

Applications of 3D Models in the Construction Office

February 19, 2014

1:00 pm – 2:30 pm EST



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>

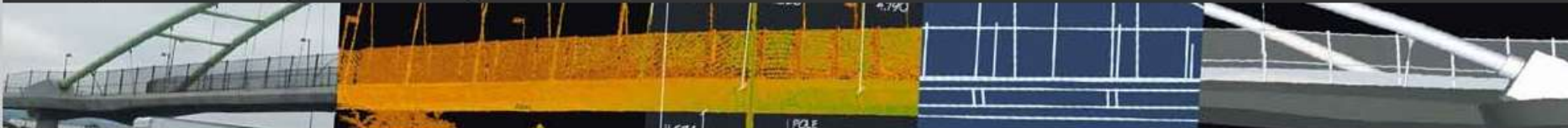
U.S. Department of Transportation
Federal Highway Administration

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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.

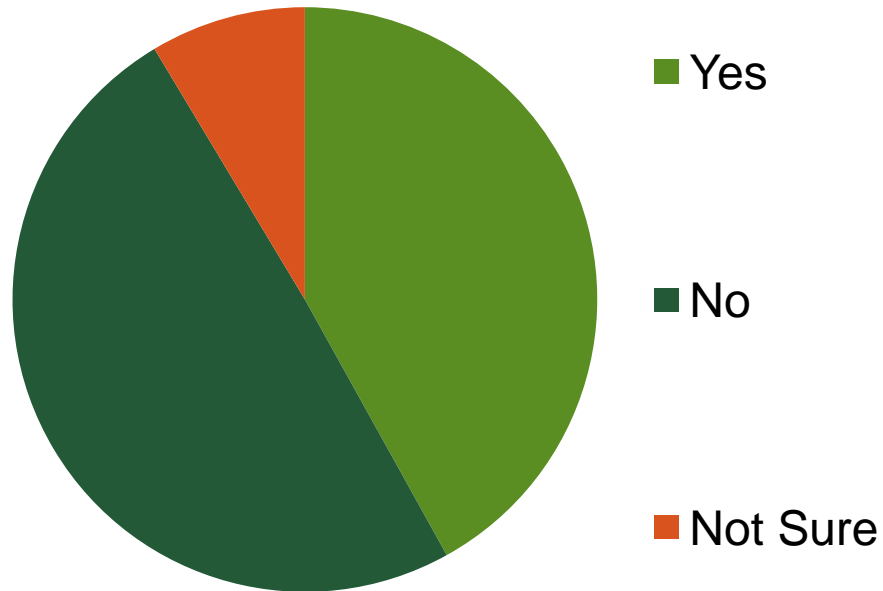
Recorded Webinars

- [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

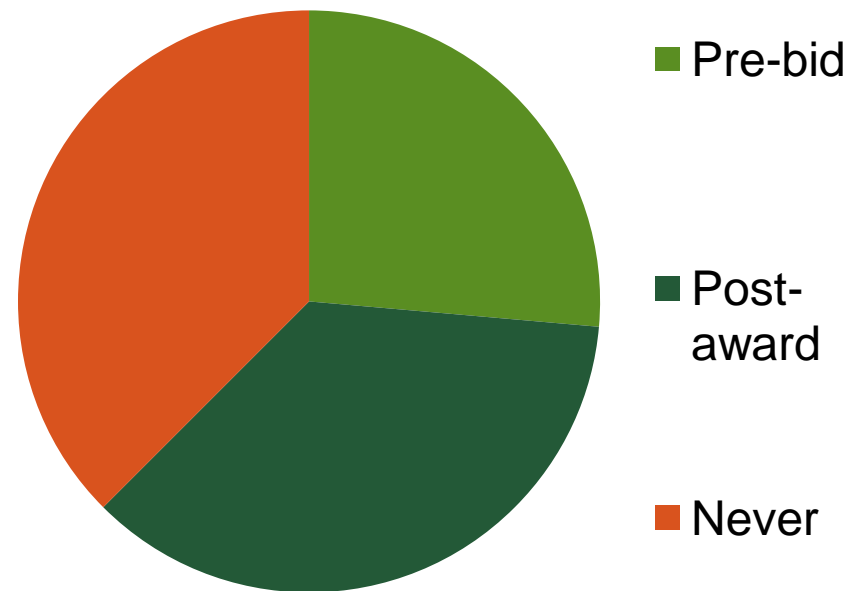


What you told us: Webinar 1

Does your agency produce 3D deliverables?



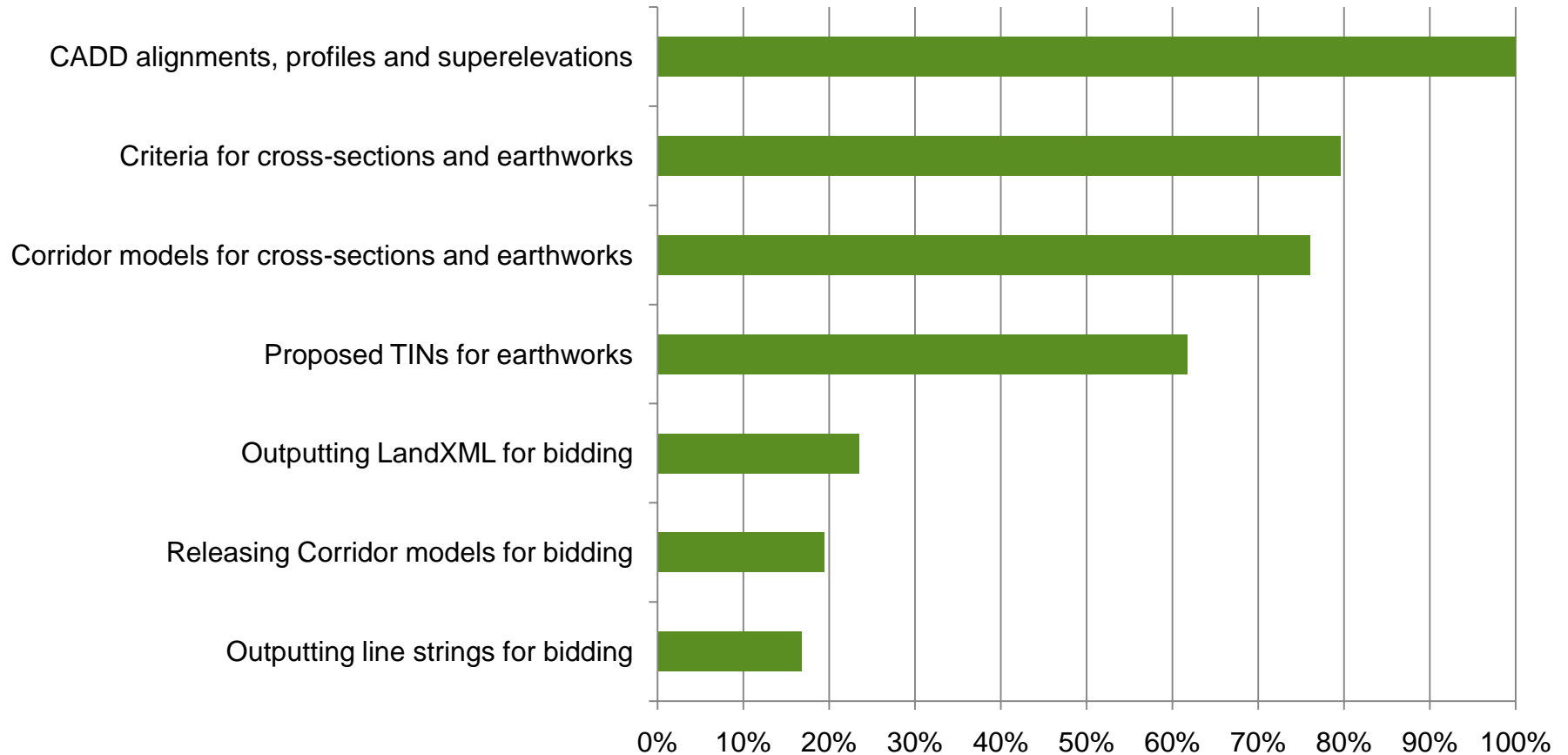
When does your agency provide 3D deliverables to contractors?





What you told us: Webinar 2

What is in your design workflow?

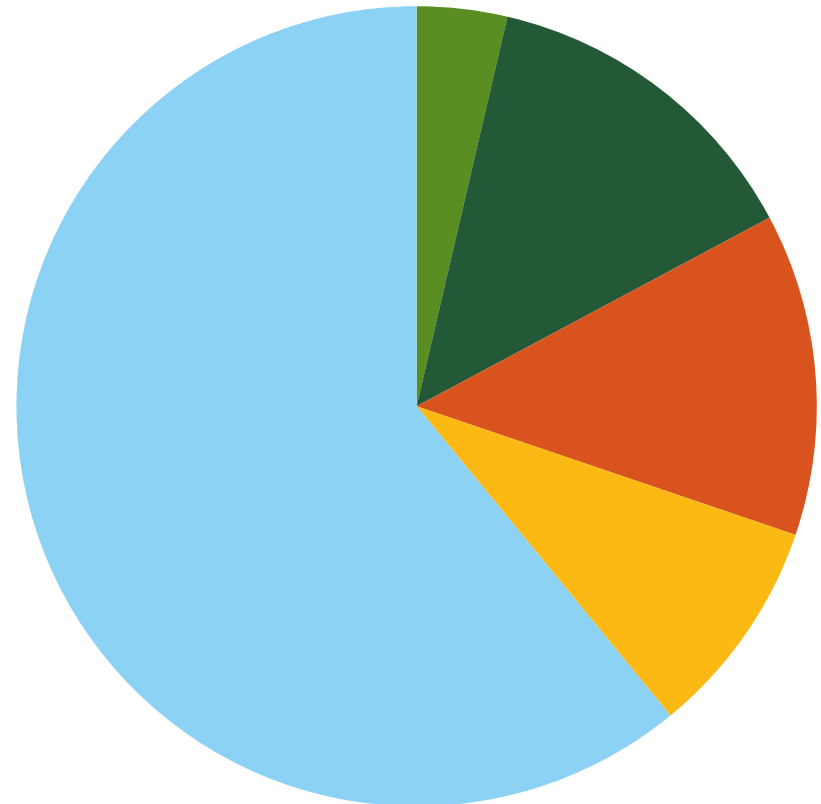




What you told us: Webinar 2

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 Existing 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)



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-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

CAD



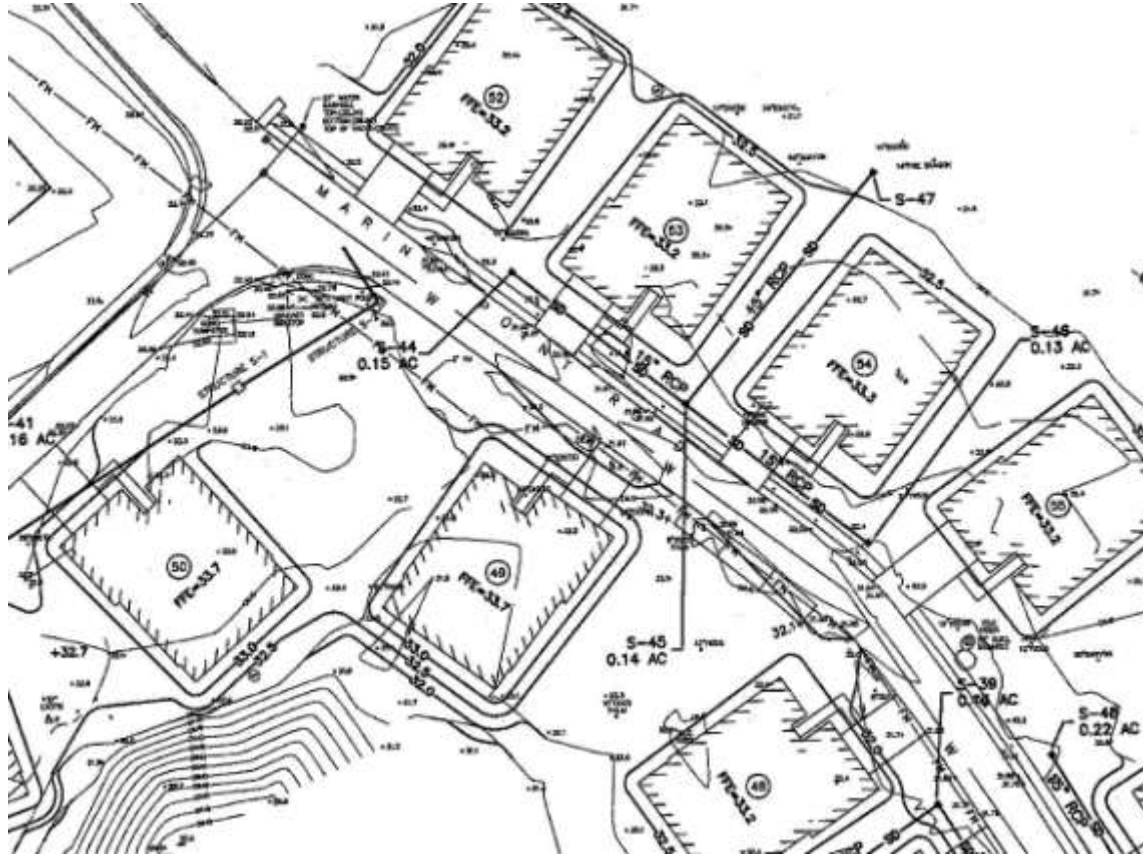
PDF's



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

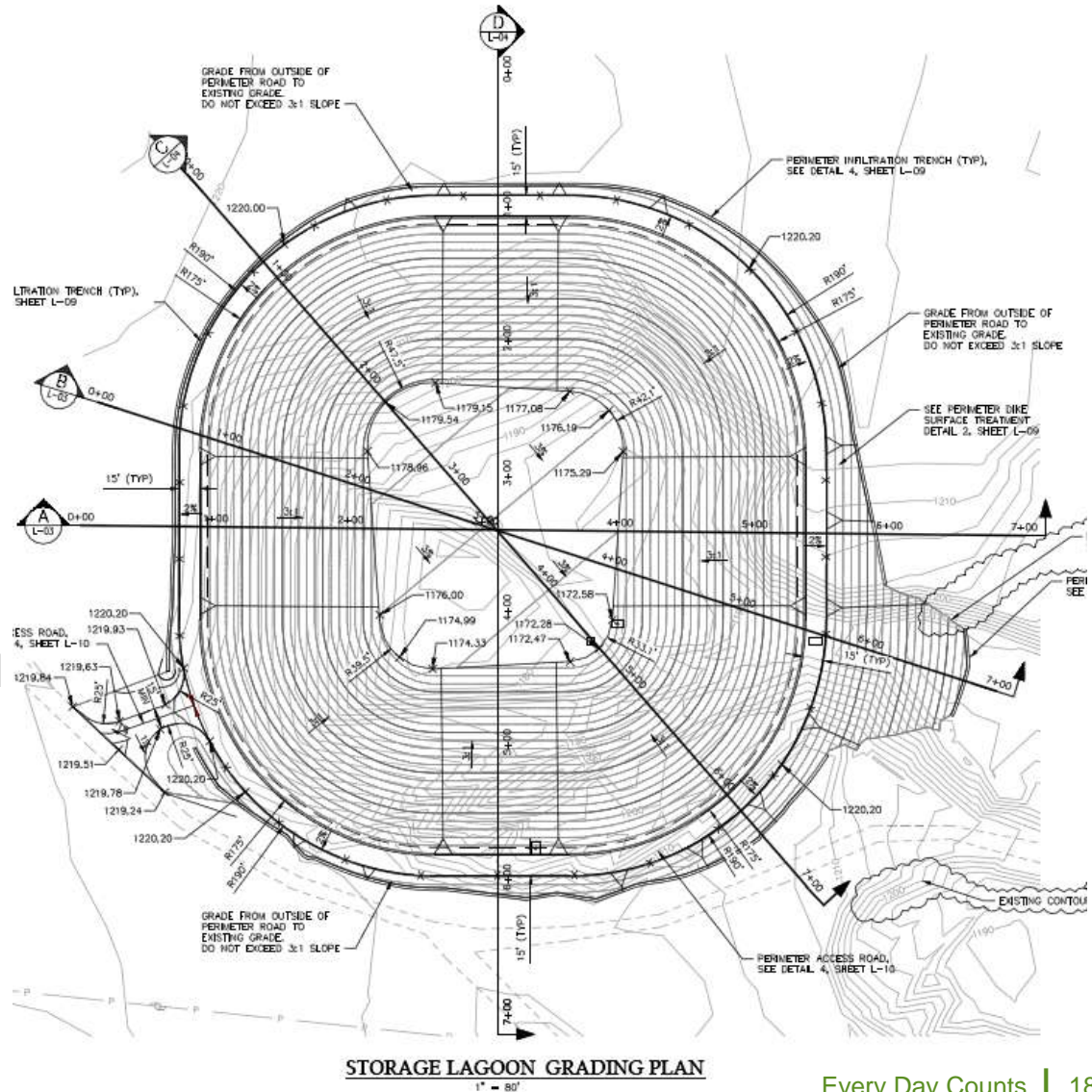




Types of Data Received by Contractors

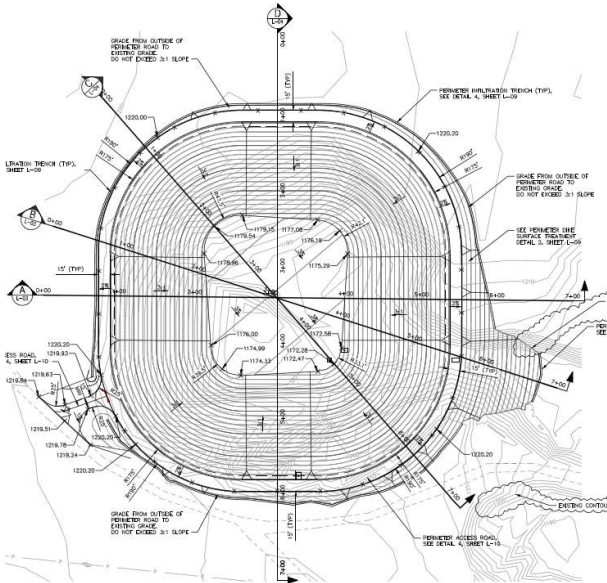
Vectorized Adobe PDF's

- 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

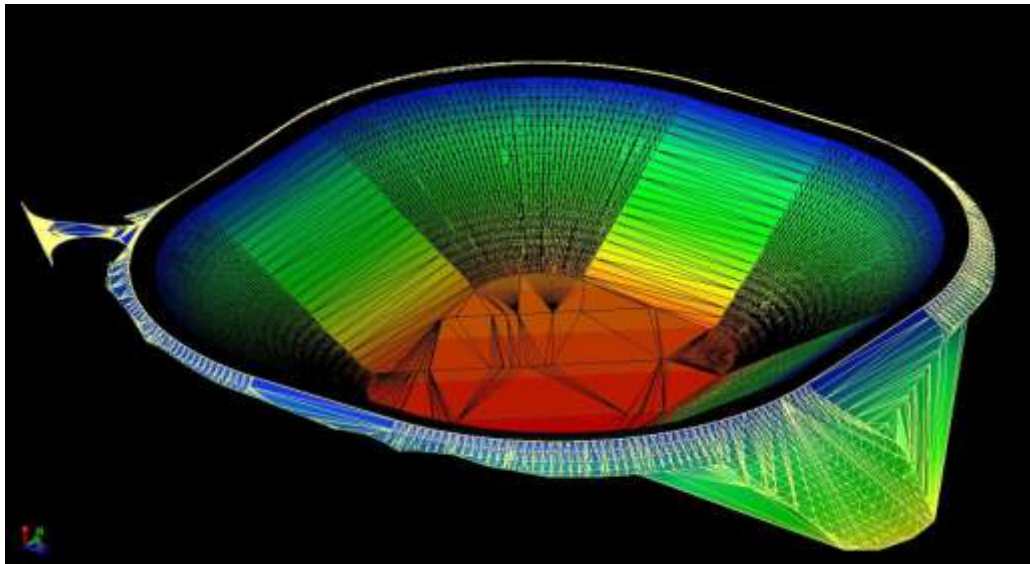
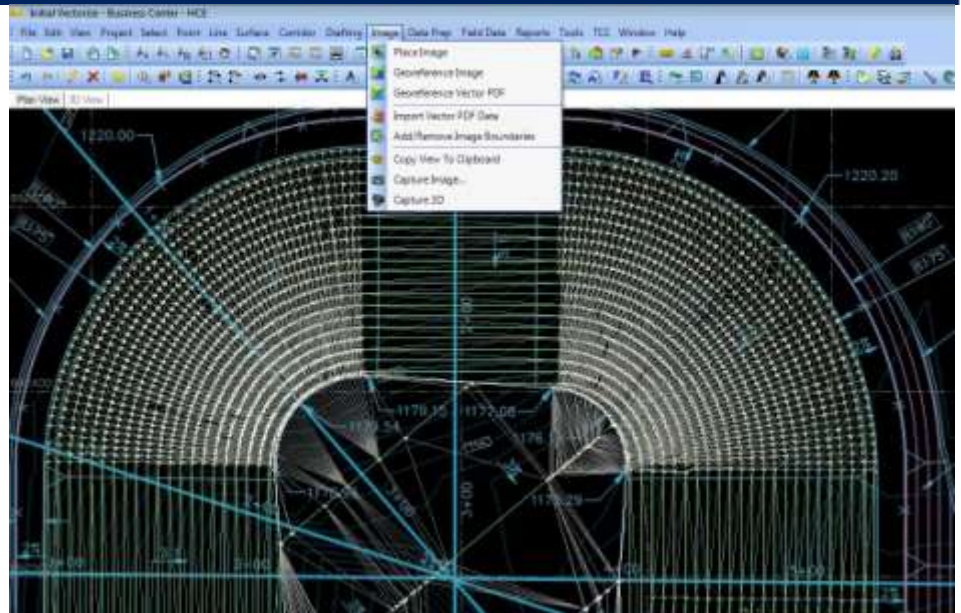




Vectorized PDF



STORAGE LAGOON GRADING PLAN
1" = 30'





Types of Data Received for Contractors

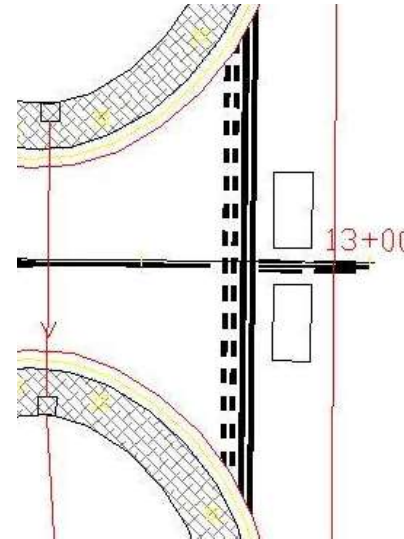
Electronic CAD and Design Data

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)



DISCLAIMER:

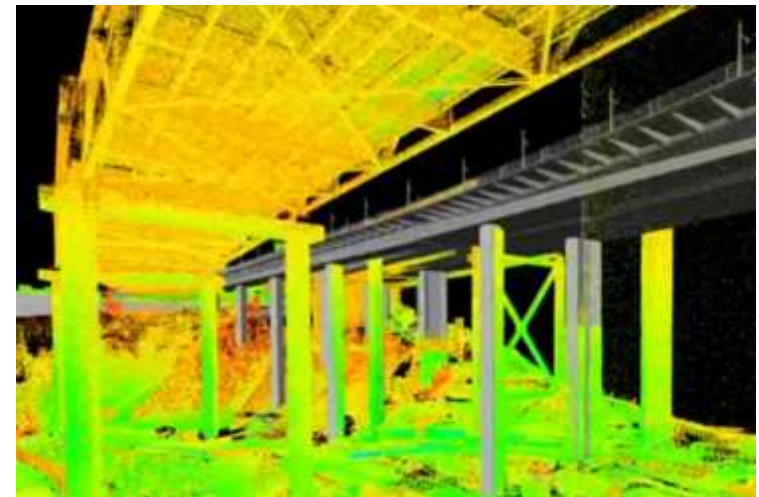
By opening the enclosed electronic

The enclosed electronic media files work files. Due to the potential for [redacted] Inc.'s ownership, pro enclosed electronic files or alteration to [redacted] Inc. Furthermore its officers, employees, agents, cont suits, or liability of any kind or cha use of the electronic files or alterex

The enclosed files are for informati documents. The electronic repres If there are any discrepancies or or govern.

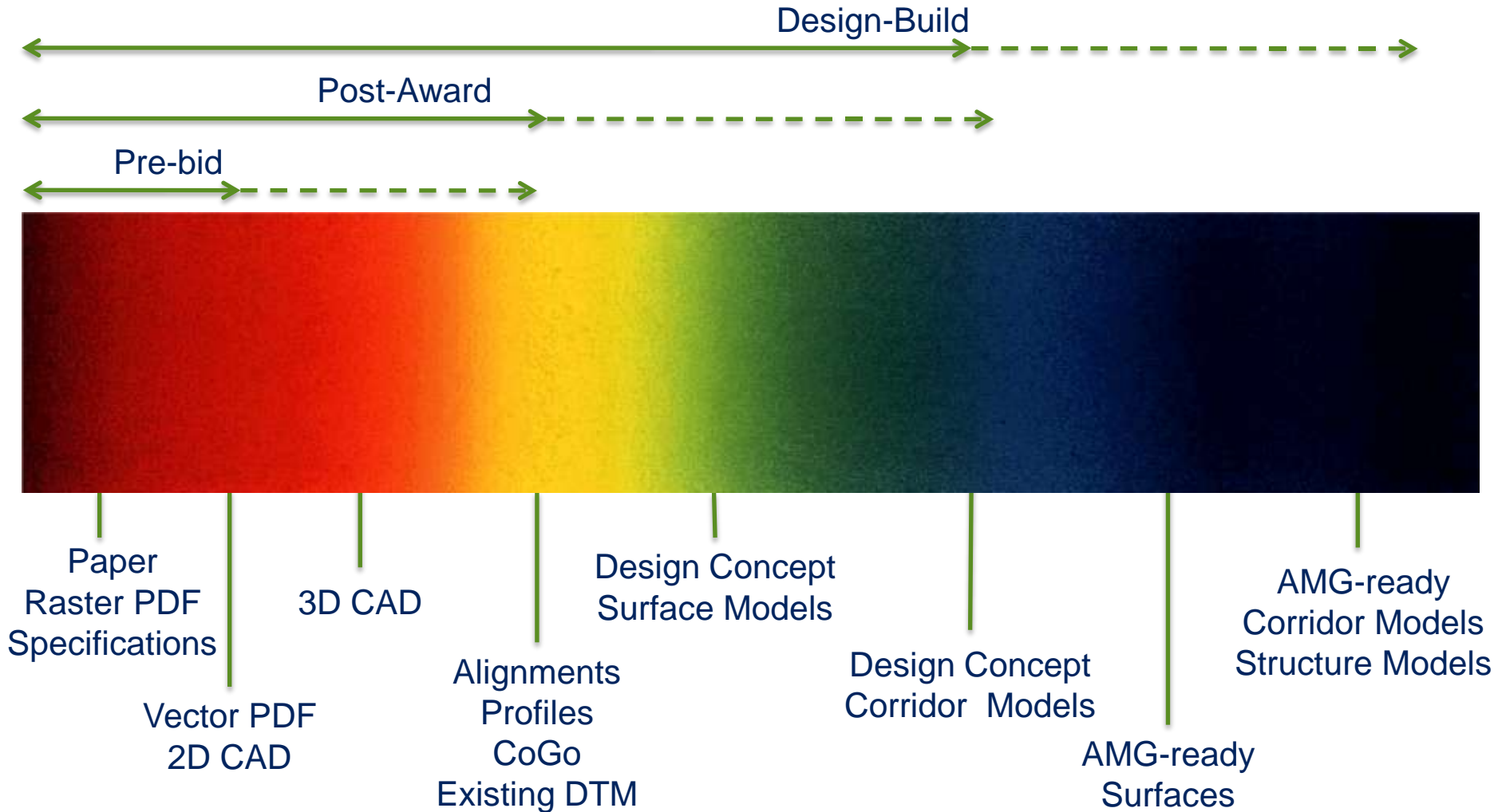
The contractor is responsible to cor and other data as detailed in the c

The contractor assumes full respons and grades resulting from the use bring in conformance to the contrax





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



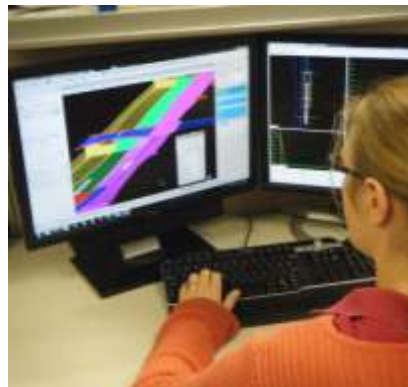
Analyze Data



Meet with Project Managers



Export Quantities to Heavy Bid



Create a 3D CADD Model



Digitize PDF Data



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





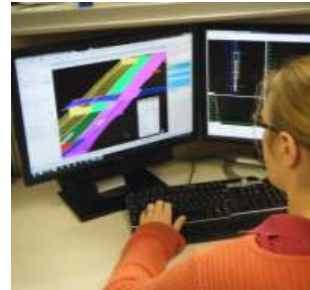
Construction-Ready Model Workflow



Analyze Data



Meet with Project Managers



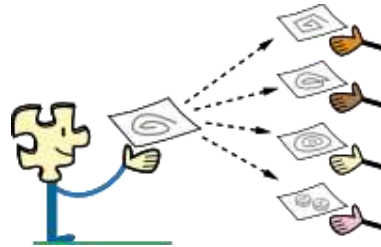
Supplement/
recreate data



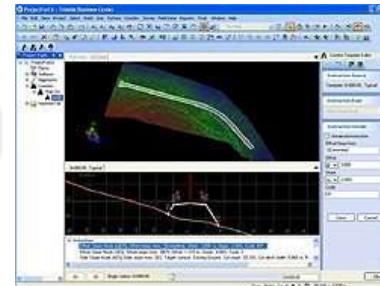
Review Means &
Methods



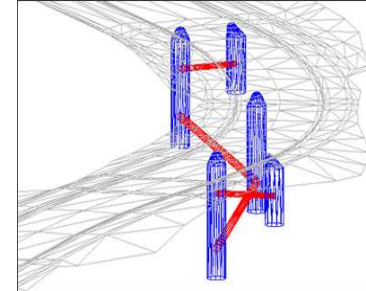
Migrate Data to
the Field



Share models with
Engineering and
Subcontractors



Review & Back-
check Models



Create Grading &
Utility Models



Quantifiable Cost Savings



			Conventional Way	New Way AccuGrade	Productivity Gain
	Staking		07:31	00:54	6:37 hours saved
	Bulk Earthmoving	D6N	04:40	04:18	+ 9 %
		330D	02:23	01:53	+ 27 %
	Subgrade grading	D6N	03:48	01:28	+ 159 %
		330D	02:56	02:43	+ 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 Half time 95 % of time saved 1 person less
	Operators (x4)	98:08 hours	47:20 hours	
	Surveyor	18:14 hours	00:54 hours	
	Worker	18:14 hours	-	

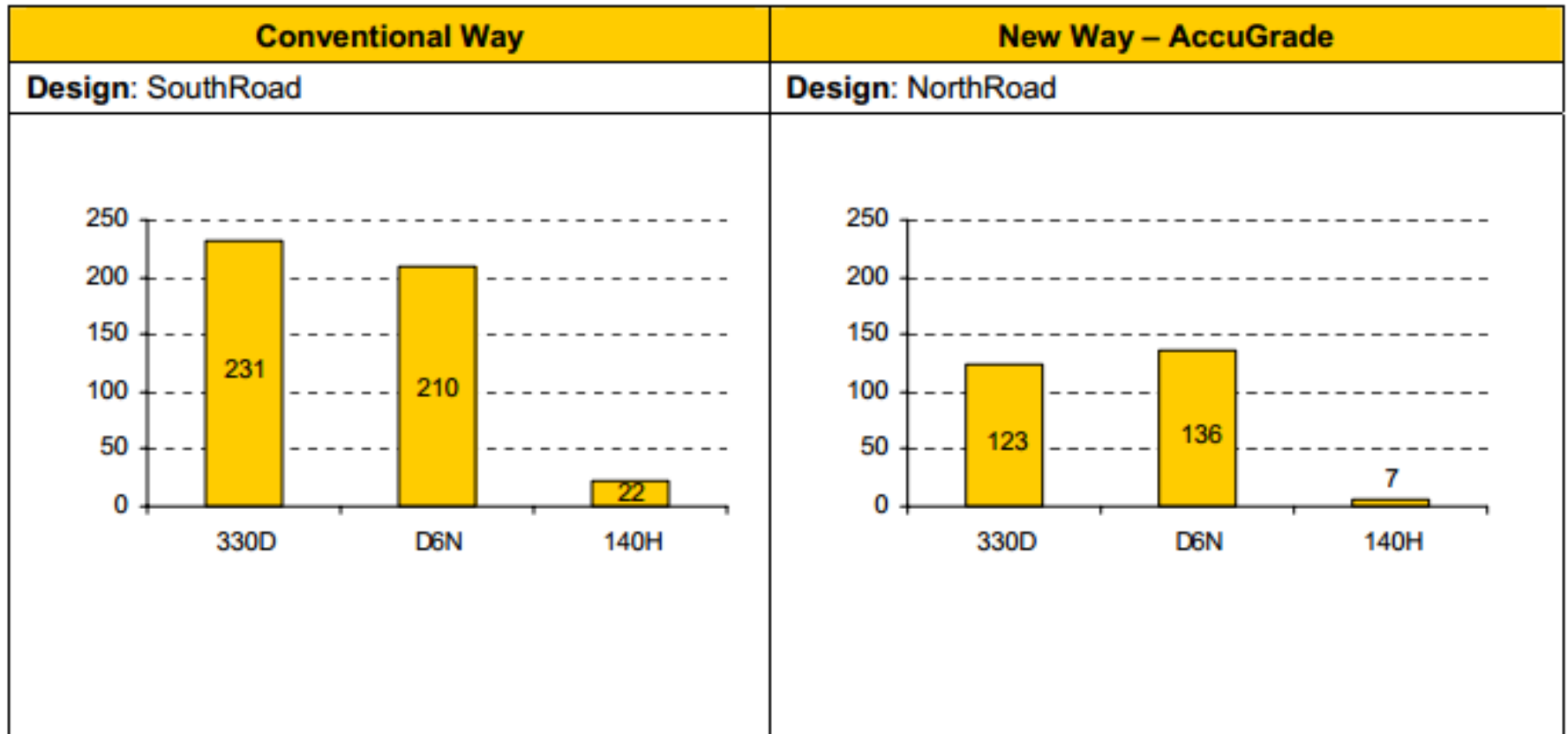
Accuracy

		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





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



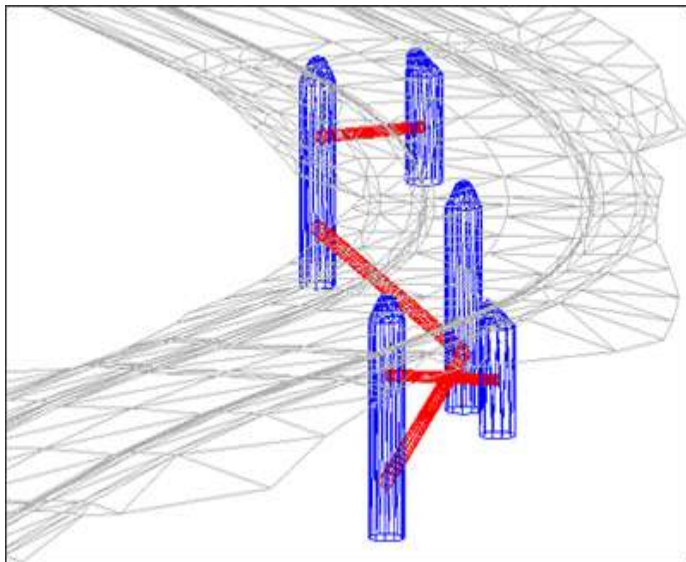


As-Builts from 3D Models & Integrated Field Data

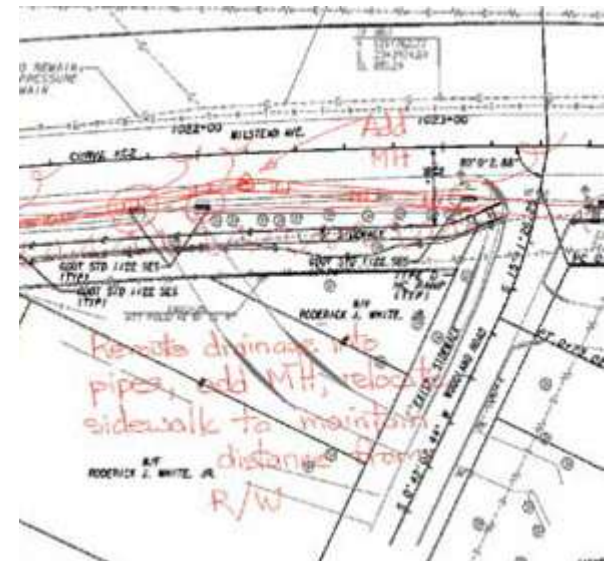
As-Builts

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

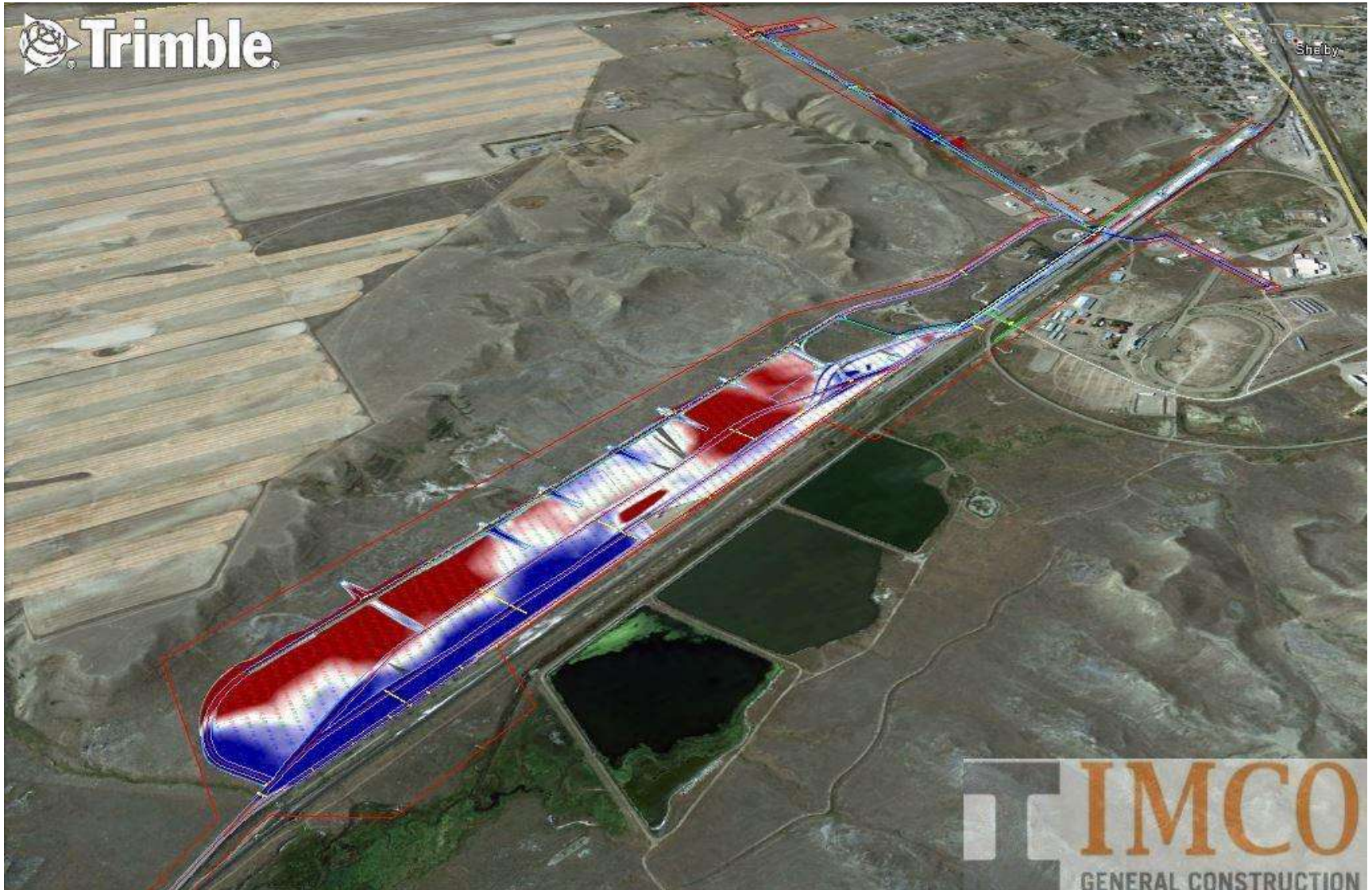


VS



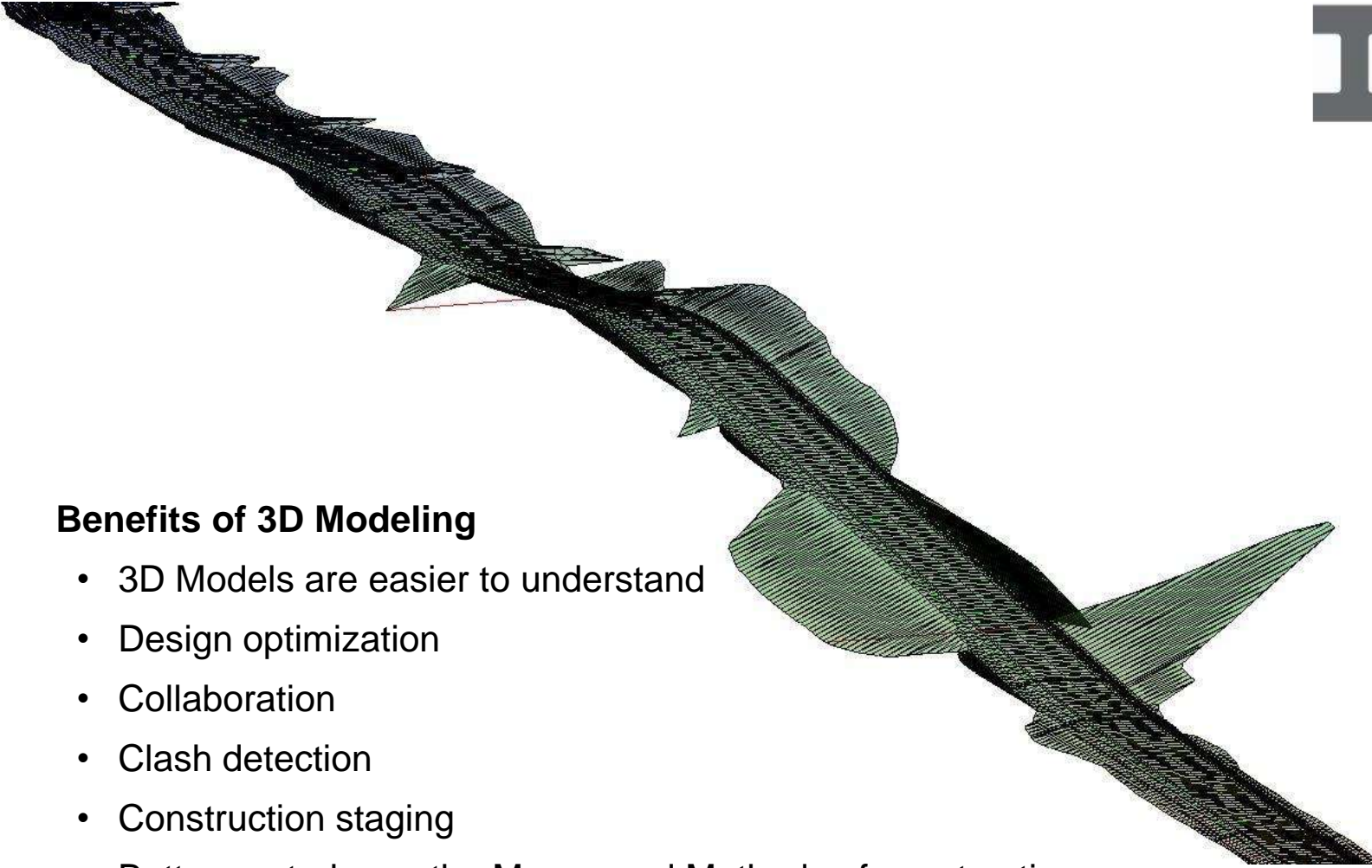


Benefits of Sharing Models with Owners & Subcontractors





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.

Brian K. Smith

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C.360.393.8821



Sam Kloes

skloes@IMCOconstruction.com

C.360.393.8821

Planning Construction Activities and Clash Detection

Karthik Ramkrishnan (RK)

The Walsh Group



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

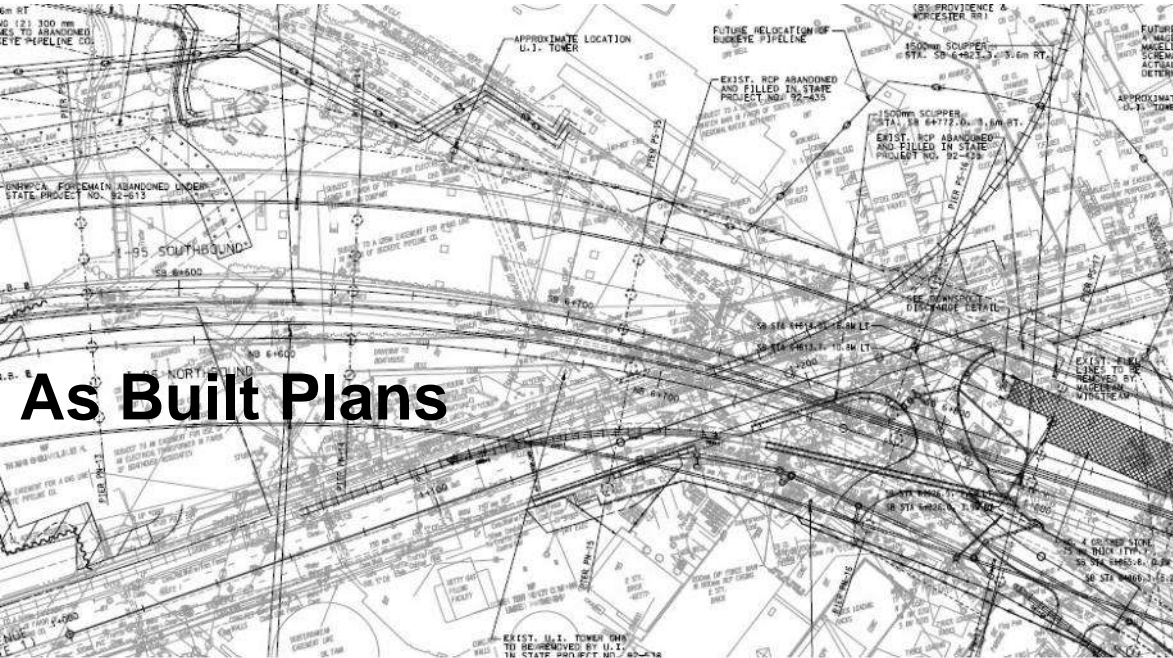


Crucial activity for the Contractor

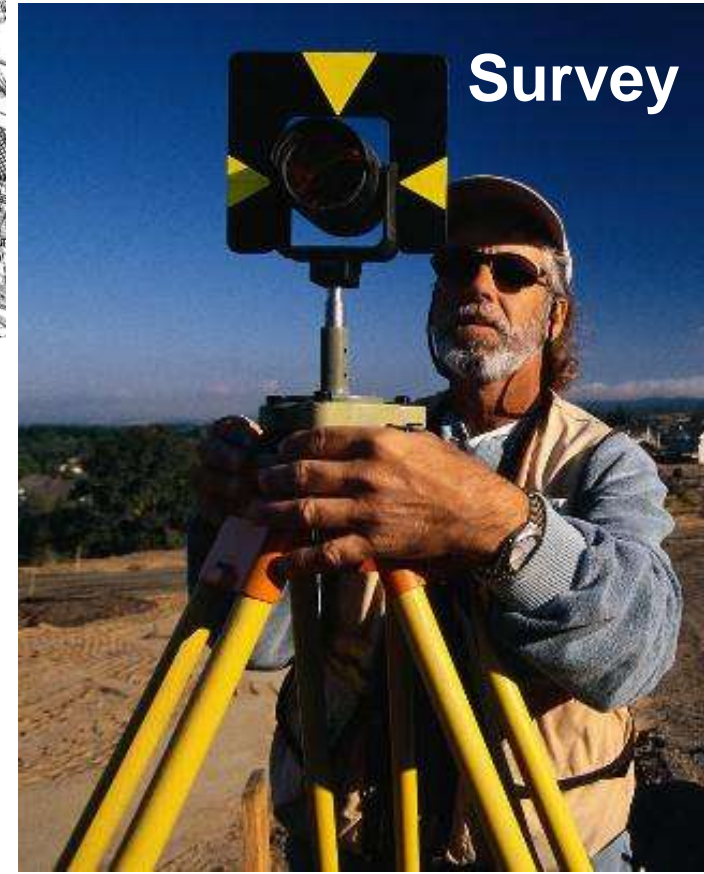
- Planning starts at **bid time**
 - Access to/from the jobsite
 - Resource location (Material + Equipment)
 - Construction clearance from existing utilities
- **Dynamic** nature of construction – Job Phasing



Basics of Jobsite Planning - Options



**Use
Internal
Resource**



Survey

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



Basics of Jobsite Planning - Options

Satellite Images



**Use
External
Resource**

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



Street View
Google Maps



Basics of Jobsite Planning - Options

Take
Photos

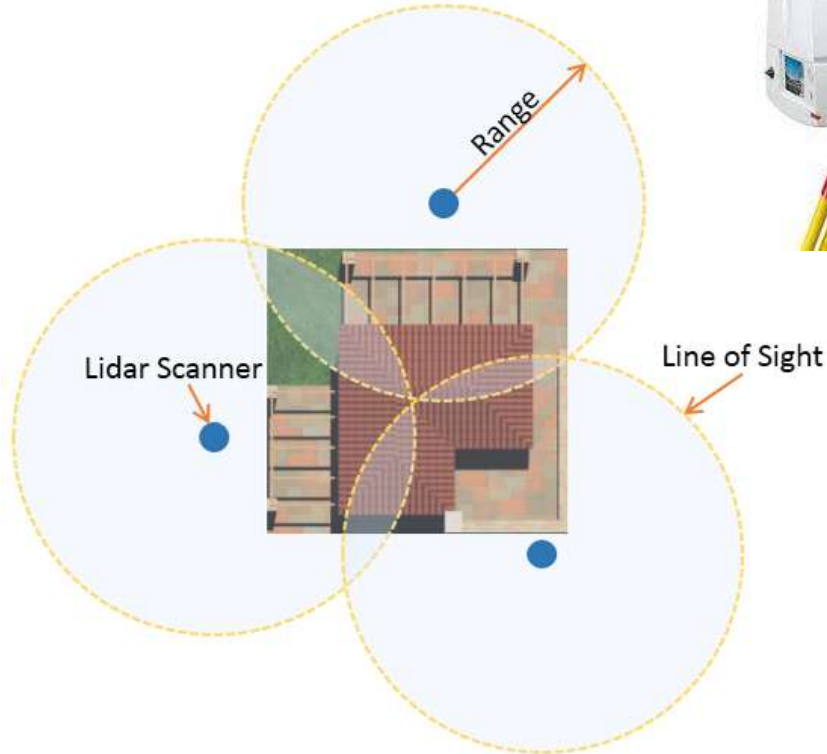




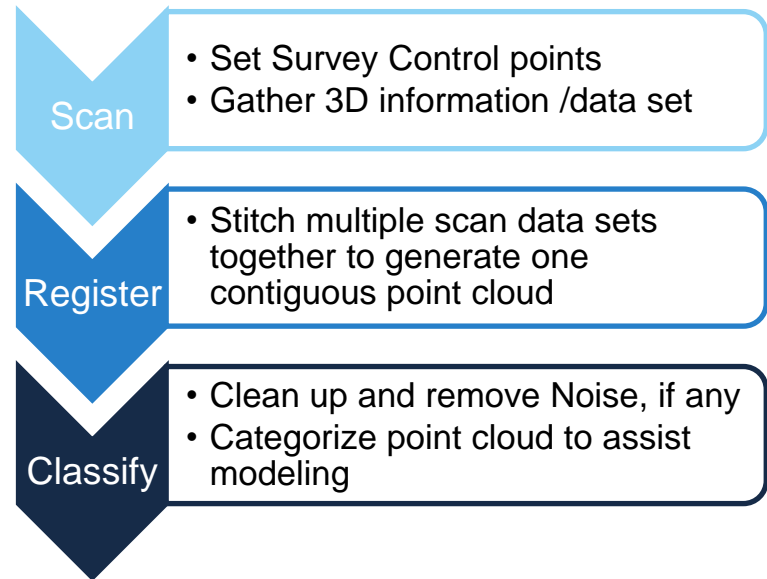
Basics of Jobsite Planning – Options

- 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

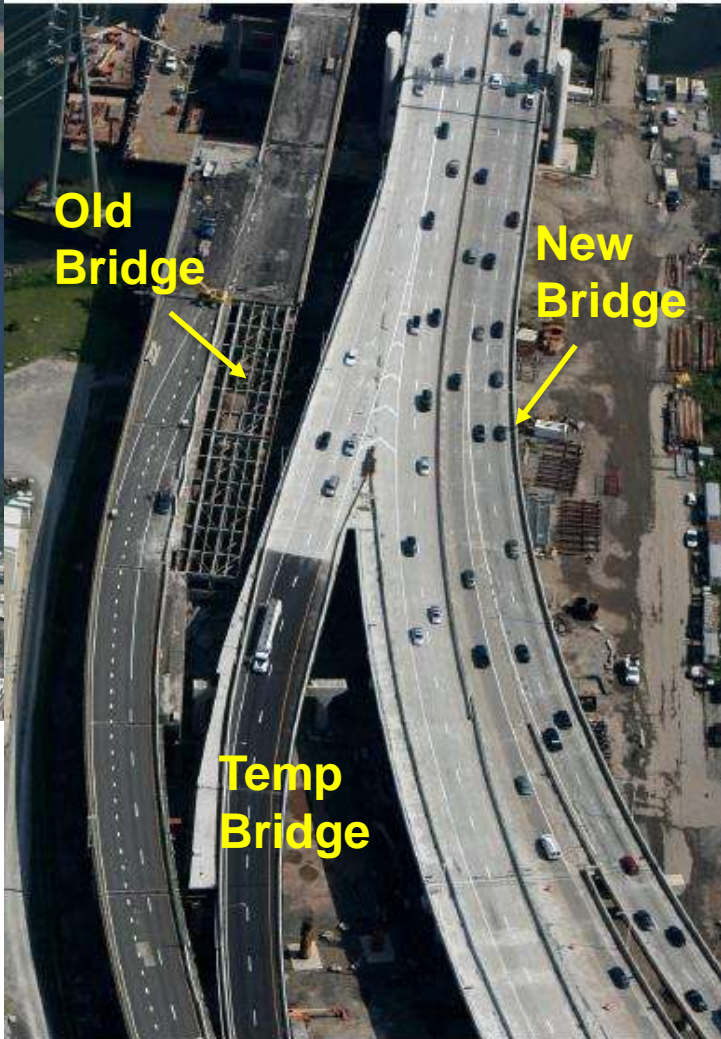




LiDAR Scans - Example



Q Bridge
New Haven, CT



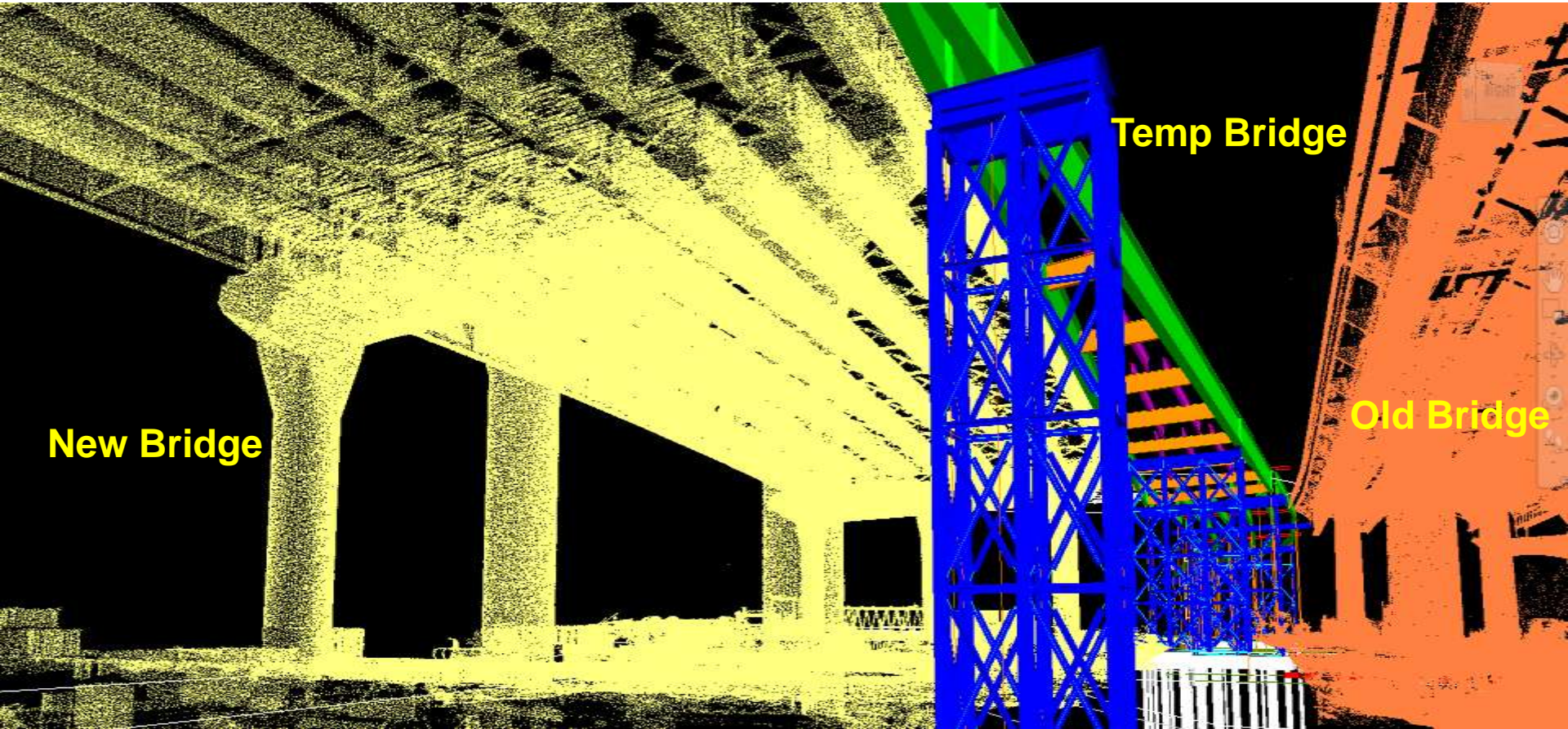
Old Bridge

New Bridge

Temp Bridge



LiDAR Scans - Example



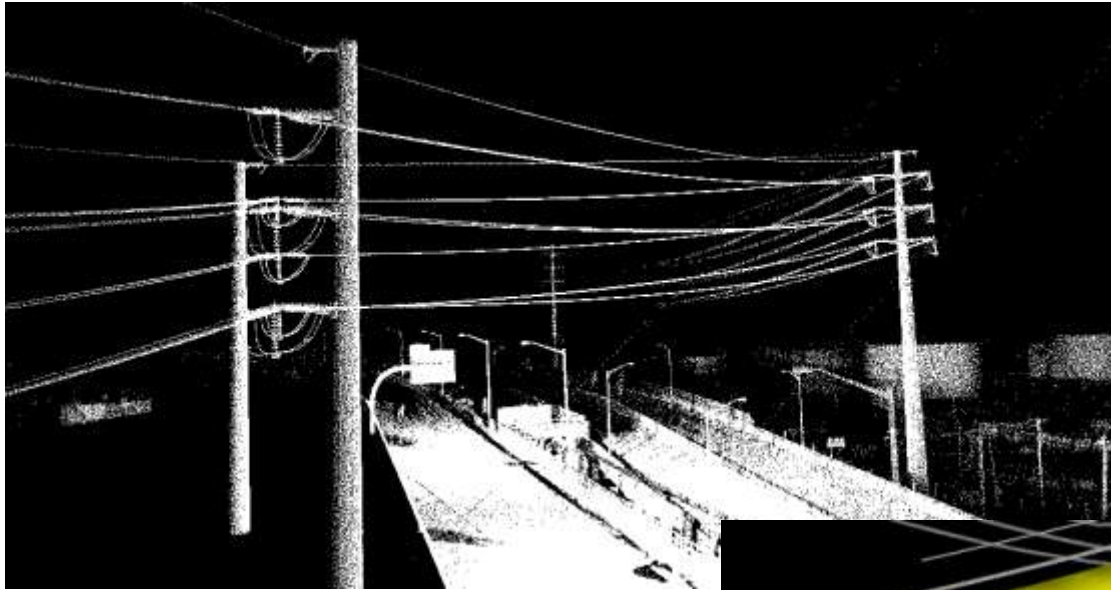
New Bridge

Temp Bridge

Old Bridge



LiDAR Scans - Example

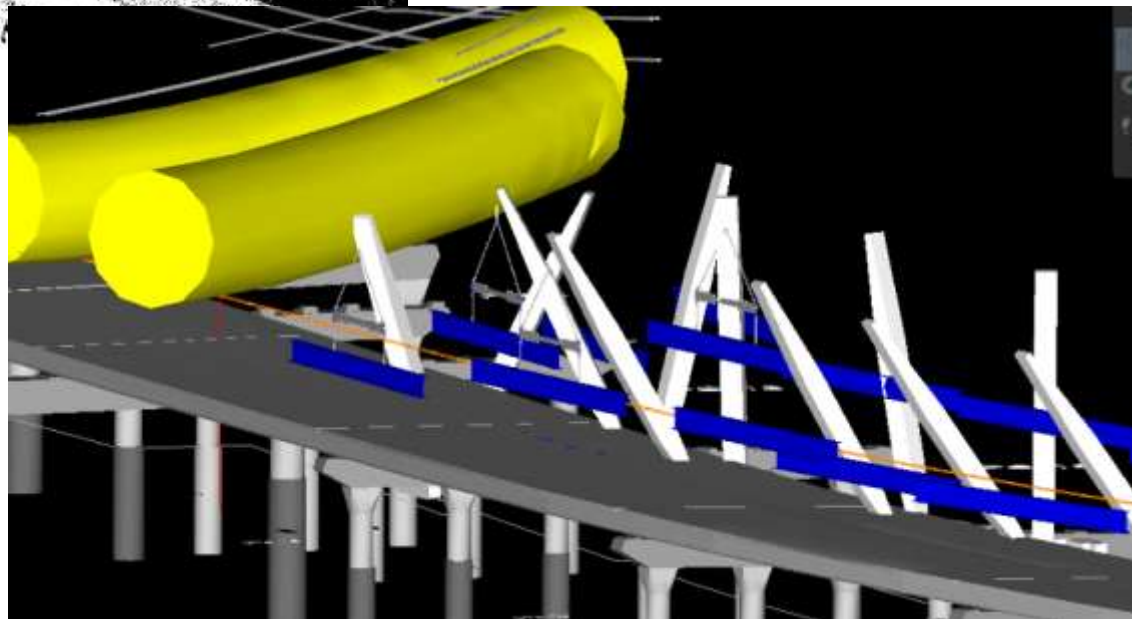


OSHA Requirement

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

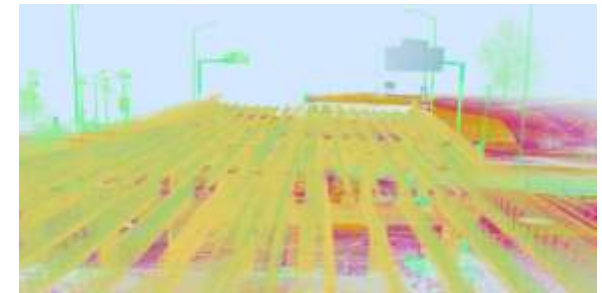
**50-200kV ~ 15' clearance
(115kV)**

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





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



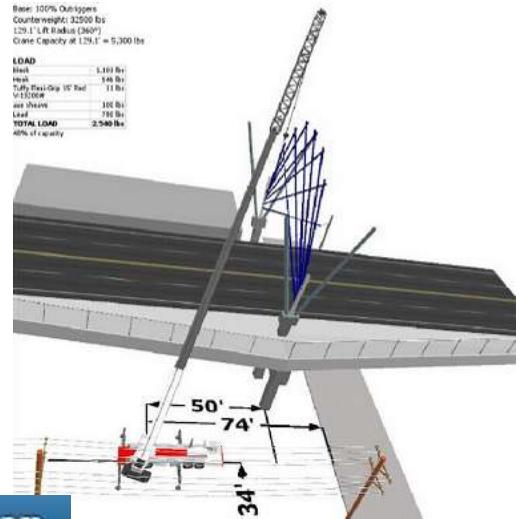
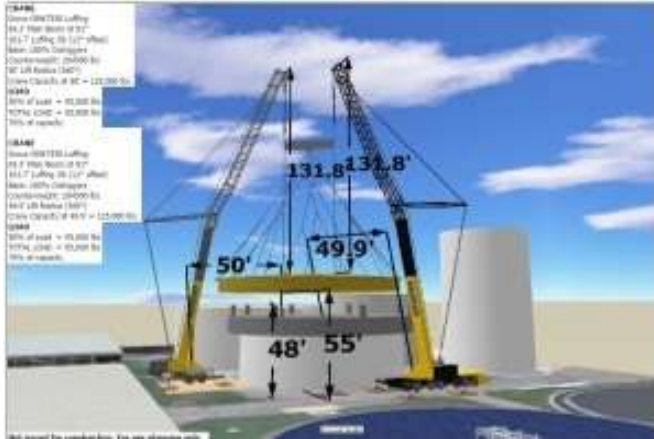
Complex Virtual Mock-ups



Milton - Madison Bridge
Kentucky / Indiana

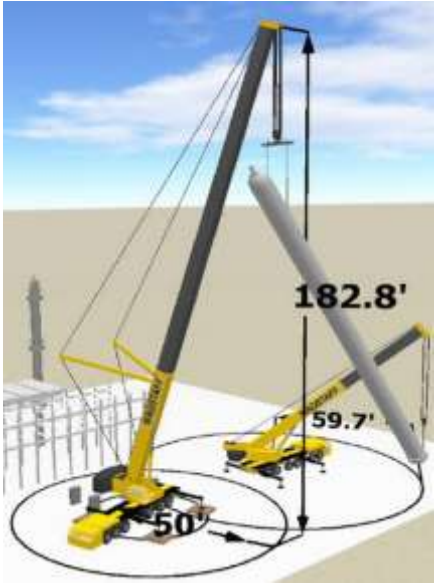
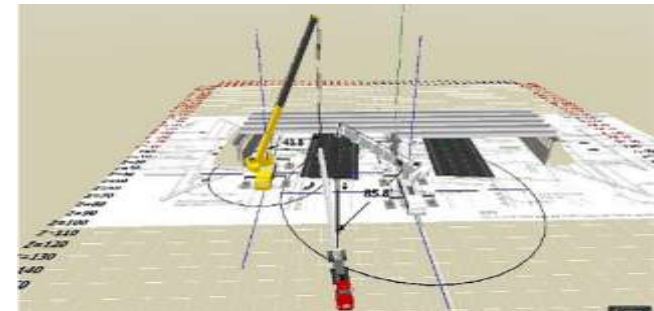


Critical Construction Simulation



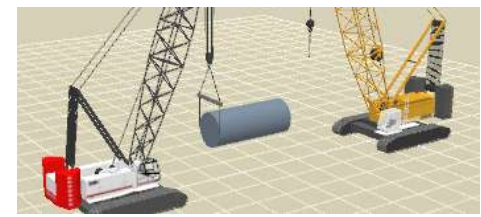
Base: 100% Outriggers
 Counterweight: 32200 lb
 129.1' LR Radius (360°)
 Crane Capacity at 129.1' = 5,300 lbs

LOAD	
Block	1,100 lb
Hook	140 lb
Top of Mast	11 lb
Wire Ropes	100 lb
Lead	100 lb
TOTAL LOAD	2,540 lb
40% of Capacity	



3D Lift Plan

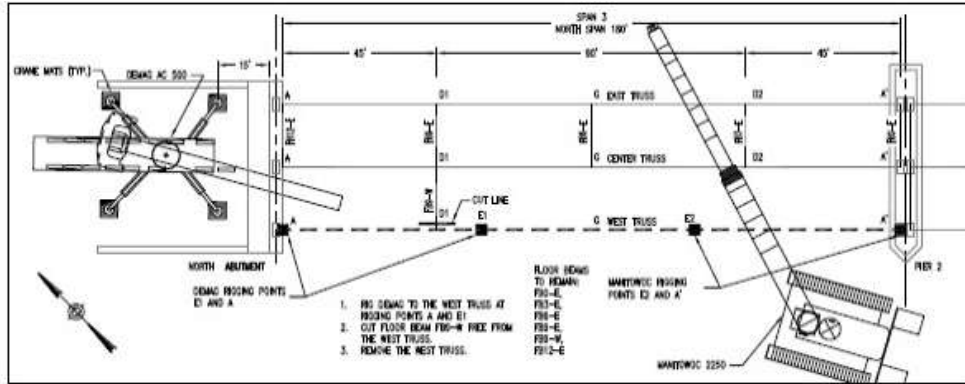
- Visualize/ Simulate crane picks with defined weight and ambient conditions.
- Accurate dimensions with In-Cabin Load charts +900 crane models
- Provides most economical crane configuration.



3D Models of all Construction Equipment available online - VALIDATE



Critical Construction Simulation - Examples



CRANE
 Manitowoc 2250 Series 3 w/ Heavy Lift Top
 150' Heavy Lift at 70.5°
 Base: Crawlers
 Counterweight: 249,200 lbs + 120,000 lbs
 59.3' Lift Radius (360°)
 Crane Capacity at 59.3' = 170,500 lbs

LOAD

Hoist Line	2,400 lbs
Block	1,426 lbs
Hook	600 lbs
Crosby Shackle S-2160 125t	178 lbs
Wire Rope (2)	1,200 lbs
Crosby Shackle G-2130	197 lbs
2-1/2" (2)	116,950 lbs
50% of Load	116,950 lbs
TOTAL LOAD	122,950 lbs

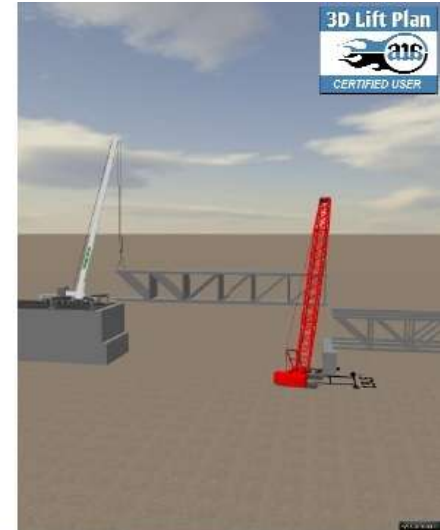
72% of capacity
 Sling Tension: 68,327 lbs

CRANE
 Terex AC 500-1
 149.6' Main Boom at 77°
 Base: 100% Outriggers 31.6 x 31.5 ft
 Counterweight: 352,800 lbs
 34.9' Lift Radius (360°)
 Crane Capacity at 34.9' = 206,400 lbs

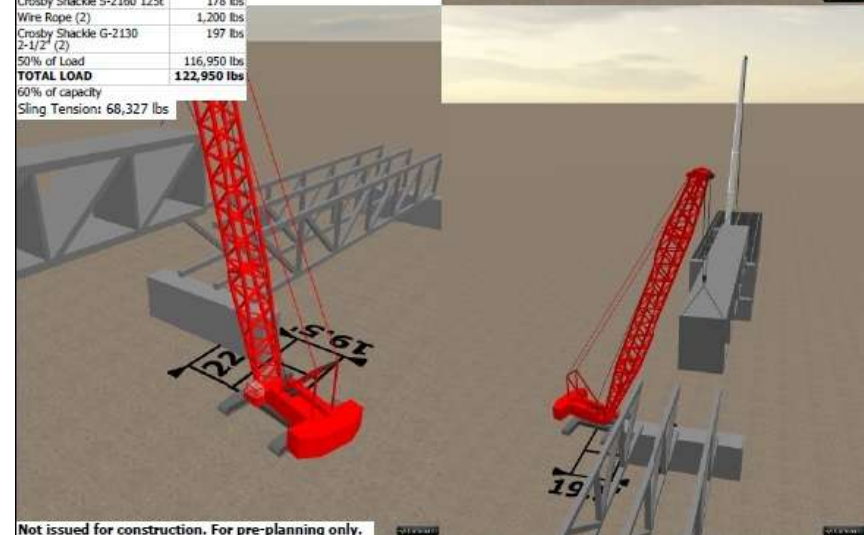
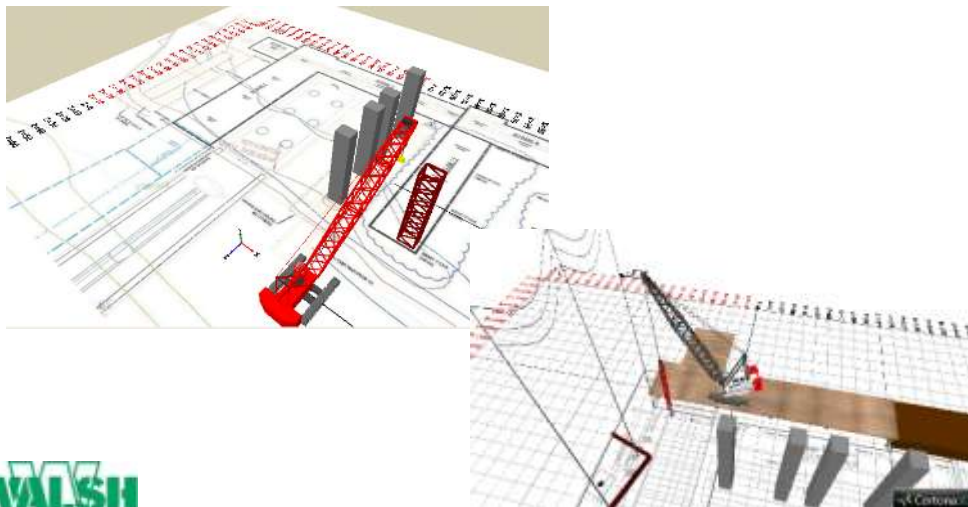
LOAD

Hoist Line	2,400 lbs
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Crosby Shackle S-2160 125t	178 lbs
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Crosby Shackle G-2130	197 lbs
2-1/2" (2)	116,950 lbs
50% of Load	116,950 lbs
TOTAL LOAD	122,950 lbs

60% of capacity
 Sling Tension: 68,327 lbs



Validate
Safe Crane Pick

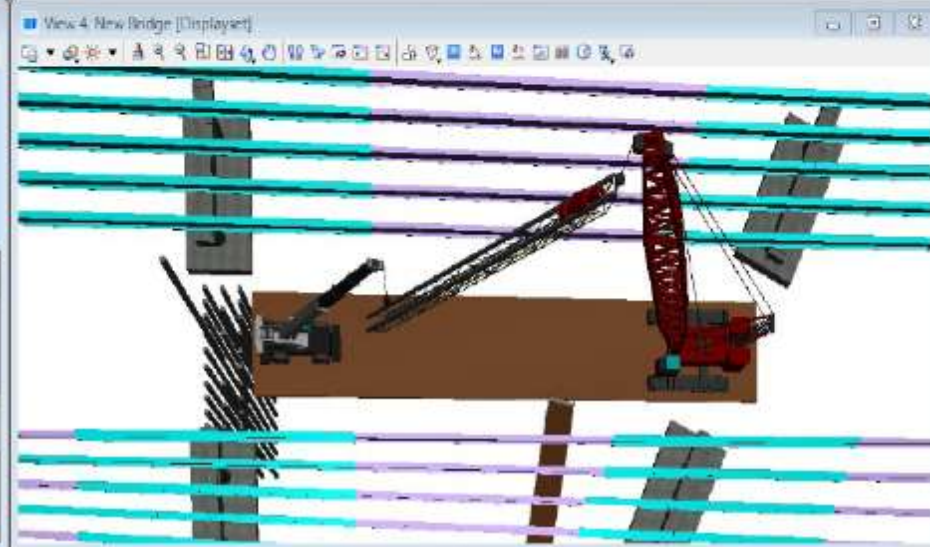
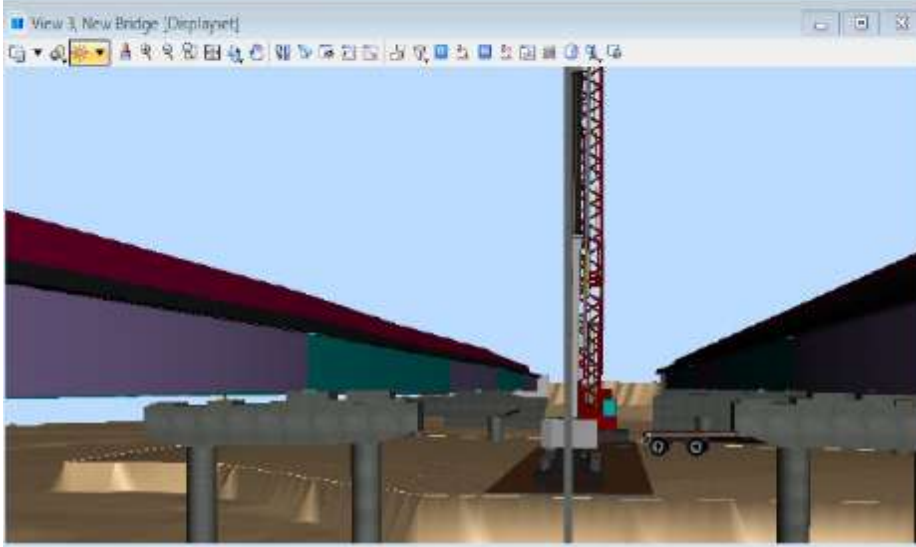
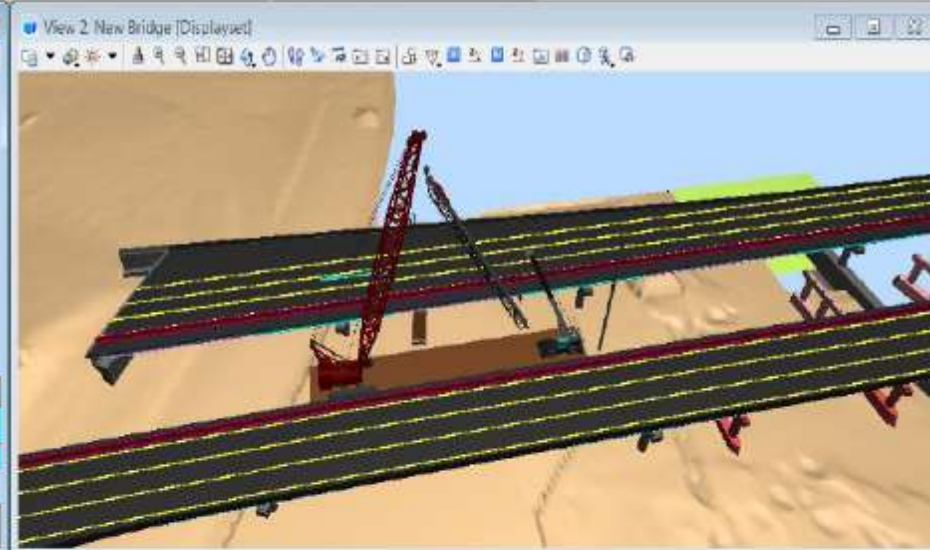


Not issued for construction. For pre-planning only.



Critical Construction Simulation - Examples

Access during Phasing



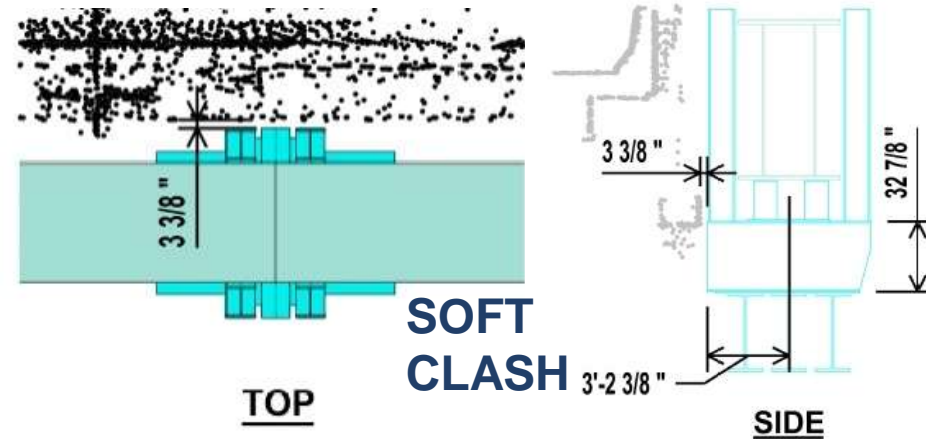
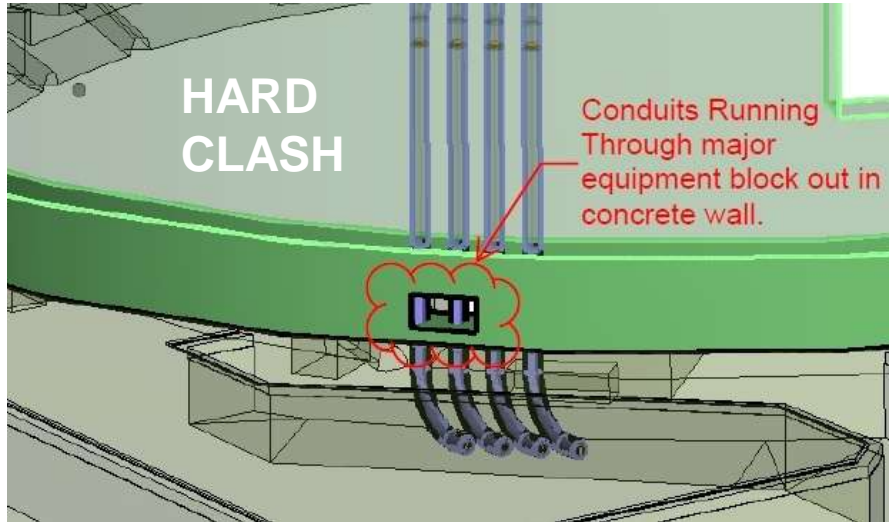


Do you use 3D clash detection?

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



Clash Detection in Heavy Construction



CLASH DETECTION

Avoiding field issues ahead of time

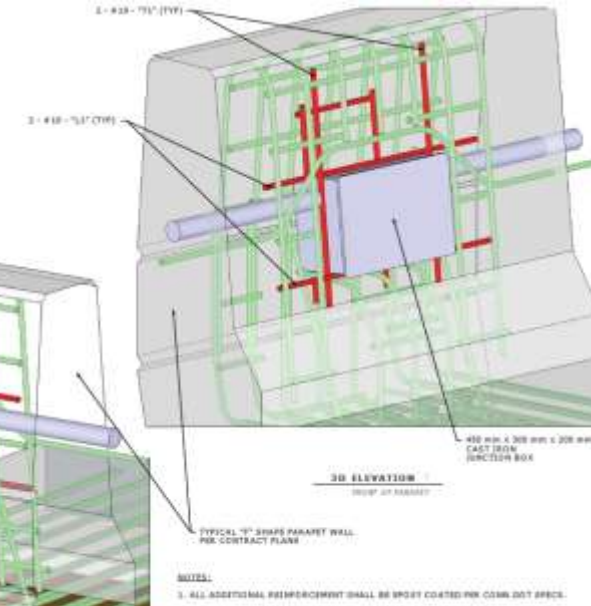
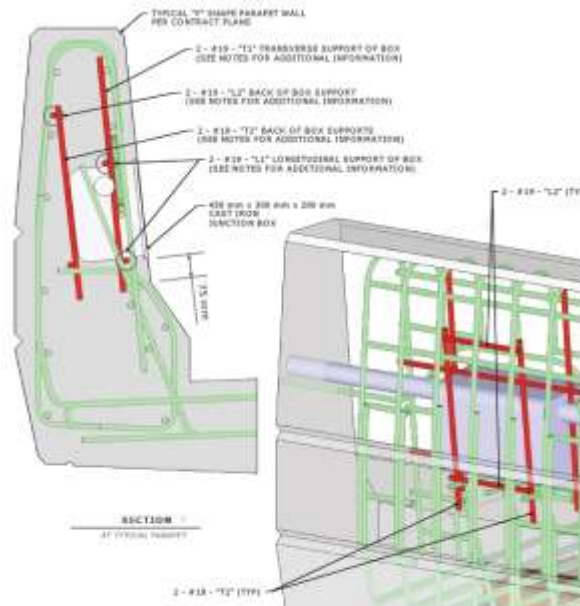
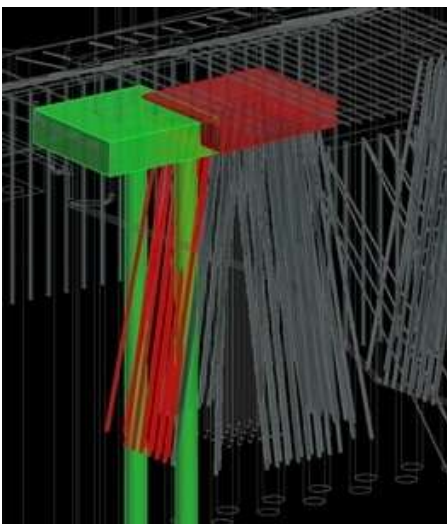
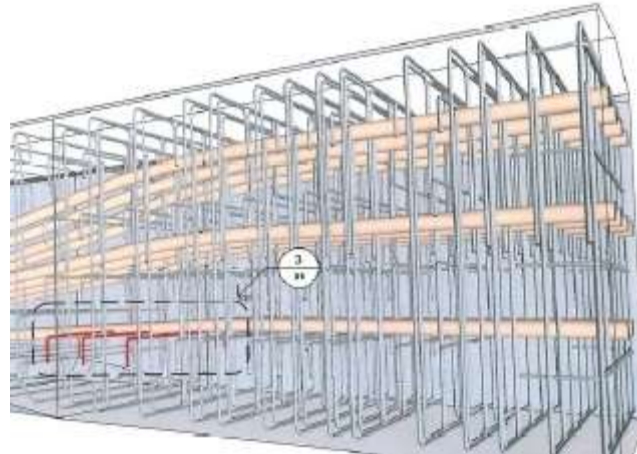
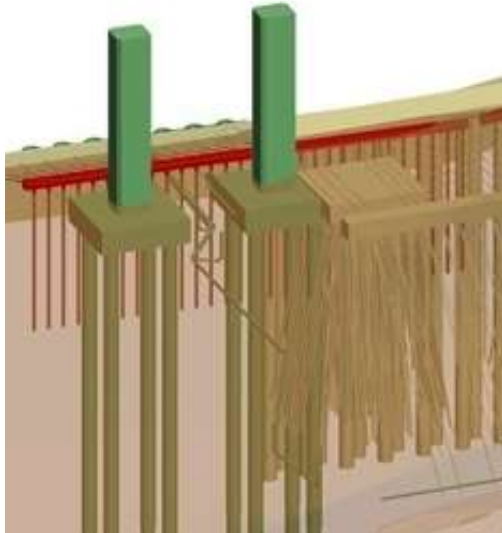
- Hard Clashes – Members directly conflict
- Soft Clashes – Tolerance issues
- Time related - Constructability issues



Image courtesy- Synchro



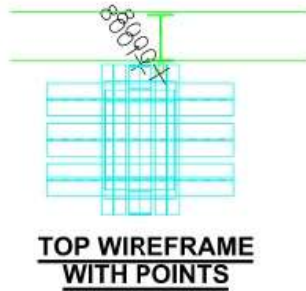
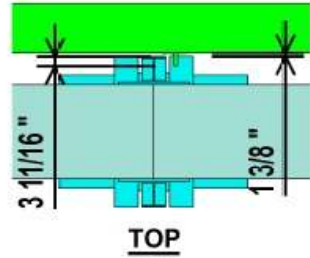
Clash Detection - Examples



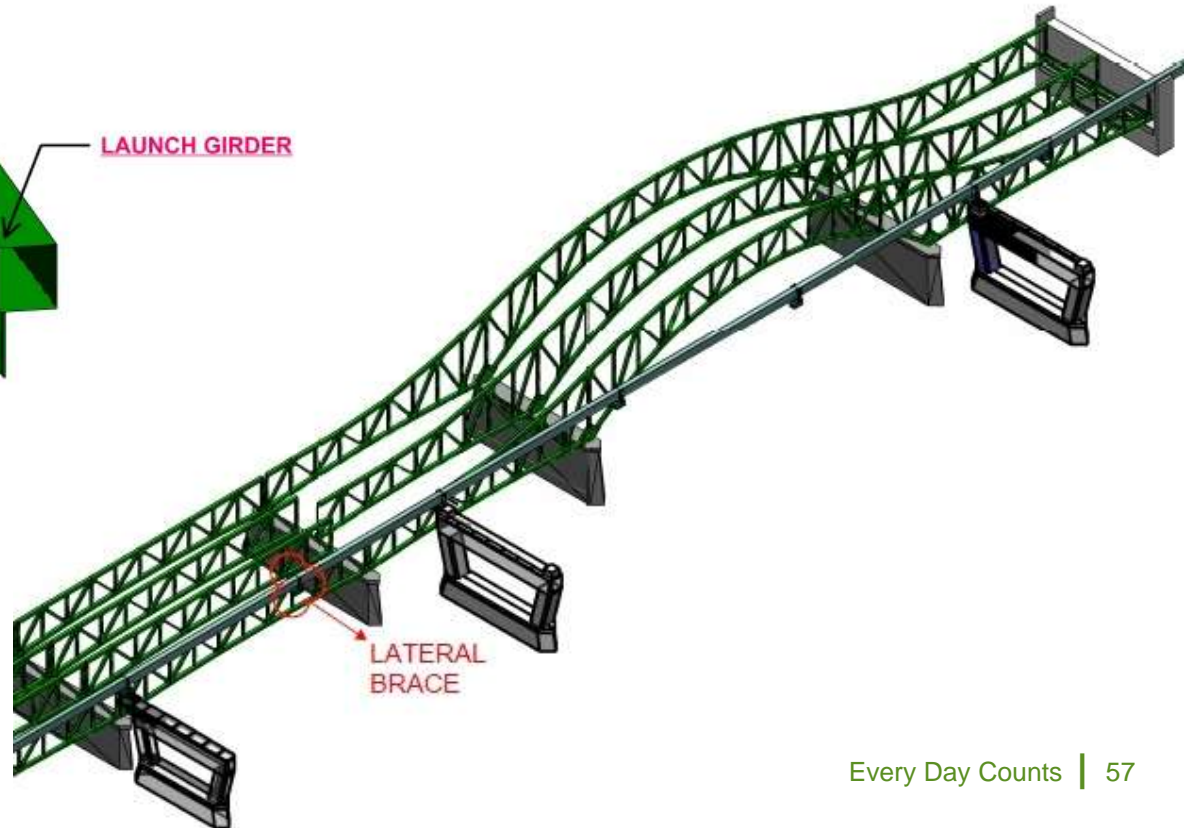
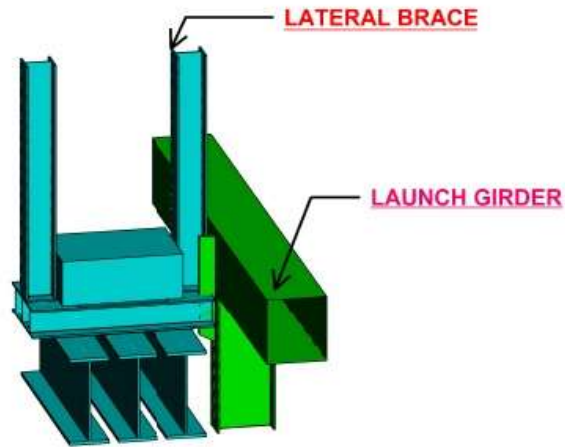
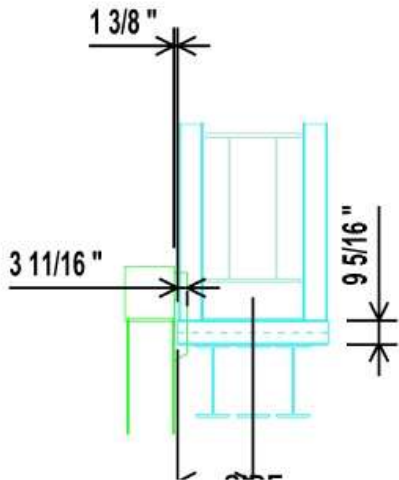
- NOTES:
1. ALL ADDITIONAL REINFORCEMENT SHALL BE SPOT COATED PER COMM. DOT SPEC.
 2. THE LOCATION AND LENGTH OF ADDITIONAL BARS SHALL BE ADJUSTED PER FIELD CONDITIONS FOR PROPER FIT AND SUPPORT OF CAST IRON JUNCTION BOX.
 3. LOCATION OF ADDITIONAL BARS SHALL BE SUCH AS TO MAINTAIN ALL SPECIFIED CLEAR COVER REQUIREMENTS OUTLINED IN THE CONTRACT DOCUMENTS.
 4. THE FRONT PANEL OF THE CAST IRON JUNCTION BOX SHALL BE COVERED WITH HEAVY TAPE AS A PREVENTION AGAINST SCRAPING DURING THE SLP FINISHING OPERATION.



Clash Detection - Examples

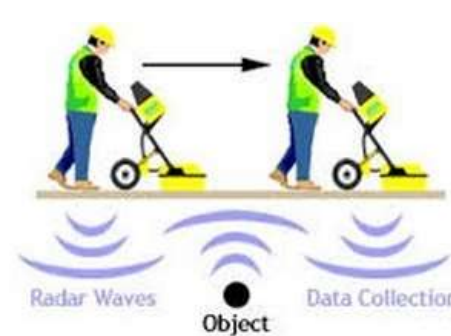


Identify Tolerance Issue in the virtual world.





Unknown Risk – We know what we see



**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



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

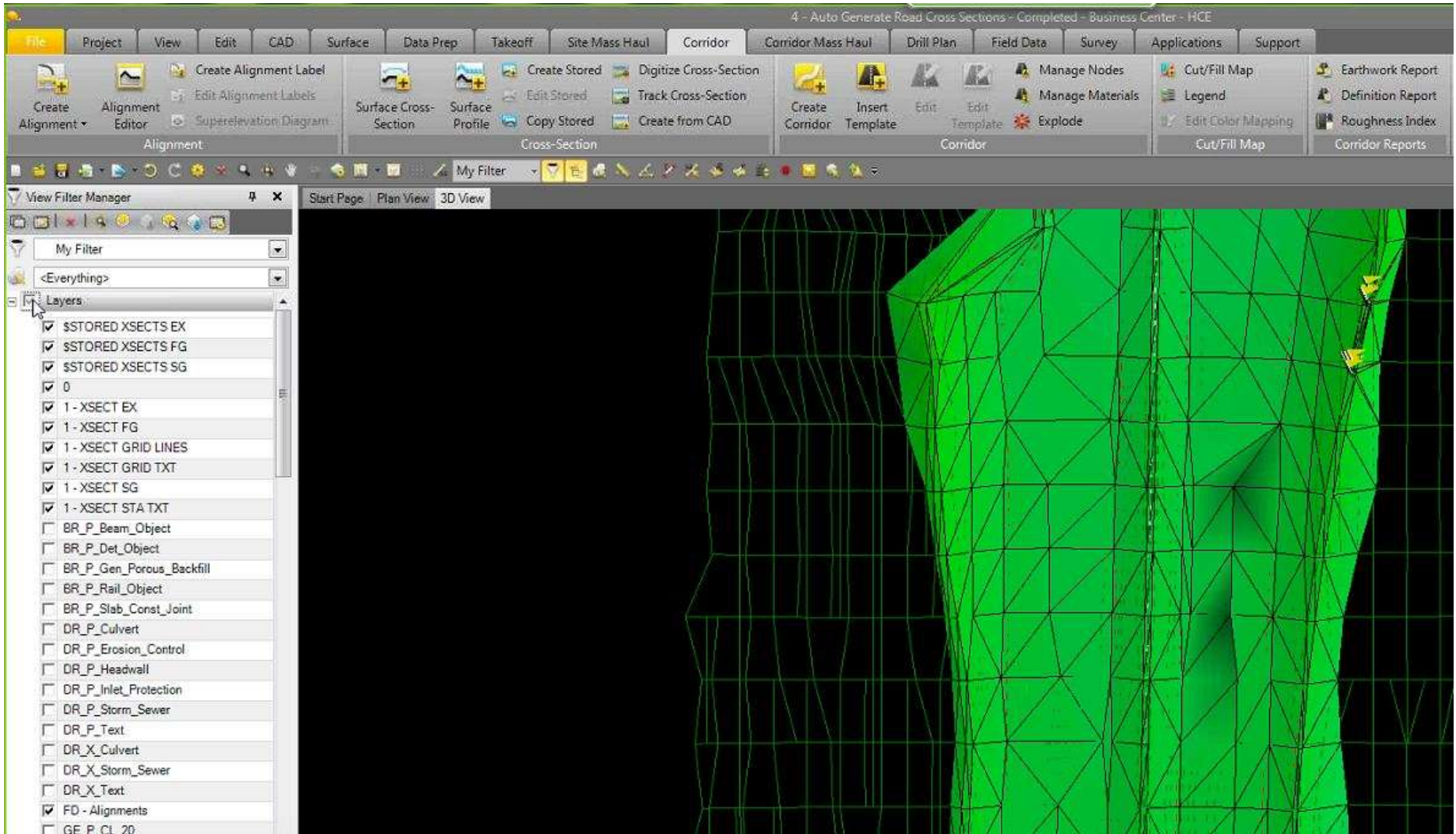


How do you use electronic design data?

- 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

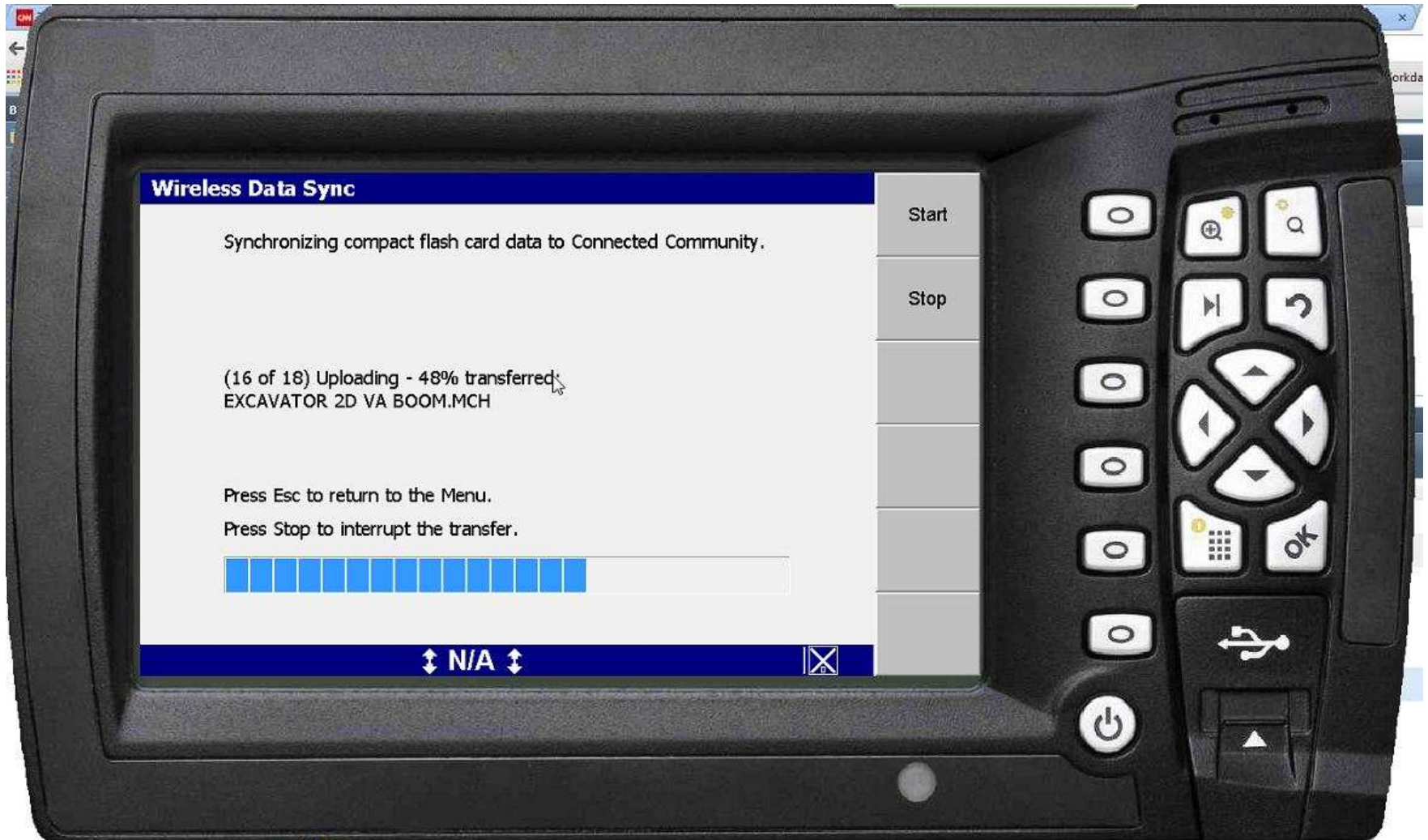


Preparing Models for AMG



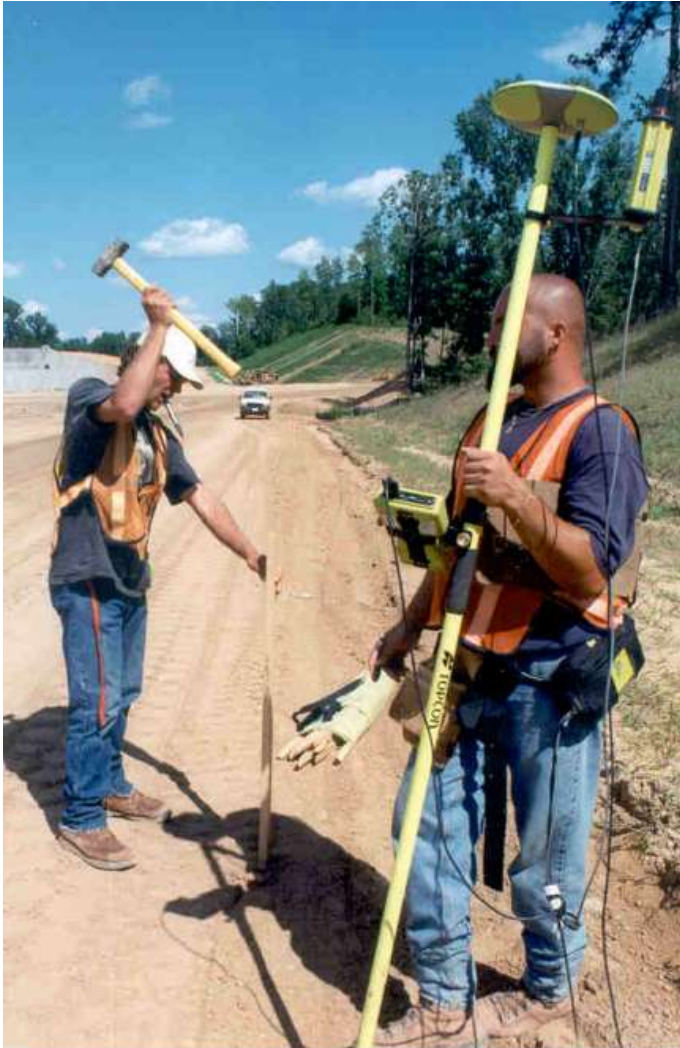


Preparing Models for AMG





Using 3D Models for Layout



Pictures Provided by Jason Billerbeck of Peterson Contractors Inc.



Stakeless Grading





Stakeless Grading



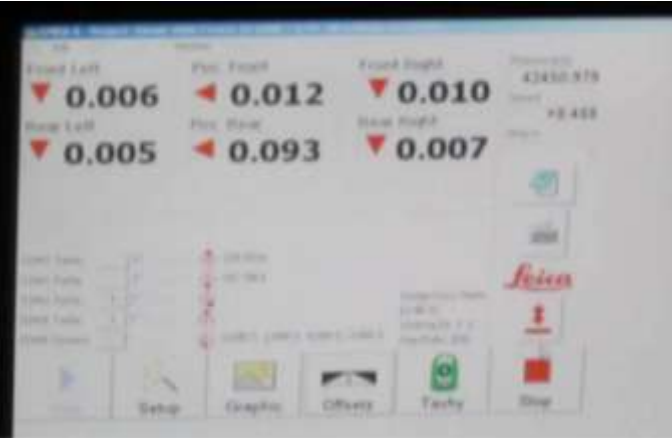


Stringless Asphalt Paving





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