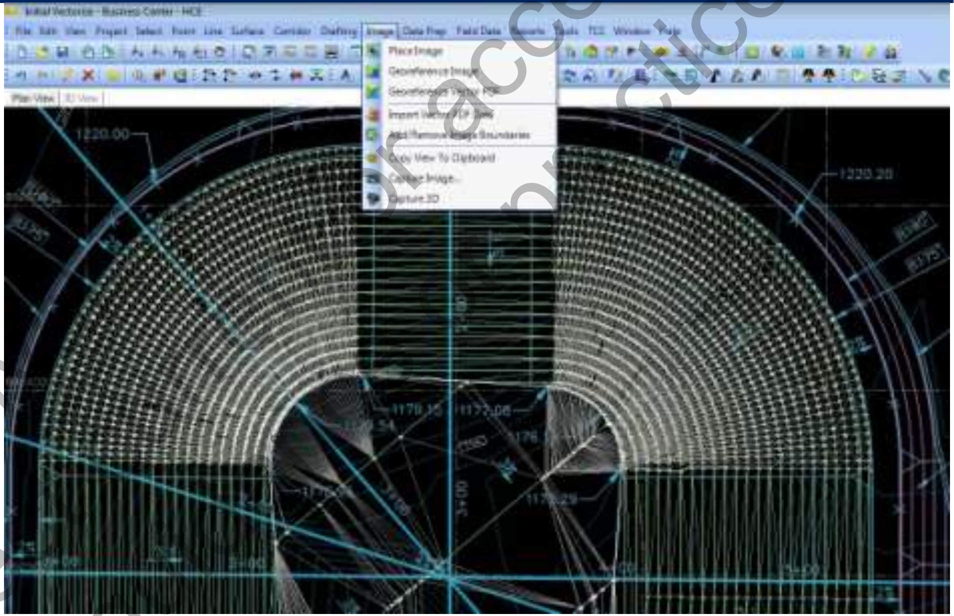


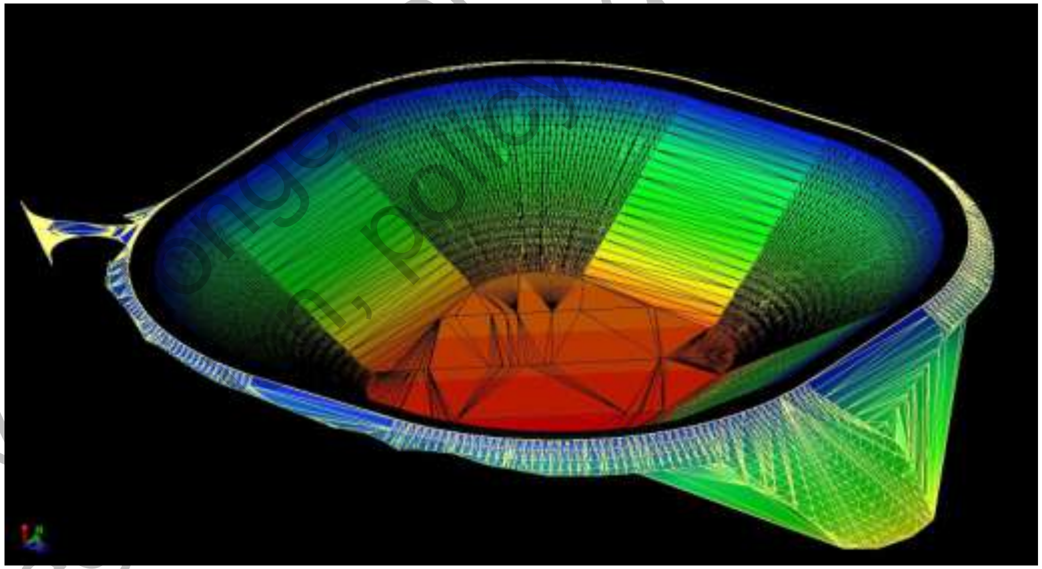
STORAGE LAGOON GRADING PLAN

1" = 80'

Vectorized PDF







Types of Data Received for Contractors

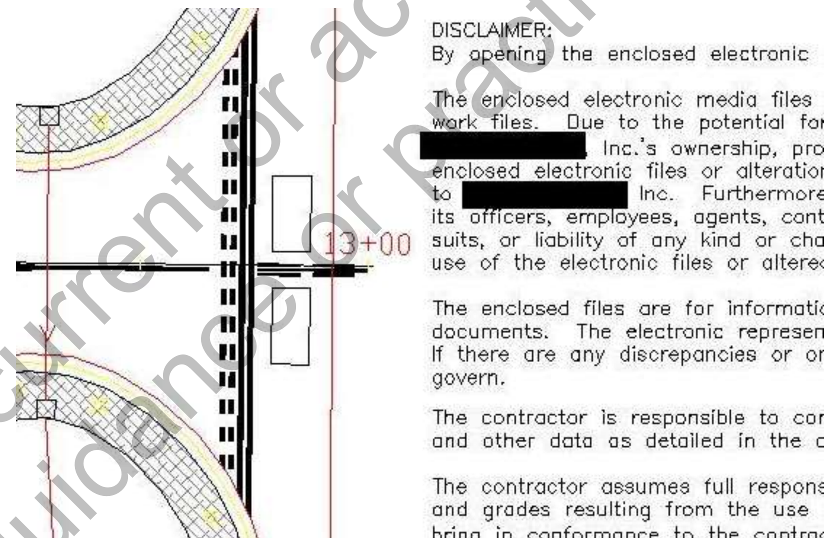
Electronic CAD and Design Data

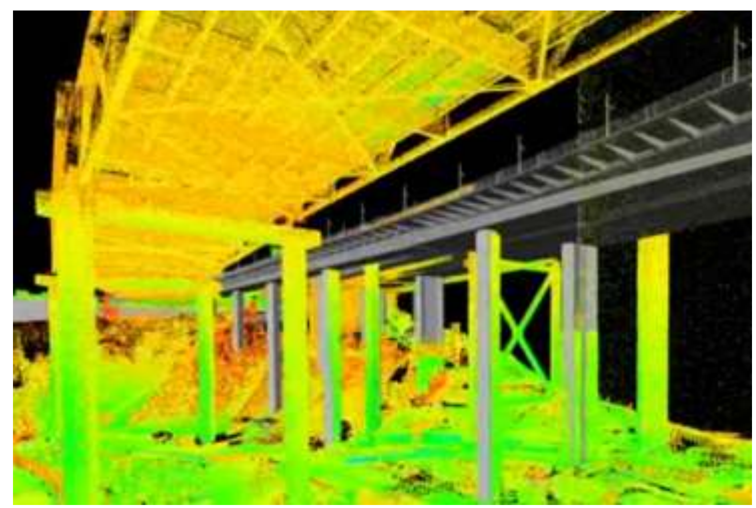
CAD formats (DWG, DGN, DXF, RVT, SHP)

- 2D & 3D files
- 3D polylines
- Surfaces
- Design information (profiles and assemblies)

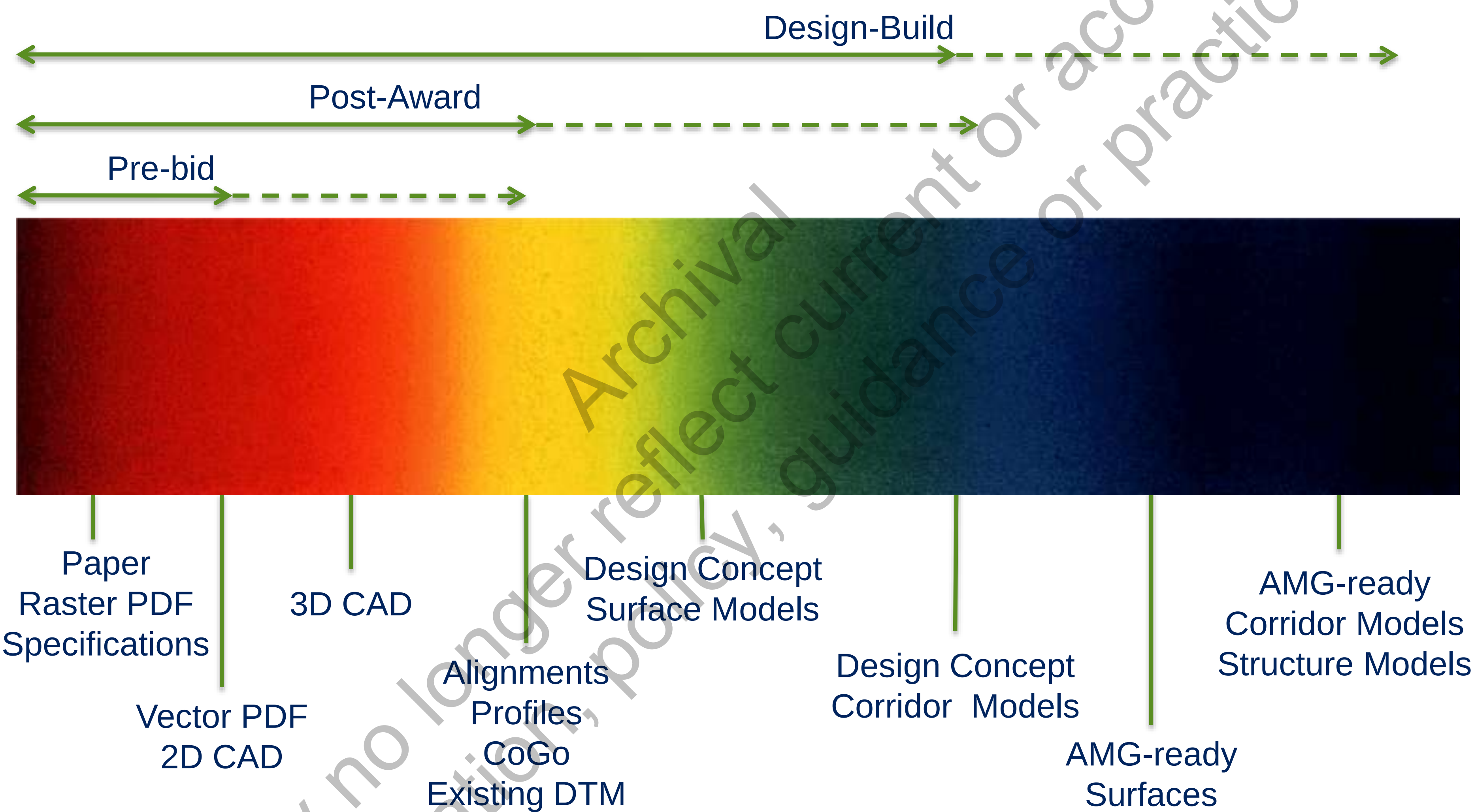
3D model exchange formats

- XML's (landXML, gbXML)
- DTM, TIN, NED (3D surface files)
- LAS (3D point cloud data)





Types of Data Received by Contractors

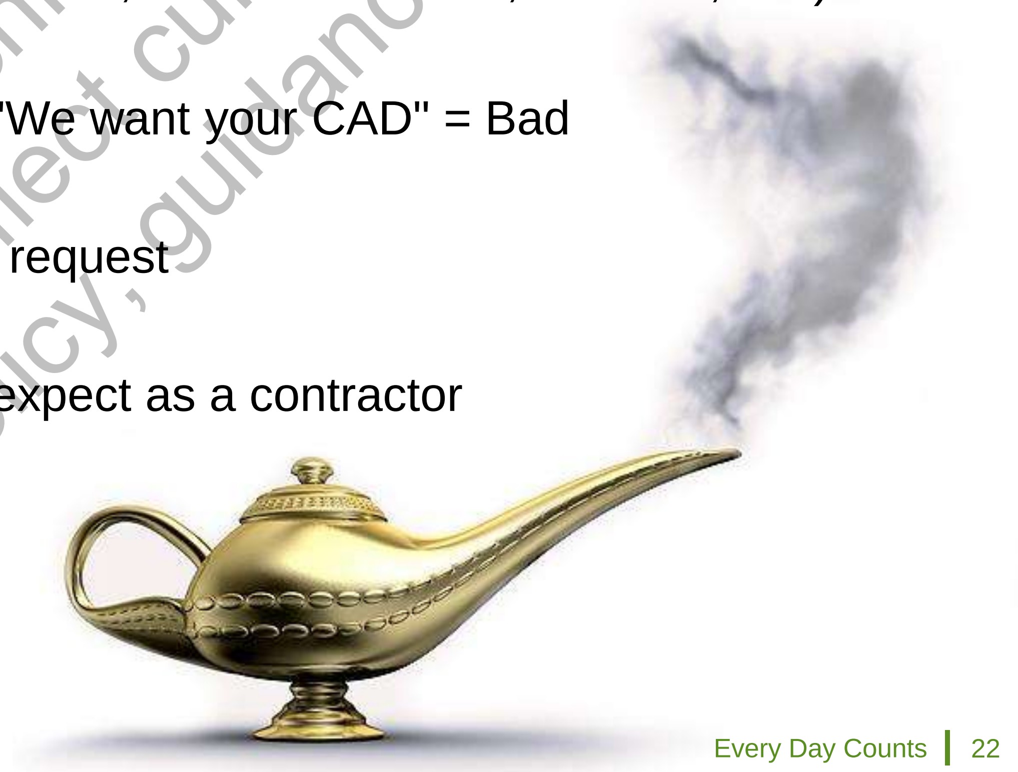


Know What to Ask For ...

Stop Asking For “CAD” and Start Asking for Project Specific Data Sets

When requesting Data remember these helpful guidelines:

- Using common terminology (File Format, Software Utilized, Release, etc.)
- Use non-threatening language ie: "We want your CAD" = Bad
- Internal training on expectation vs. request
- Managing expectations - what we expect as a contractor



Building 3D Models for Construction

When building a model the level of detail and accuracy is determined by the individual task, available data, and resource allocation.

The different types of 3D Models built are:

- Quantity Takeoffs
- Construction Ready
- Rework

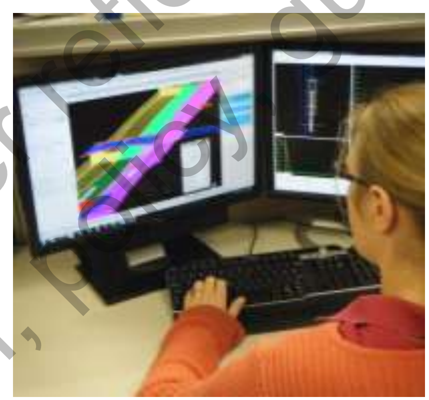
We start with a process we have coined **Forensic Plan Reading**

Quantity Take-off Model Workflow

Analyze Data

Meet with Project Managers

Digitize PDF Data



Create a 3D CADD Model

Building Efficiency Together

Export Quantities to Heavy Bid

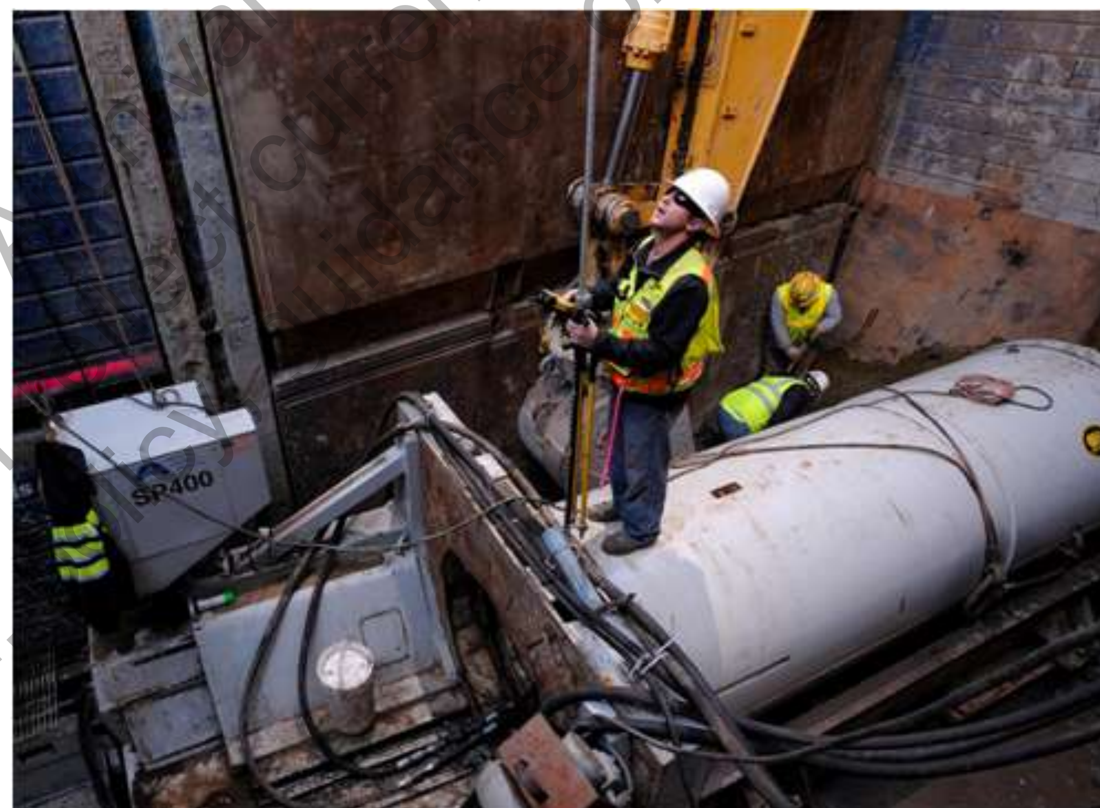
Building 3D Models for Construction

Construction Ready Data

Models have a very high level of accuracy and detail. They are easily revised or adapted in the event of a change of condition or change order directive.

Some uses of the construction ready model data are:

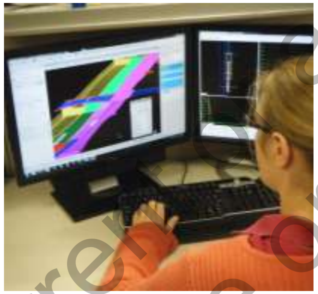
- Stakeout of Utilities
- Right of Ways
- Roadway Features
- Grading Limits
- Erosion Control Measures



Construction-Ready Model Workflow

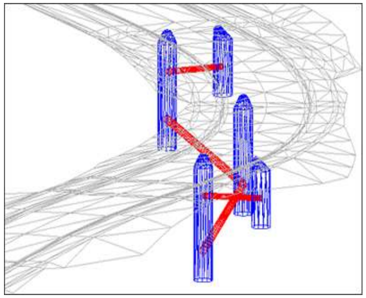
Analyze Data

Meet with Project Managers

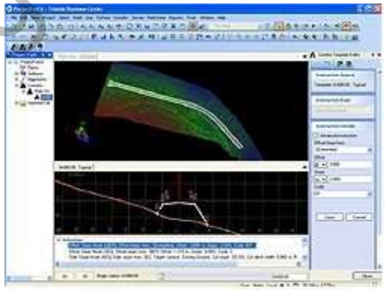


Supplement/ recreate data

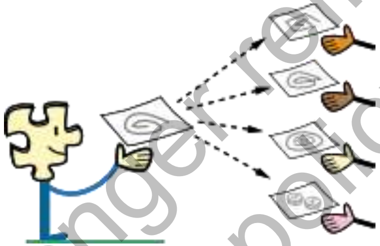
Review Means & Methods



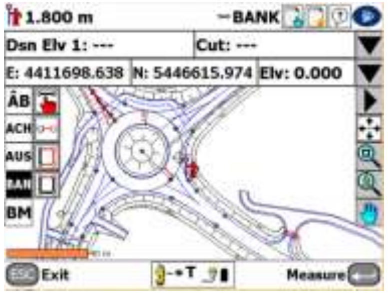
Create Grading & Utility Models



Review & Back-check Models



Share models with Engineering and Subcontractors



Migrate Data to the Field

Quantifiable Cost Savings

		Conventional Way	New Way AccuGrade	Productivity Gain
Staking		07:31	00:54	6:37 hours saved
Bulk Earthmoving	D6N 330D	04:40 02:23	04:18 01:53	+ 9 % + 27 %
Subgrade grading	D6N 330D	03:48 02:56	01:28 02:43	+ 159 % + 8 %
Base Course grading	D6N	02:24	00:53	+ 172 %
Base course fine grading	140H	01:49	00.32	+ 241%
Total		**24:32**	**11:50**	**+ 101%**

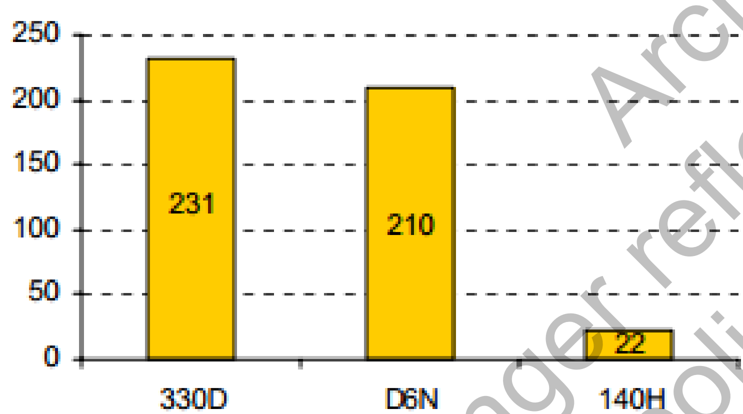
Additional Head count	Conventional Way	New Way	Gain
Foreman	Full Time **24:32 hours**	Full Time **11:50 hours**	**Half time**
Operators (x4)	98:08 hours	47:20 hours	**Half time**
Surveyor	18:14 hours	00:54 hours	**95 % of time saved**
Worker	18:14 hours	-	**1 person less**

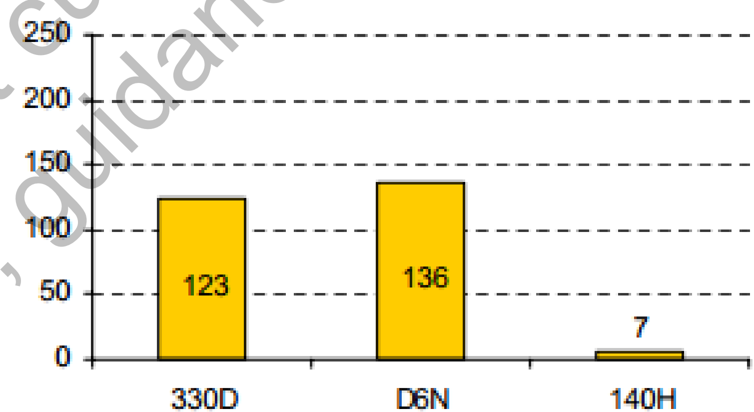
Accuracy	Conventional Way % in Tolerance of ± 3 cm	New Way % in Tolerance of ± 2 cm
Subgrade	35%	86%
Base course	45%	98%

Minimized Environmental Impact

3.9 – Fuel consumption

Conventional Way	New Way – AccuGrade
Design: SouthRoad	**Design**: NorthRoad





Improved Safety and Reduced Exposure to Hazards

Are 3D models reviewed prior to construction?

- 3D model review is required by the owner
- 3D model review is volunteered by the contractor
- 3D model review is requested by the designer
- No 3D model review occurs

Managing Revisions

A 3D Model Simply and Clearly Communicates Revisions & Issues

- Share models and issues with engineering and subcontractors
- Review issues in 3D Design or requested changes
- Meet with Project Managers
- Propose resolution
- Proposed revision made to In-House Drawing
- Send revised drawing with RFI to Design Engineer
- Receive authorization to proceed (faster turn-around)
- Migrate data to Field

Legal Concerns of Contractor Generated 3D Models

Contractors Concerns Using 3D Models

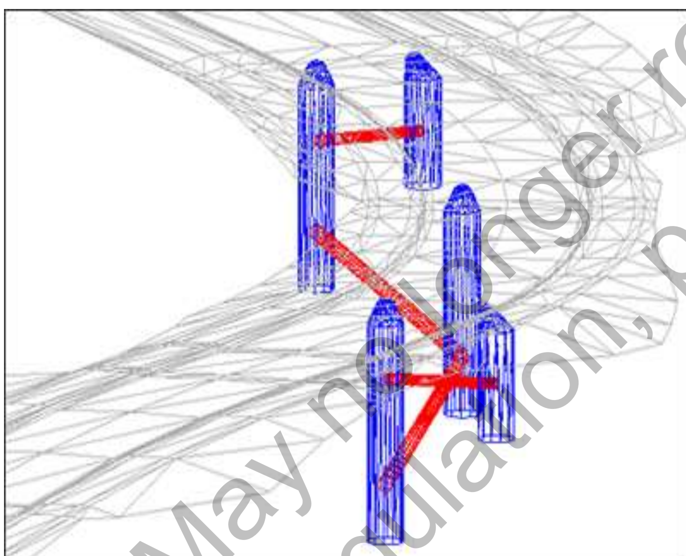
- Professional design responsibility
- Liability for design intent
- Determining Means and Methods of construction
- Taking responsibility for updating models and ensuring accuracy

As-Builts from 3D Models & Integrated Field Data

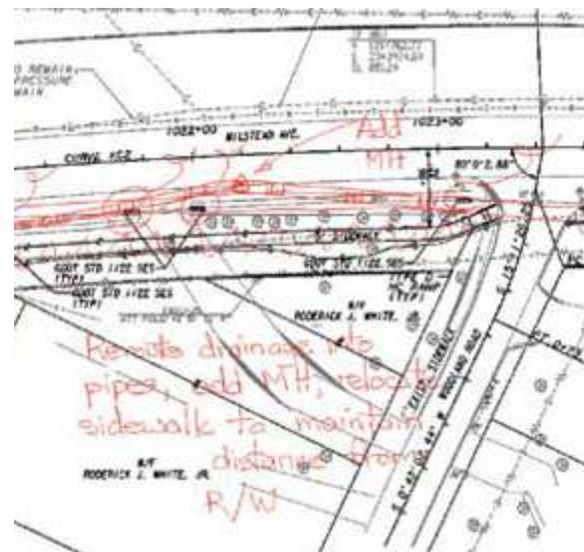
As-Builts

On a grading or road project 3D as-built data may include:

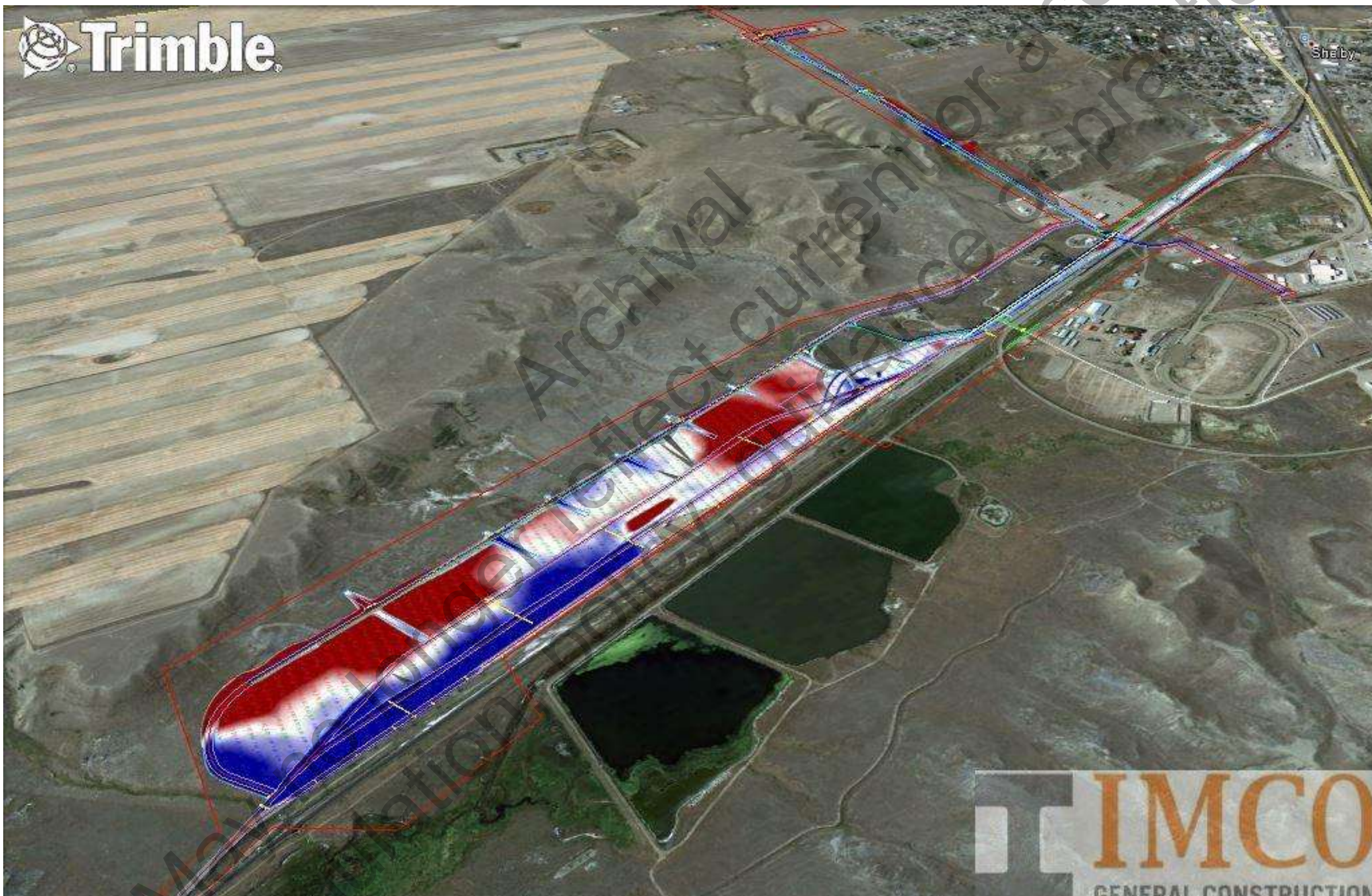
- XML or DTM of prepared surface topo
- XML or DTM of final as-built
- ASCII, CSV or DWG containing point groups of all surfacing survey points
- 3D linework or pipe network of installed utilities
- ASCII, CSV or DWG containing survey data on newly installed and existing utilities located
- 3D Laser Scans in PTS or LAS format



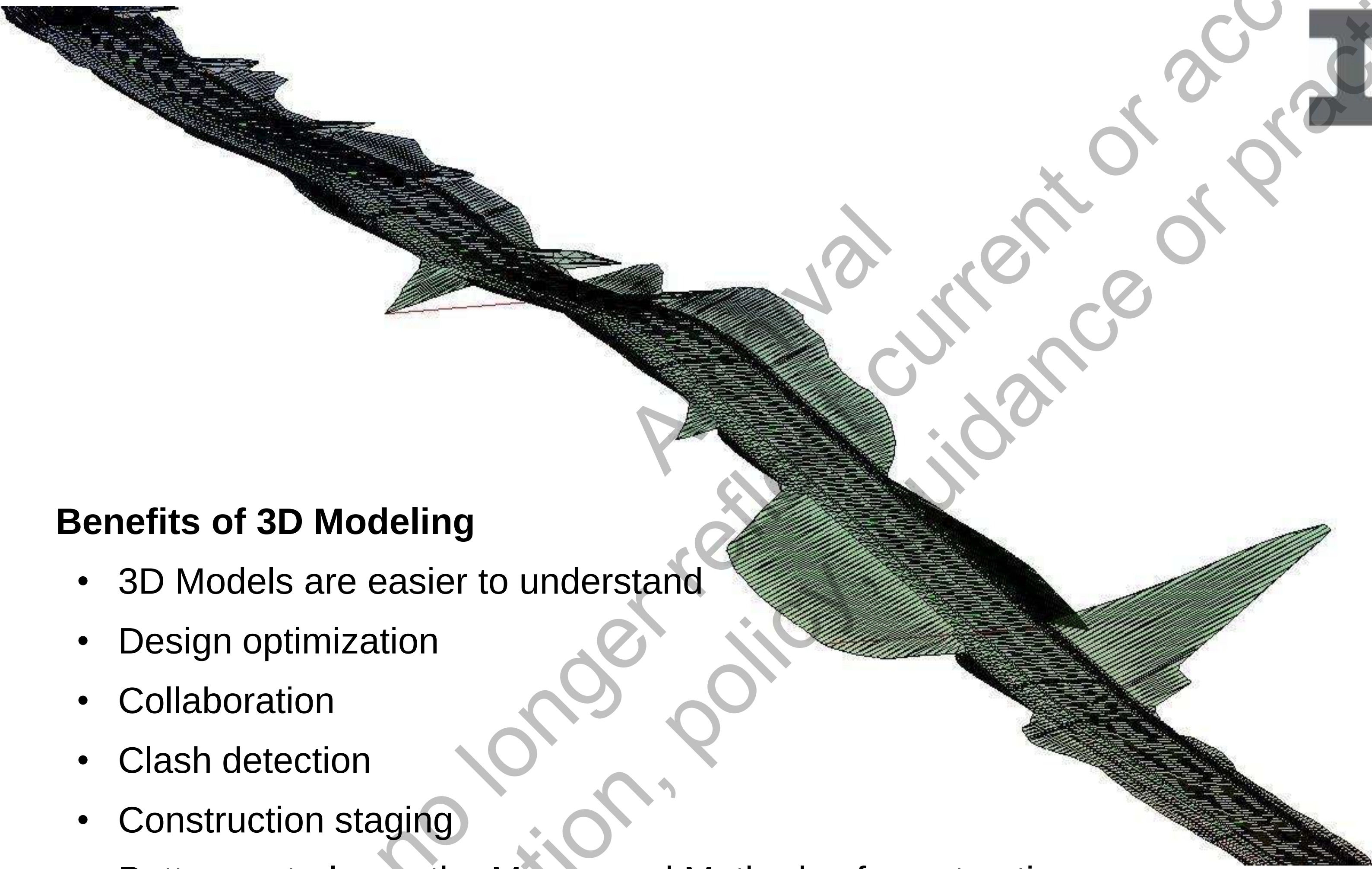
VS



Benefits of Sharing Models with Owners & Subcontractors



Benefits of Sharing Models with Owners & Subcontractors



Benefits of 3D Modeling

- 3D Models are easier to understand
- Design optimization
- Collaboration
- Clash detection
- Construction staging
- Better control over the Means and Methods of construction
- Management of expectations

Verify Learning Outcomes

- List different ways to create 3D Engineered Models for Construction
- Describe how 3D models can be used for Quantity Take-off

Contact Information

Thank You! Please feel free to contact either of us directly.

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Planning Construction Activities and Clash Detection

Karthik Ramkrishnan (RK)

The Walsh Group

Every Day Counts

innovation ingenuity imagination invention

U.S. Department of Transportation

Federal Highway Administration

Learning Objectives

- Describe different ways to plan construction activities using 3D models
- Discuss different uses of clash detection

How extensive is your 3D pre-planning?

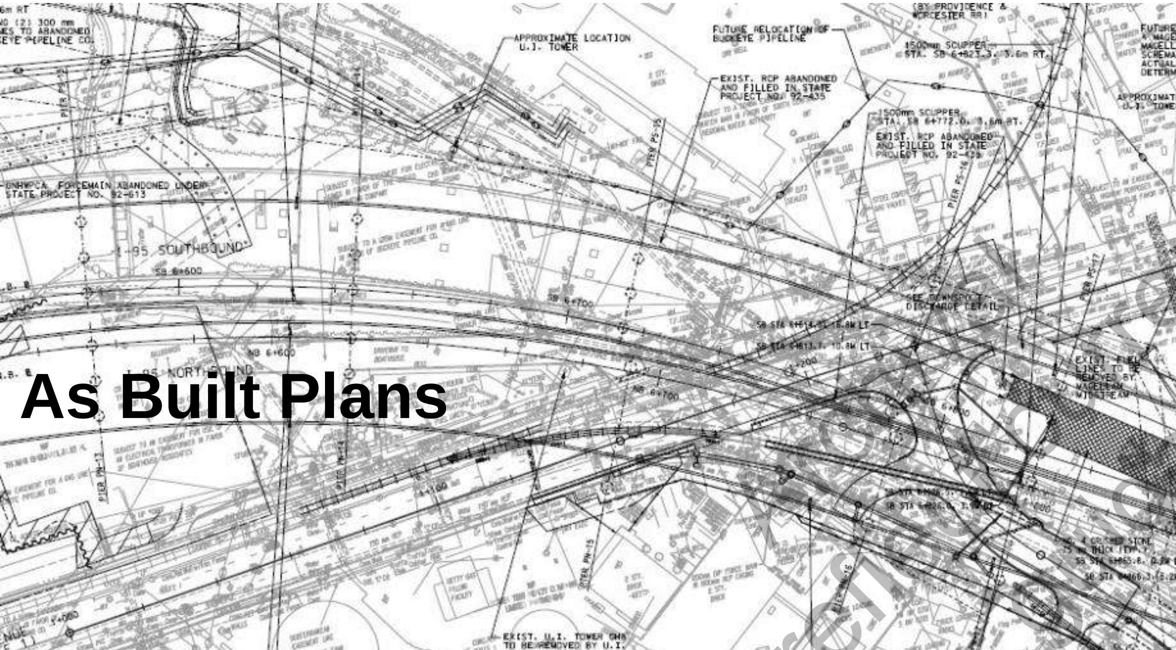
- Review project staging
- Review MPT/MOT staging
- Plan equipment movements
- Prepare critical pick plans e.g. erection sequences
- Prepare graphics for constructability reviews
- Prepare graphics for public involvement
- We do not pre-plan in 3D

Basics of Jobsite Planning

<u>Crucial activity for the Contractor</u>

- Planning starts at **bid time**
  - Access to/from the jobsite
  - Resource location (Material + Equipment)
  - Construction clearance from existing utilities
- **Dynamic** nature of construction – Job Phasing

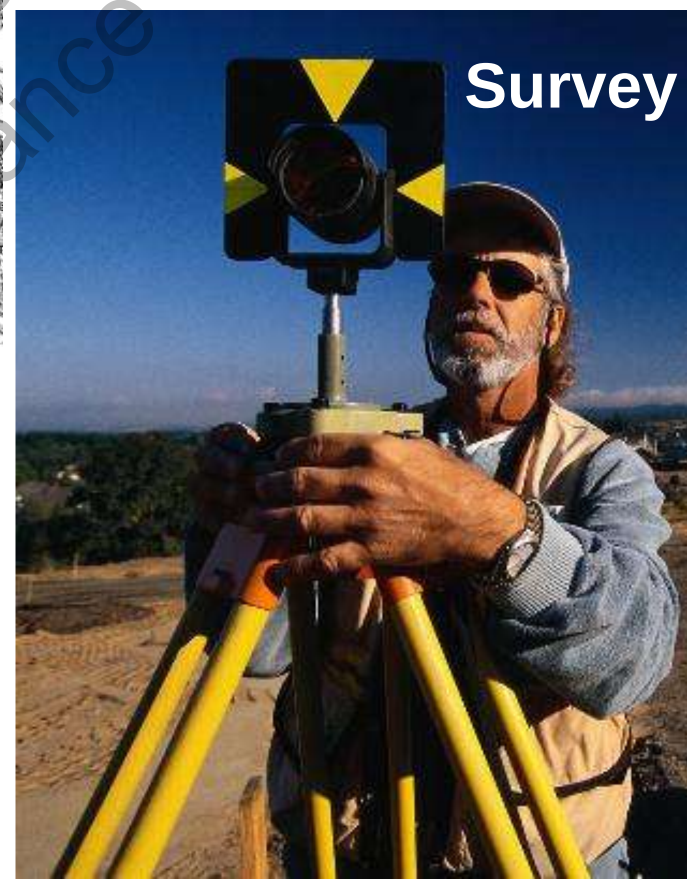
Basics of Jobsite Planning - Options



As Built Plans

- As Built condition – **Valid/ Accurate?**

Use Internal Resource



Survey

Image Courtesy : Google Images

Basics of Jobsite Planning - Options

Use External Resource

- **Latest condition** ?
- Visual Aid
- Street view – Only Major roads

Image Courtesy : Google Maps

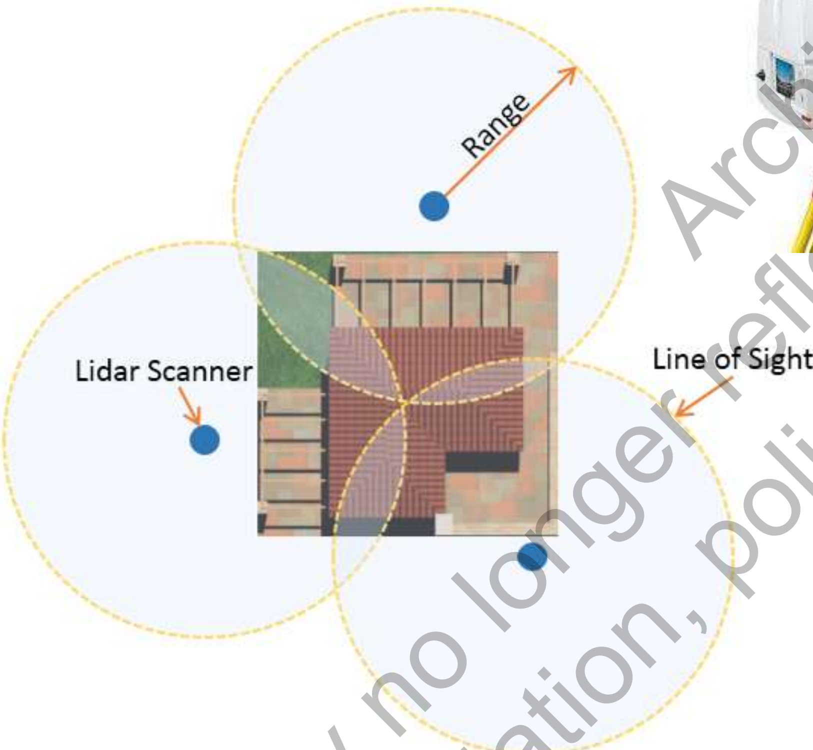
Basics of Jobsite Planning - Options

Take Photos

Basics of Jobsite Planning – Options

- LiDAR (Light Detection and Ranging)

  Refer Webinar Series 2 – Supporting 3D Design by John Krause (FDOT) @ www.fhwa.dot.gov/3D/



Captures - **What you see**

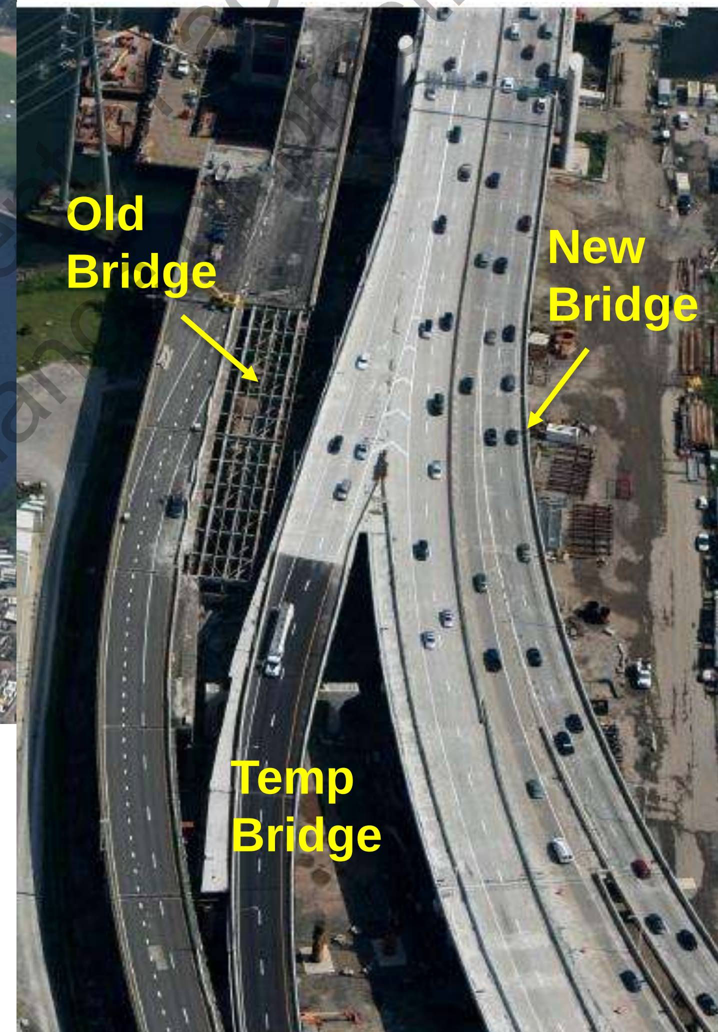
Scan
- Set Survey Control points
- Gather 3D information /data set

Register
- Stitch multiple scan data sets together to generate one contiguous point cloud

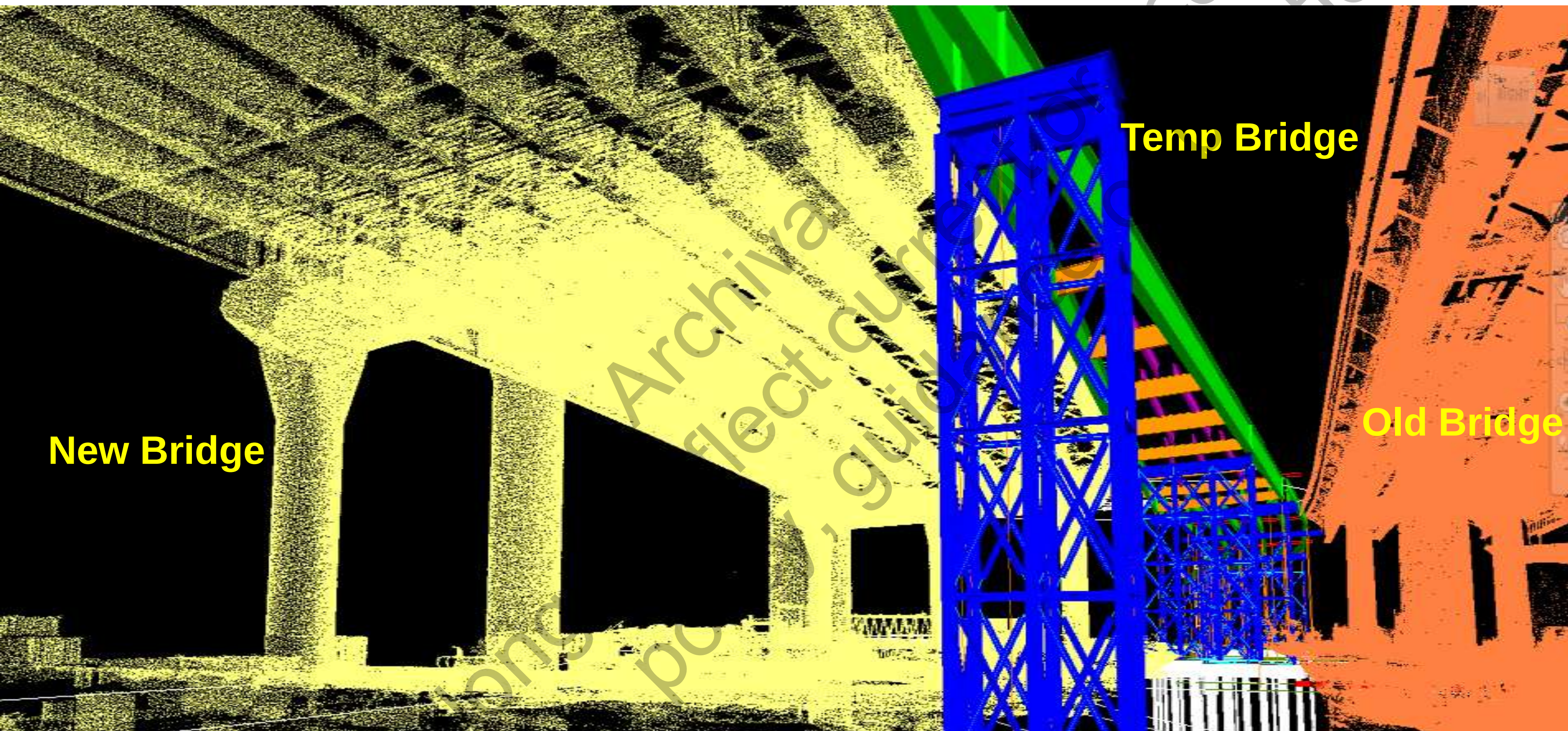
Classify
- Clean up and remove Noise, if any
- Categorize point cloud to assist modeling

Image Courtesy : Google Images

LiDAR Scans - Example



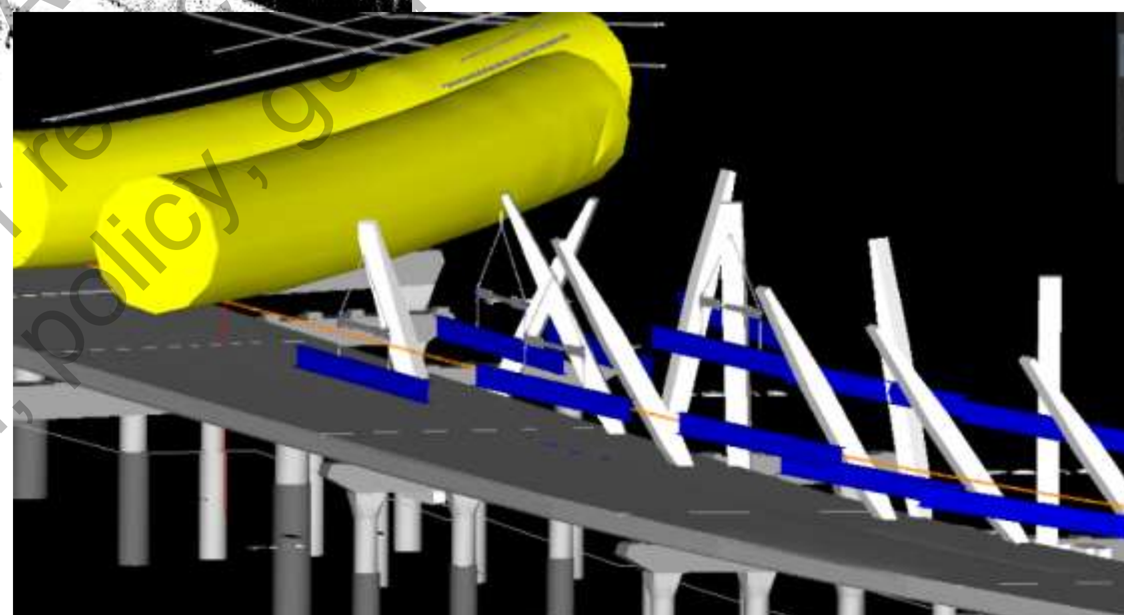
LiDAR Scans - Example



LiDAR Scans - Example

OSHA Requirement
1926.1408(a)(2)(iii) Table A

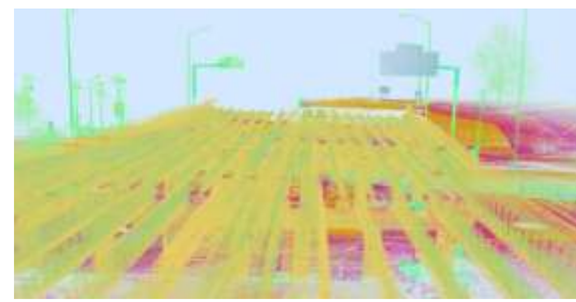
50-200kV ~ 15' clearance
(115kV)



Walsh Requirement
Min. 20' clearance even for De-Energized line.

Walsh Construction Company - PCL Joint Venture II

LiDAR Scans - Lessons Learned

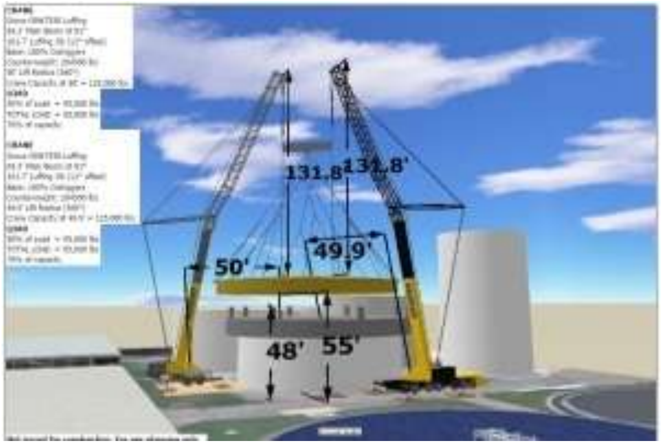


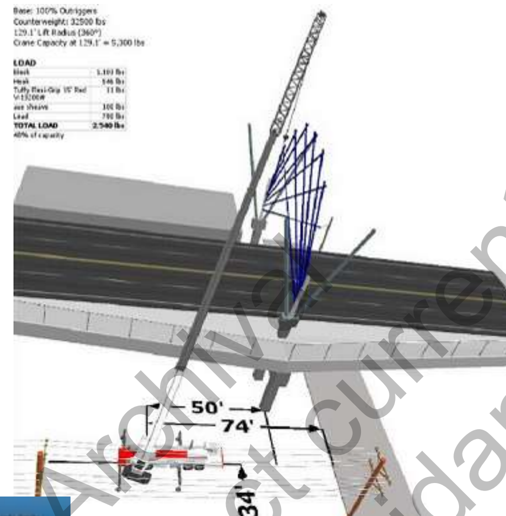
- **Post Processing - Scan data**
  - Aligning scan data to correct State Plane coordinates – **Need Survey**
  - Carefully clean **NOISE** – Live Traffic, Vegetation, etc.
  - Point Cloud density (Size) / Photogrammetry – RGB value/ Intensity

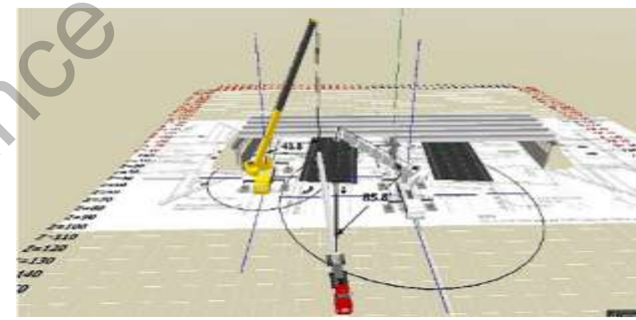
Complex Virtual Mock-ups

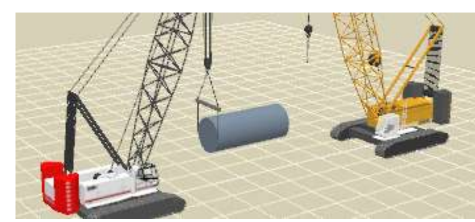
Milton - Madison Bridge
Kentucky / Indiana

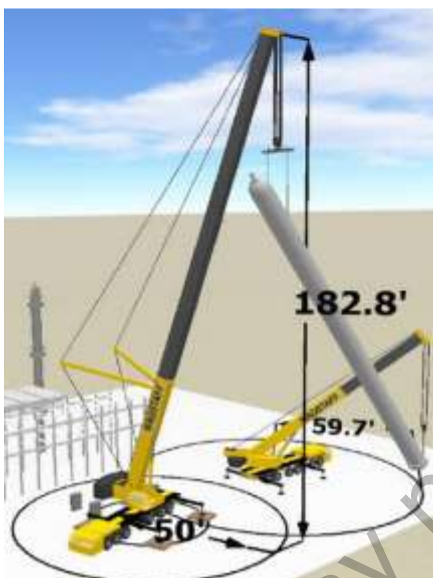
Critical Construction Simulation











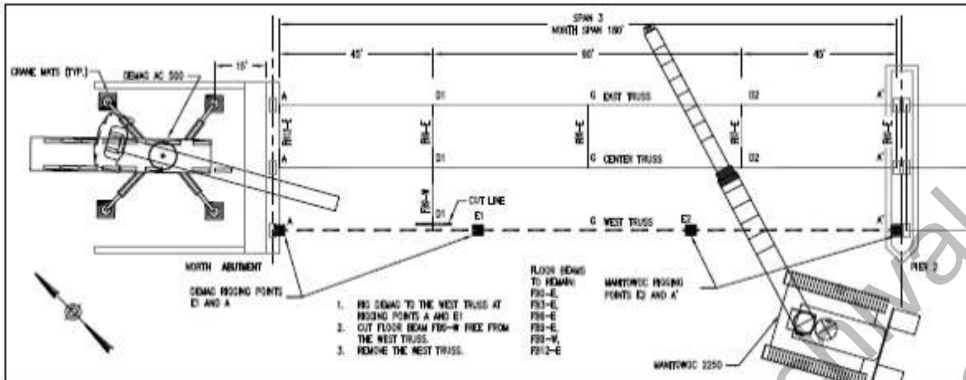
3D Lift Plan

- Visualize/ Simulate crane picks with defined weight and ambient conditions.
- Accurate dimensions with In-Cabin Load charts +900 crane models
- Provides most economical crane configuration.

3D Models of all Construction Equipment available online - VALIDATE

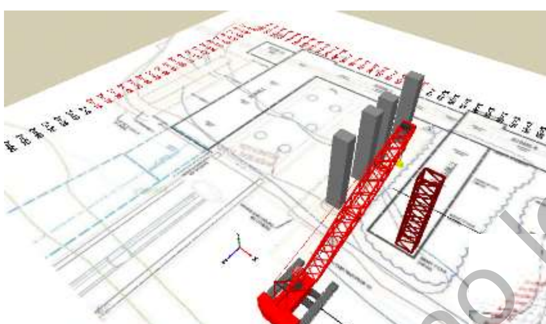
Image Courtesy : 3D Lift Plan (http://www.3dliftplan.com/)

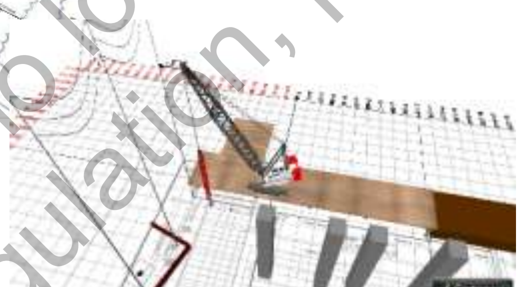
Critical Construction Simulation - Examples

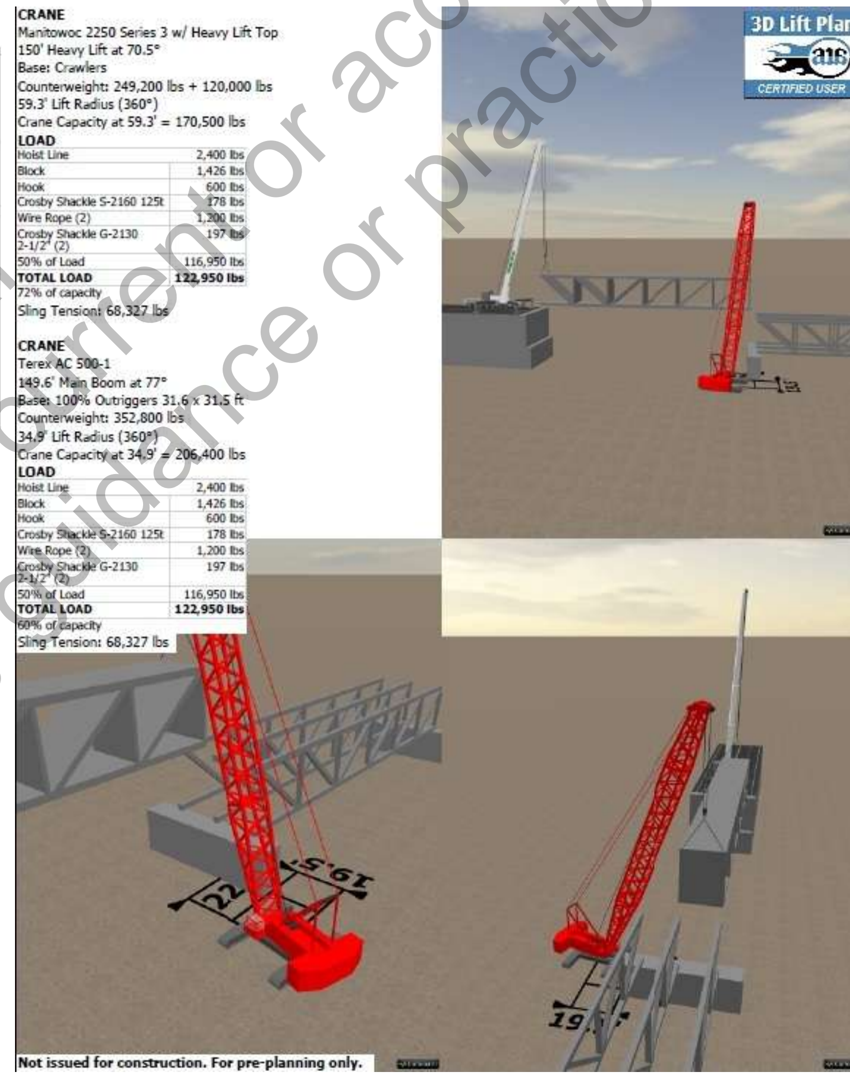


Validate

Safe Crane Pick

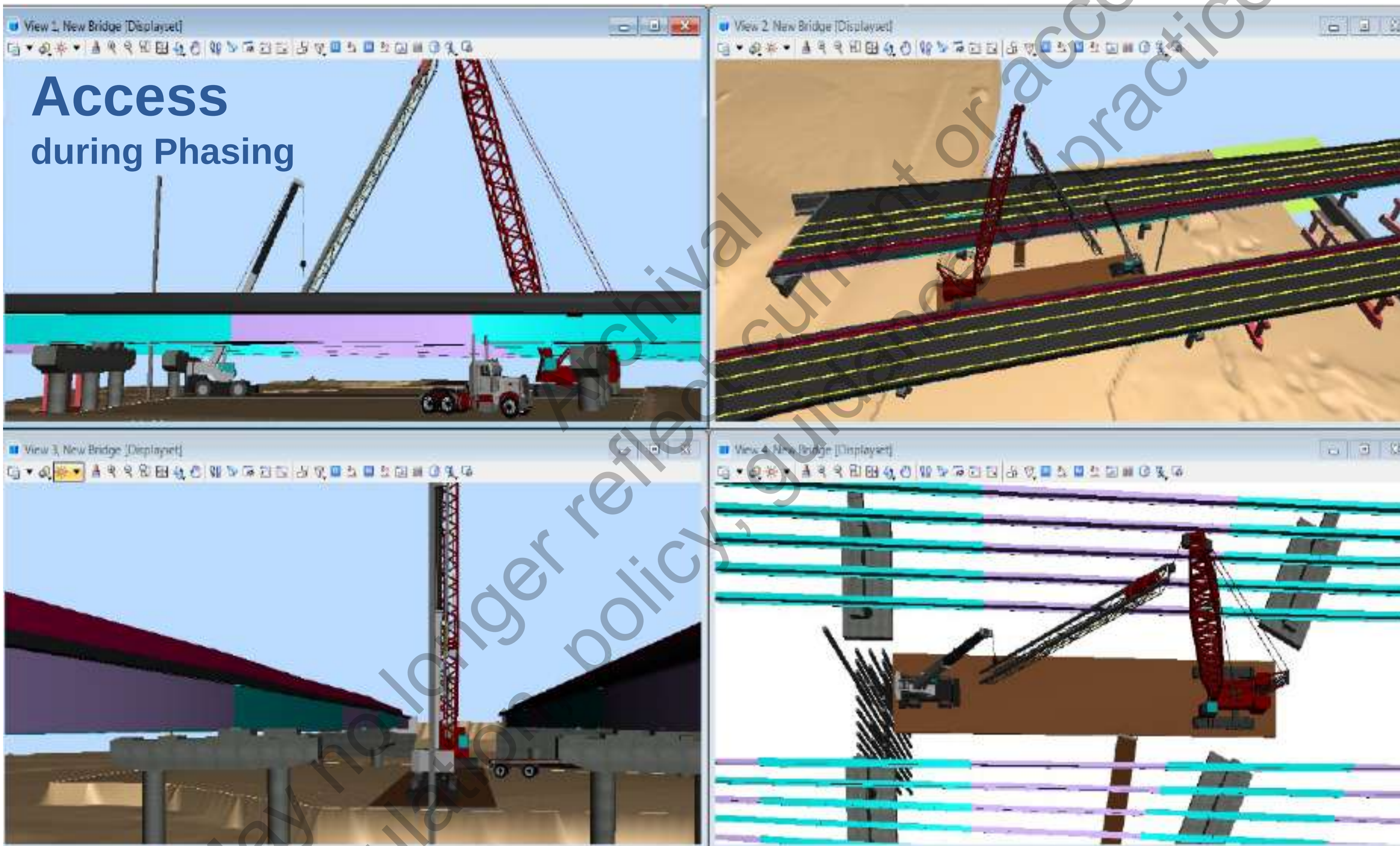






Critical Construction Simulation - Examples

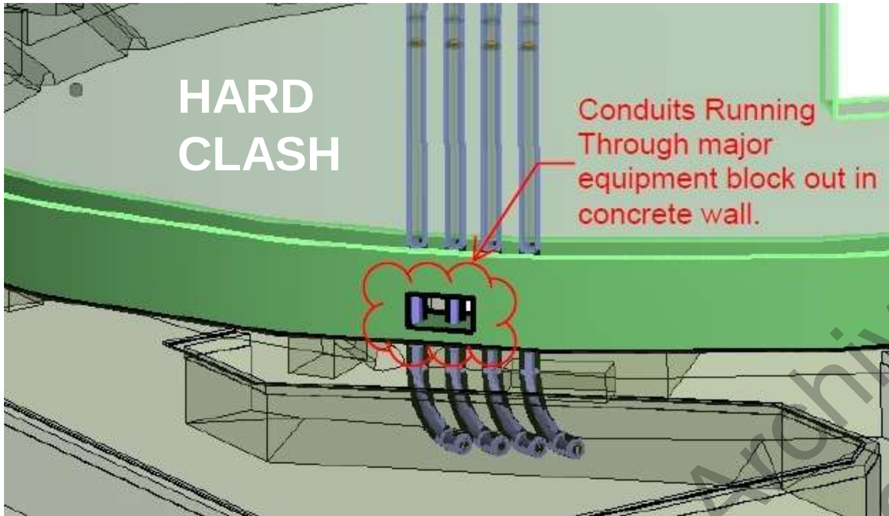
Access
during Phasing



Do you use 3D clash detection?

- Always
- Usually
- Sometimes
- Would like to
- No

Clash Detection in Heavy Construction



CLASH DETECTION

Avoiding field issues ahead of time

- Hard Clashes – Members directly conflict
- Soft Clashes – Tolerance issues
- Time related - Constructability issues

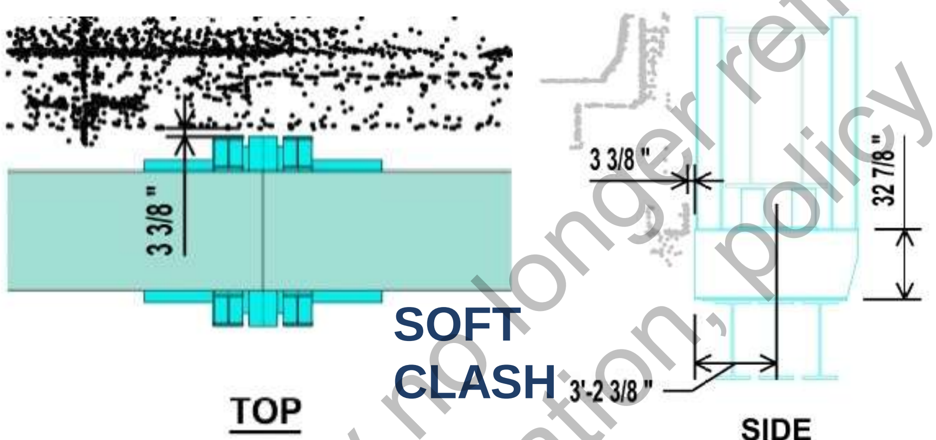
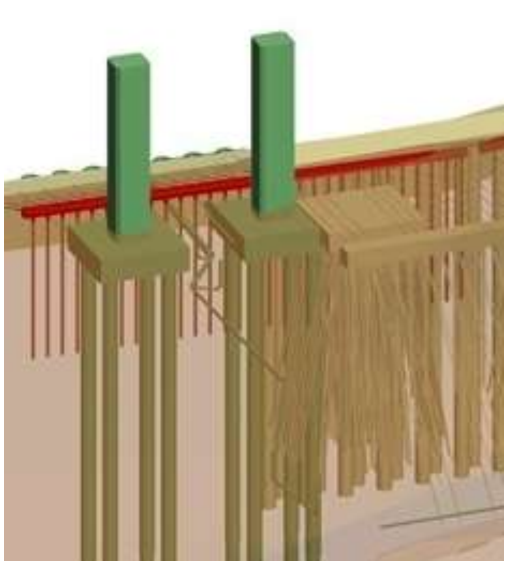
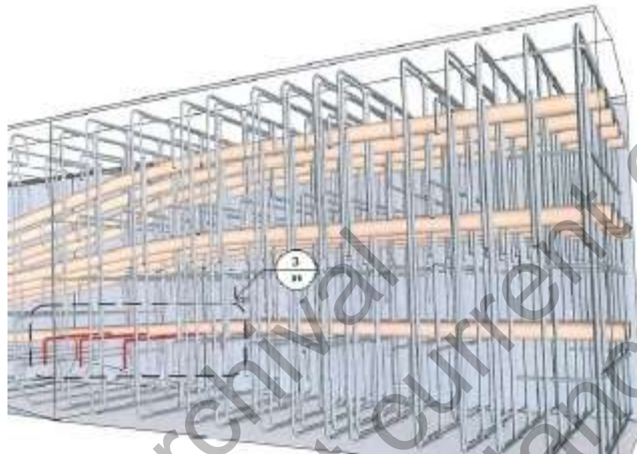
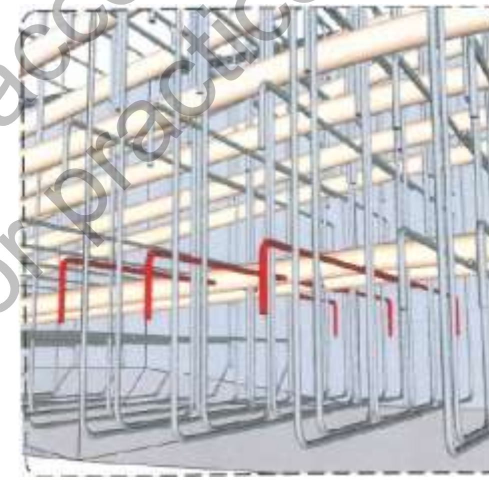


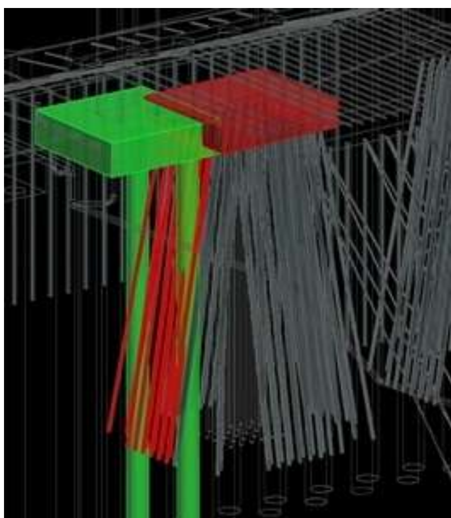
Image courtesy- Synchro

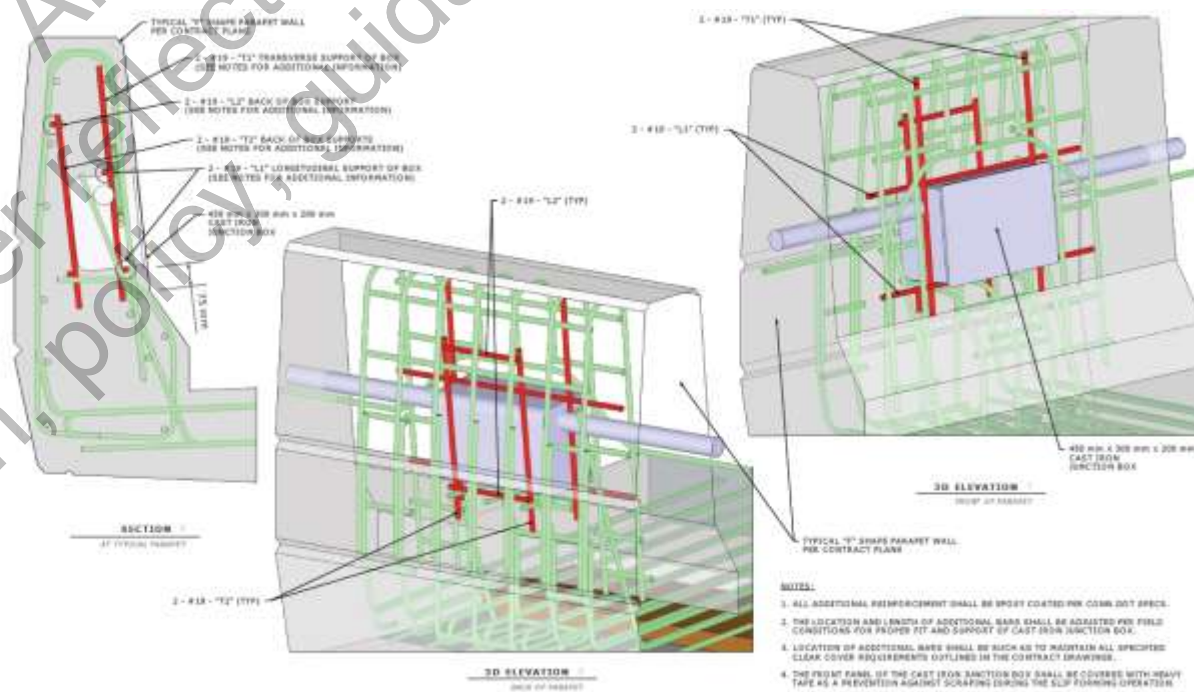
Clash Detection - Examples





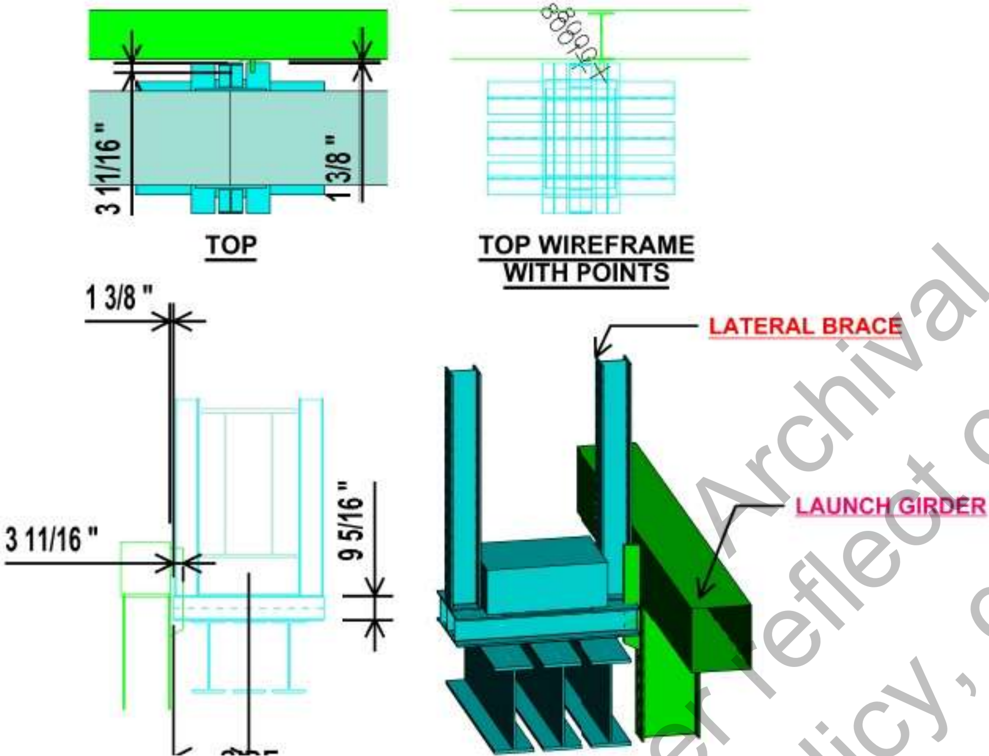






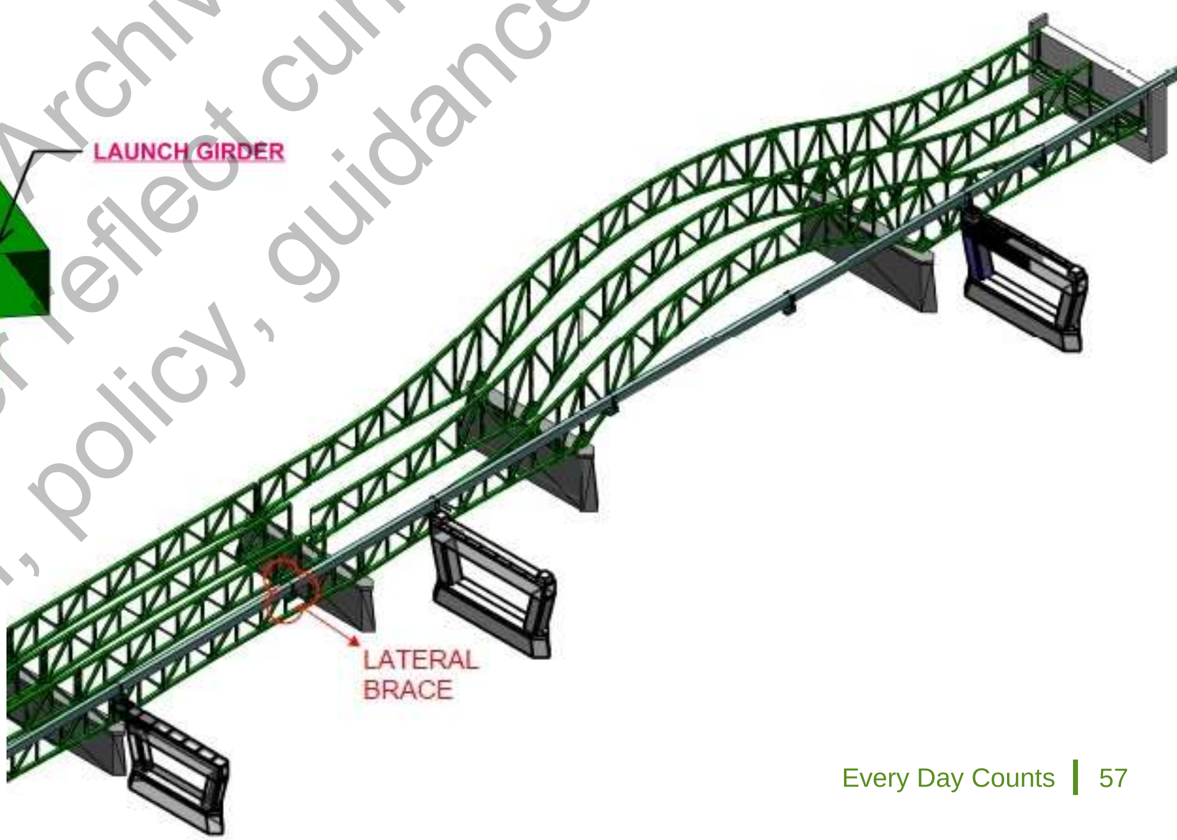
WALSH

Clash Detection - Examples

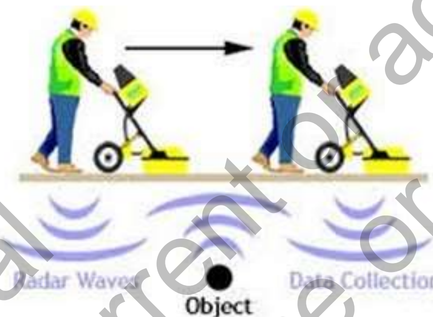


Identify Tolerance Issue

in the virtual world.



Unknown Risk – We know what we see



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Know what's below. Call before you dig.

Underground Utilities

As an Industry we all share tremendous risk when dealing with underground utilities.

- Outdated Utility Plans – Old abandoned lines are still found On-Site, causing delay and additional cost.
- Technology Inhibitions – Advanced GPR can only provide approximate details, range restrictions.
- Reliance on Test Pits

Image Courtesy : Google Images/ Bentley

Verify Learning Outcomes

- Describe different ways to plan construction activities using 3D models
- Discuss different uses of clash detection

Executing Construction with 3D Engineered Models

Ryan Forrestel

Cold Spring Construction

U.S. Department of Transportation
Federal Highway Administration

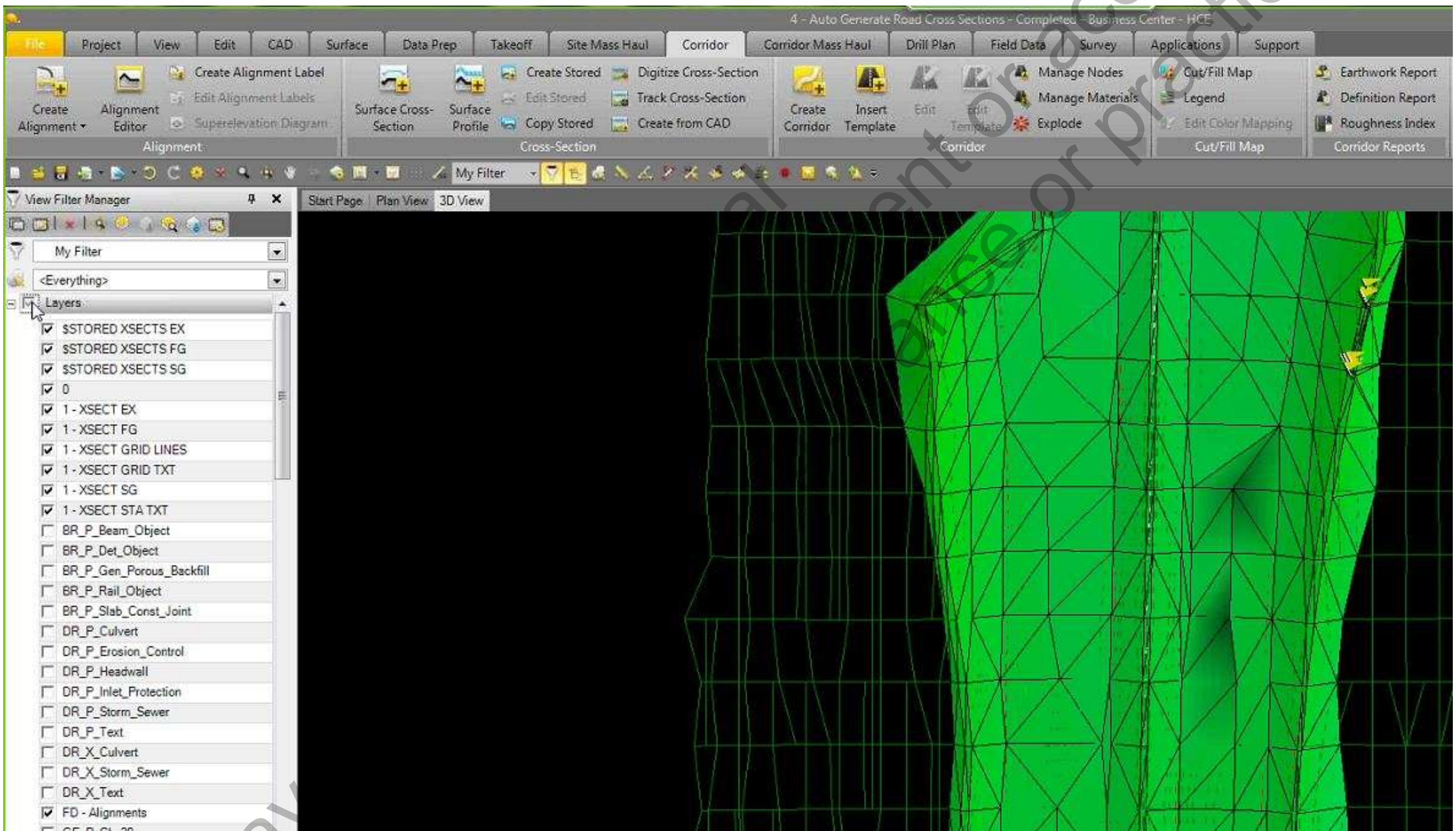
Learning Objectives

- Describe how 3D models are used with survey equipment to execute construction
- Discuss the different equipment/model needs to achieve tolerance for different construction activities

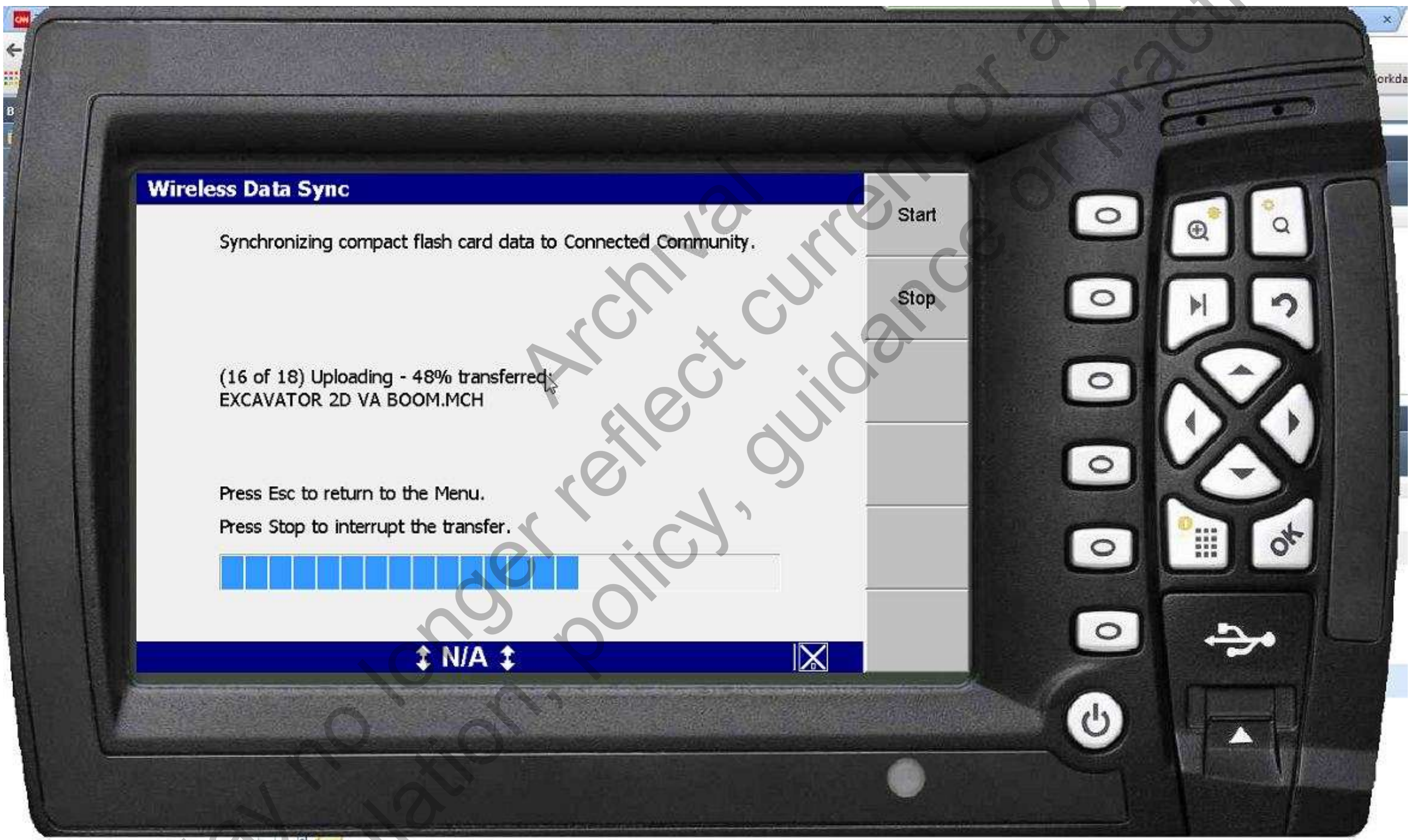
How do you use electronic design data?

- To get a better understanding of the plans
- Creating a construction model for AMG
- Checking a finished model
- Construction layout with rovers
- Checking construction tolerances (QA)
- Determining quantities for payment (Measurement)
- Other (please identify in Chat)
- Do not use it

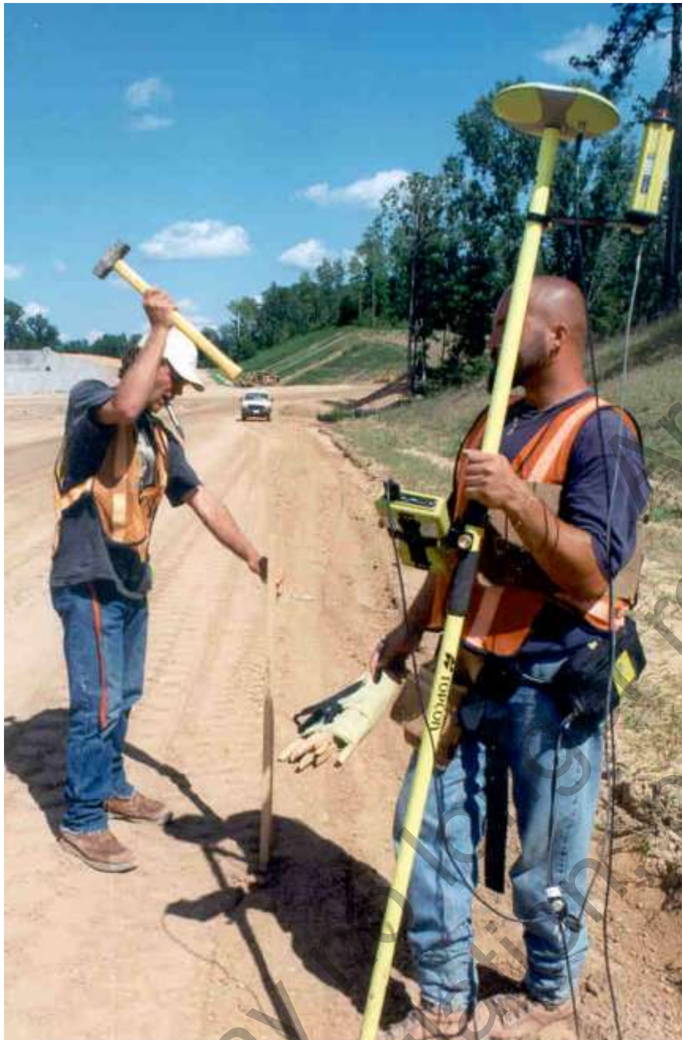
Preparing Models for AMG



Preparing Models for AMG



Using 3D Models for Layout



Pictures Provided by Jason Billerbeck of Peterson Contracters Inc.

Stakeless Grading

Stakeless Grading

Stringless Asphalt Paving

Stringless Concrete Paving

Stringless Concrete Paving

Enhanced Safety

Verify Learning Outcomes

- Describe how 3D models are used with survey equipment to execute construction
- Discuss the different equipment/model needs to achieve tolerance for different construction activities

Upcoming Webinars and Close

Douglas Townes, P.E.
FHWA Resource Center

U.S. Department of Transportation
Federal Highway Administration

3D Engineered Models Webinar Series

Webinar 1: Overview of 3D Models for Construction
Webinar 2: Creating 3D Engineered Models
Webinar 3: Applications of 3D Models in the Contractor's Office
Webinar 4: Applications of 3D Models on the Construction Site
Webinar 5: Managing and Sharing 3D Models for Construction
Webinar 6: Overcoming Challenges to Using 3D Models for Construction
Webinar 7: Steps to Requiring 3D Engineered Models for Construction
Webinar 8: Adding Time, Cost and other Information to 3D Models

Up Next: Webinar 4

Applications of 3D Models on the Construction Site

April 2, 2014

1:00 pm – 2:30 pm

www.fhwa.dot.gov/3D

Douglas.townes@dot.gov