3D Engineered Models for Construction

AGC-ODOT Annual Meeting
February 18, 2014

National Discussion on 3D Design

Steve Cooley
ODOT Contract Administration Engineer

What is 3D Design for Construction?

1. Providing 3D Engineering data to Contractors at Advertisement.
2. 3D Engineering data will be in a format conducive to:
   - Bid preparation
   - Construction
   - Support Machine Control

National Overview

FHWA Every Day Counts 2 Initiative

- Deliver a series of webinars and workshops.
- To accelerate the deployment of 3D Engineered Models for Construction.
- Goal to have 50 projects constructed using 3D Modeling in 25 States by the end of 2014.

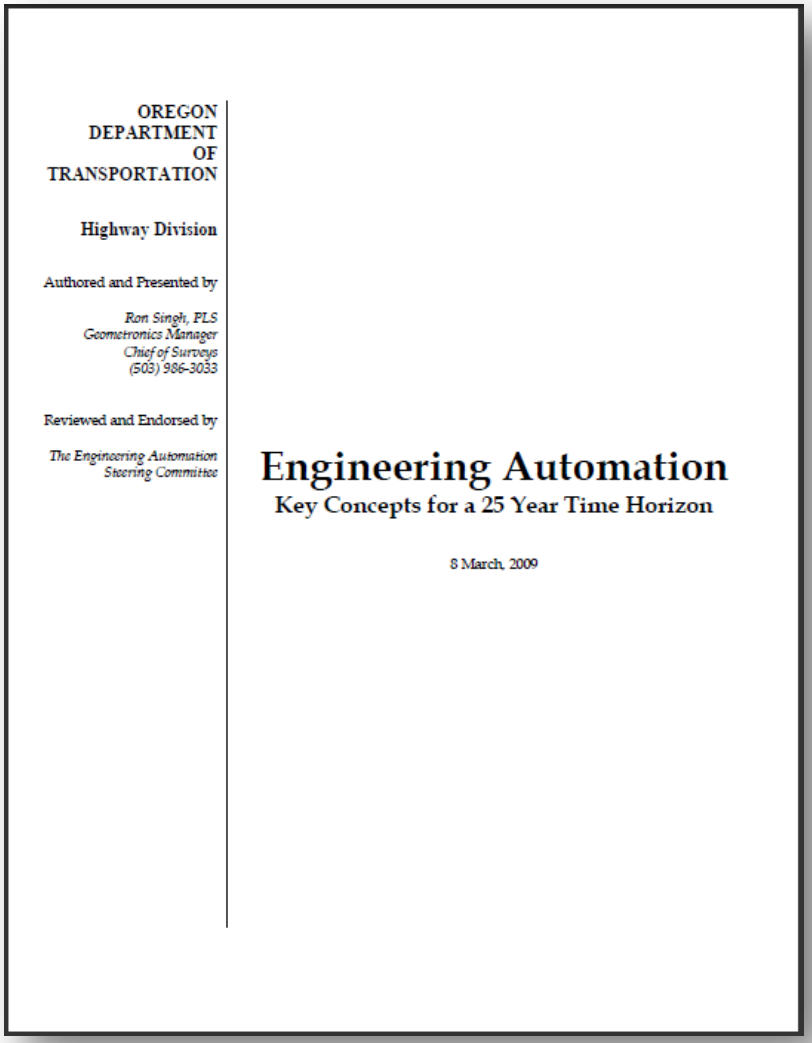
ODOT's Participation

- Developed and implementing 3D Design for Construction deliverables.
- Participated on a TWG to develop Workshop.
- Assisted in Delivery of the Arkansas Workshop last Month.
- Membership on National Committees.

Automated Machine Guidance

Ron Singh, PLS
ODOT Chief of Surveys
Geometronics Manager

Engineering Automation



OREGON
DEPARTMENT
OF
TRANSPORTATION

Highway Division

Authored and Presented by

Ron Singh, PLS
Geomatronics Manager
Chief of Surveys
(503) 986-3033

Reviewed and Endorsed by

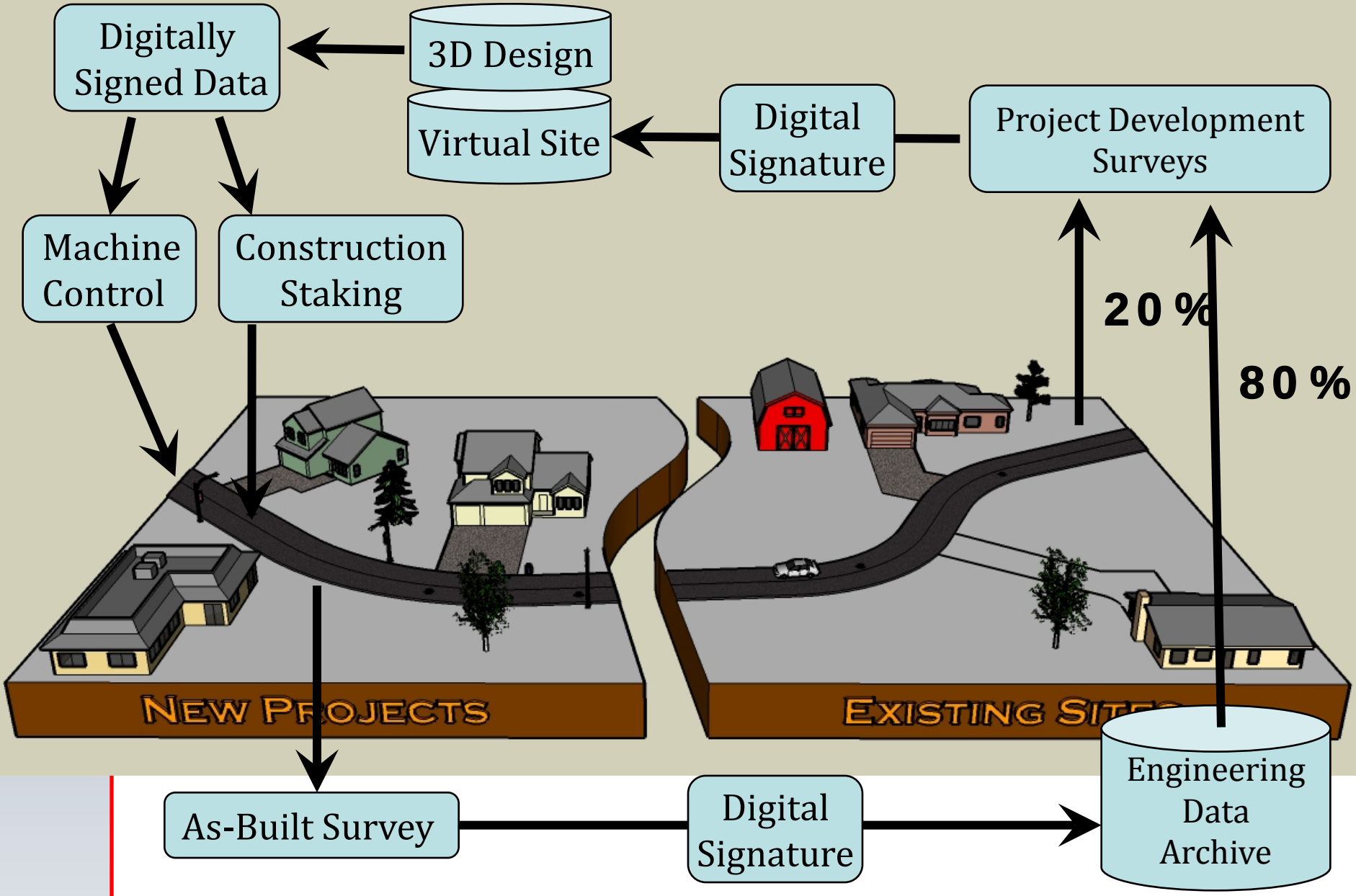
The Engineering Automation Steering Committee

Engineering Automation
Key Concepts for a 25 Year Time Horizon

8 March, 2009

Key Concepts (excerpt)

- Full 3D/4D/5D Design
- Visualization
- Construction Automation
  - >Construction machine guidance and control
  - >Inspection tools
  - >Enhanced use of GPS (RTN, IMU)
  - >Remote construction site monitoring
  - >Materials delivery and certification


Digitally Signed Data
3D Design
Virtual Site
Digital Signature
Project Development Surveys
Machine Control
Construction Staking
20 %
80 %
NEW PROJECTS
EXISTING SITES
As-Built Survey
Digital Signature
Engineering Data Archive

Machine Guidance

A Machine Guidance system uses automation to provide the equipment operator a visual indicator of the position of the cutting edge (blade, bucket, screed, etc) relative to the design surface being constructed.

The operator controls everything.

Machine Control

A Machine Control system is where the cutting edge of the equipment is fully controlled by automation.

The system is connected to and controls the hydraulics while the operator simply drives the equipment and manages the automation.

3 Components of Machine Control

1. The design and resulting data
2. The machine w/computer, sensors, hydraulic control, and radio
3. The positioning system – GPS, TPS, laser, or combination

Guidance Systems

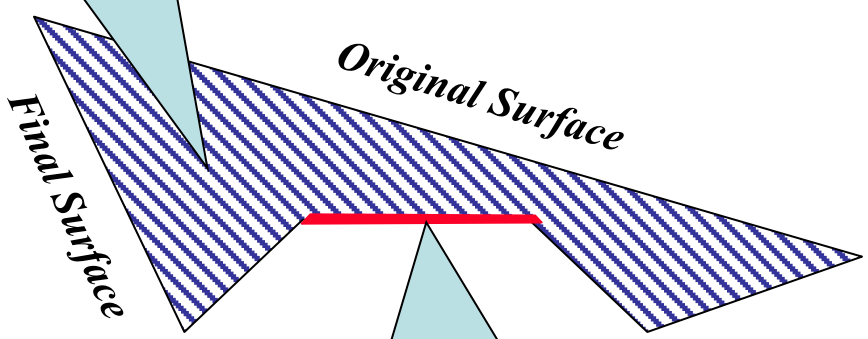
Provides the interface between engineering design and the machine operator

Types of Guidance Systems

- Stakes
- String lines
- Sonic sensors
- Lasers
- GPS
- Total Stations
- GPS w/lasers

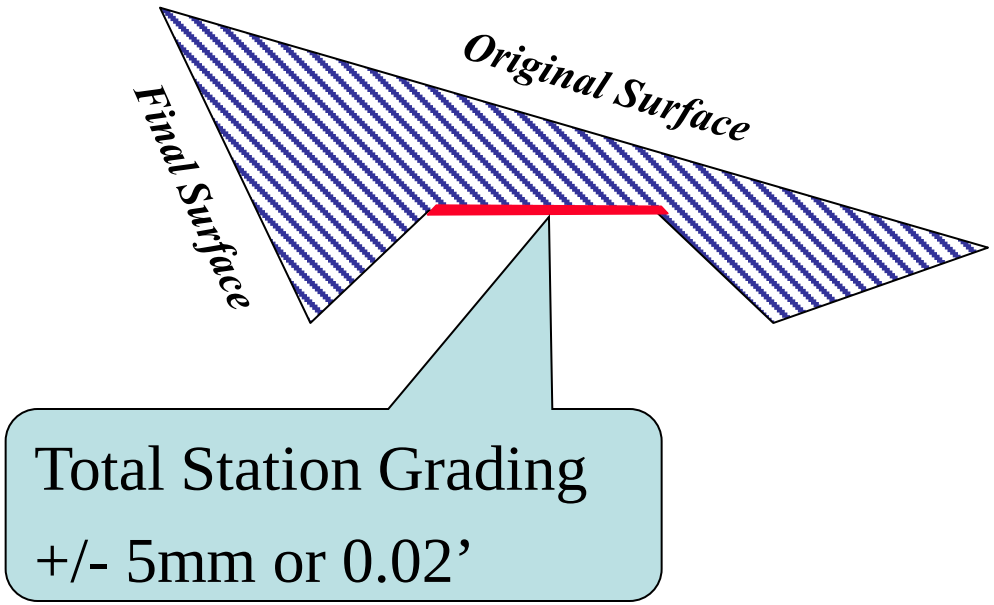
Guidance/Control by GPS

Bulk Excavation
GPS Grading
+/- 30 mm or 0.1’



Fine Grading
Generally Not By GPS

Control by Total Station



Control by Laser Augmented GPS

Laser augmented GPS systems deliver a few millimeters of vertical accuracy using conventional lasers capable of working on an inclined plane

Machine Control

The ultimate system

- No stakes required
- No grade checker required
- Records data for quality control
- Records data for volume computation
- Data could be transmitted to engineer, inspector, or surveyor for “real time” checks

National Initiatives

- Every Day Counts II - FHWA
  - 3D Design
  - Automated Machine Guidance
- Intelligent Construction Systems and Technologies – National Academies

Issues to Consider

- Coordinate System
  - Represents Ground
  - Same as Original Survey and Design
- Quality Original Ground DTM
  - Suitable for 3D design
- 3D Design
  - Suitable for AMG
- Data Exchange
  - Lossless File Format
  - Validate - Close the Loop

Issues to Consider

- Engineer of Record
  - legal issues
- Design Intent
- Do Not Exceed Positioning System Limitations
- Calibrate and Check Systems
- Validate Construction
  - Confidence Points, etc.

Pre-Construction Survey

- Tasks performed by the Agency just prior to construction
- To verify Horizontal and Vertical Control
- To verify Original Ground DTM
- To recover any new monuments of record
- To assist in any utility relocation staking
- Conducted by the Agency at, or near, the bid let date – to confirm survey readiness for construction

The (Virtual) Oregon Trail:
Construction Administration in 3D

Della Mosier
ODOT Region 4 Roadway/Hydro Manager

3D Engineered Models

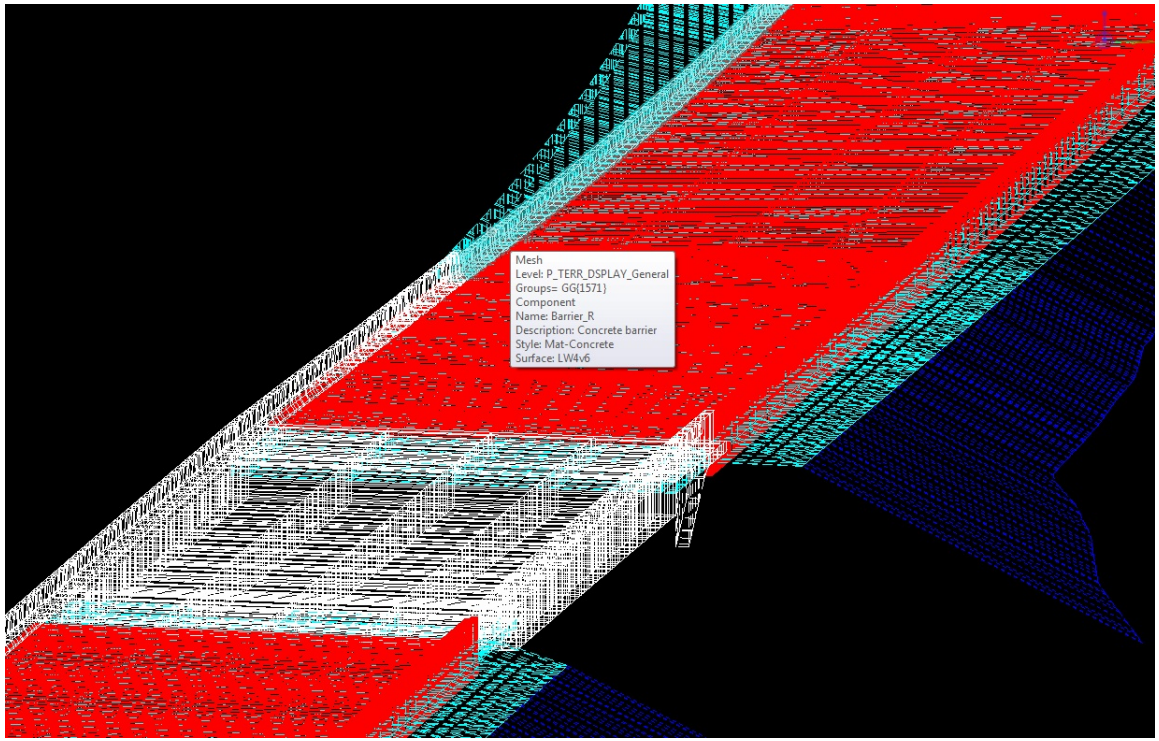
Preliminary Engineering

Construction Engineering

Asset Management

Constructible 3D Engineered Models

Delivering Digital Data for Bid



3D Roadway Design Tech Bulletin (Jan 2014)

Purpose:

"To provide clarification concerning the required content, process/workflows, delivery timelines, and quality control of digital 3D Roadway Design data for Oregon's Statewide Transportation Improvement Program (STIP) projects."

Timelines

Projects Letting in 2014: Voluntary

Projects Letting in 2015: Required

Exceptions

Exceptions Granted by the Region Roadway Manager

- Projects without significant earthwork component
- Many Local Agency projects
- Projects with compressed design delivery schedules

How Will I Be Notified at Bid?

eBIDS Notice is provided with Contract Documents

Oregon
John A. Kitzhaber, Governor

Department of Transportation
Technical Services
Office of Project Letting
4040 Fairview Industrial Drive SE
Salem, OR 97302
Telephone 503-986-4040

Date: January 6, 2014

To: **PLAN HOLDERS**

Notice of eBIDS Roadway Digital Design Data

Subject: Contract Number 14653
OR39: Merrill N. City Limits – California State Line Sec.
Klamath Falls – Malin & Hatfield Highways
Klamath County
Grading, drainage, paving, signs & signals
(Bids to be opened and read January 30, 2014)

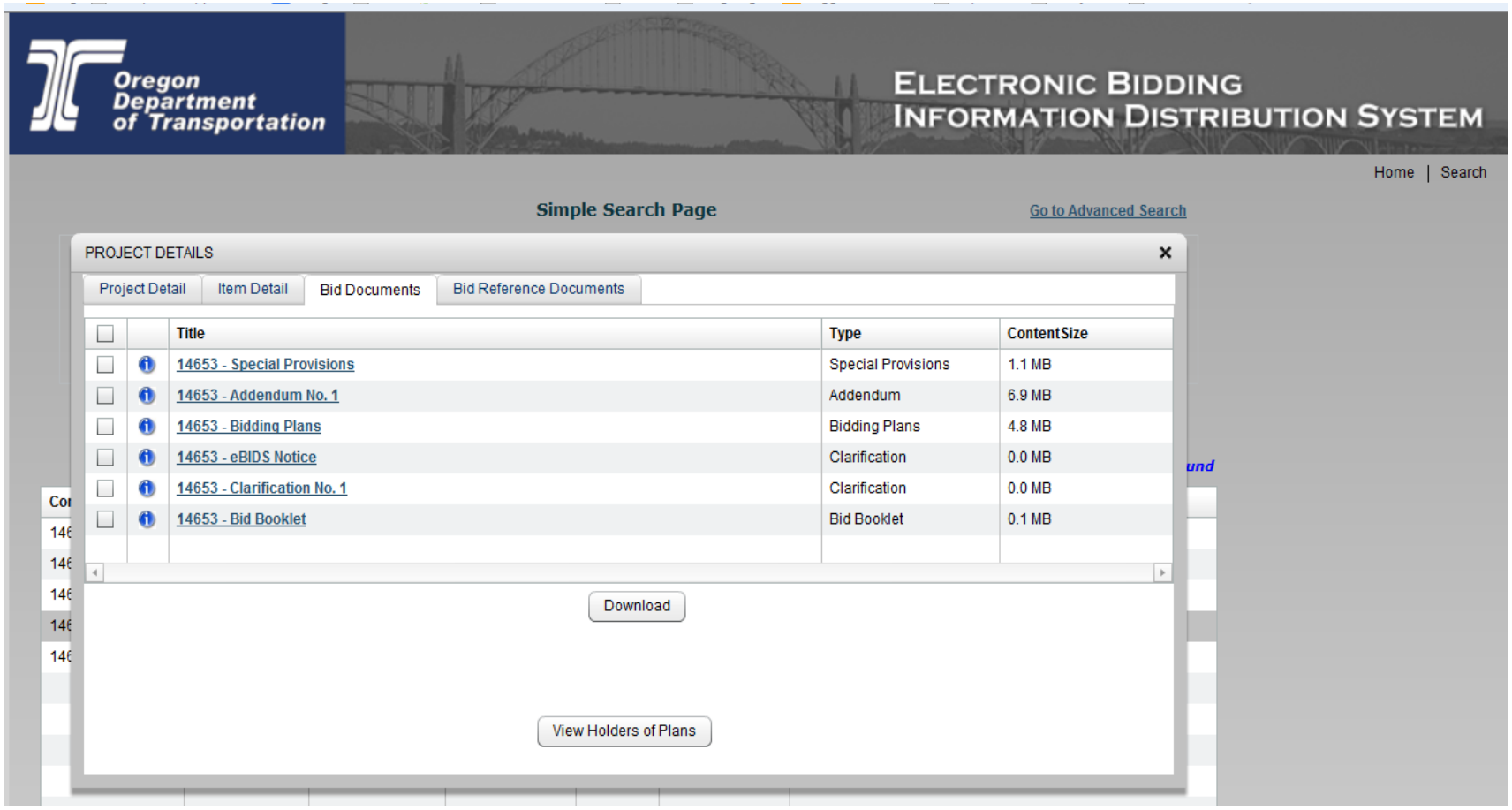
ODOT design staff have prepared an "eBIDS Handoff Package" that contains roadway digital design data. The digital data includes alignment data and three-dimensional surfaces provided in LandXML format, as described in the attached eBIDS Handoff Checklist and Computer File Index.

The "eBIDS Handoff Package" roadway digital design data provided on the eBIDS reference documents site is for bidding purposes only. As with all documents on the eBIDS reference documents site, use of this data for any other purpose is at the Bidder's own risk.

In addition to the "eBIDS Handoff Package", a "Construction Survey Handoff Package" will be provided to the awarded Contractor at the pre-survey meeting. Additional information regarding the content of the Construction Survey Handoff Package is provided in Appendix M of ODOT's Highway Design Manual. The roadway digital design data provided to the awarded Contractor may be used to aid in the use of automated machine control equipment, such as GPS grade control, for earthwork construction. Three dimensional representations of physical project component "solids" (pipes, footings, structures, poles, etc.) will not be provided.

Attachments: eBIDS Handoff Checklist and Computer File Index

Data Available for Bid: eBIDS Notice



Title	Type	ContentSize
14653 - Special Provisions	Special Provisions	1.1 MB
14653 - Addendum No. 1	Addendum	6.9 MB
14653 - Bidding Plans	Bidding Plans	4.8 MB
14653 - eBIDS Notice	Clarification	0.0 MB
14653 - Clarification No. 1	Clarification	0.0 MB
14653 - Bid Booklet	Bid Booklet	0.1 MB

How Will I Know What I'm Getting?

ODOT Roadway Digital Design - eBIDS Handoff Checklist*

PROJECT	OR39: Merrill N. City Limits - California State Line
HIGHWAY	Klamath Falls - Malin Hwy. & Hatfield Hwy.
COUNTY	Klamath
KEY #	17549
MP	13.51 to 18.93
DATE	6-Jan-14

ITEM	DESCRIPTION**	REQUIRED	COMPLETE?
Notice of eBIDS Roadway Digital Design Data Letter	Include Notice of eBIDS Roadway Digital Design Data Letter using template provided.	Yes	☑
Computer File Index	Primary Alignment Names & Descriptions (Centerlines)	Yes	☑
	Secondary Alignment Names & Descriptions (Curbs, EP radius, etc.)	Not Currently Required	
	Design Finish Grade Names & Descriptions	Yes	☑
	Design Subgrade Names & Descriptions	Not Currently Required	☑
	Existing Ground Name & Description (to be certified by Project Surveyor)	Yes	☑
	Cross Section File Names & Descriptions	Yes	☑
Alignment Data	Primary Alignments in LandXML Format	Yes	☑
	Secondary Alignments in LandXML Format	Not Currently Required	
Surface Data	Design Finish Grade in LandXML Format	Yes	☑
	Design Subgrade in LandXML Format	Not Currently Required	☑
	Design Top of Rock in LandXML Format	Not Currently Required	
	Existing Ground in LandXML Format (to be supplied by Project Surveyor)	Yes	☑
Cross Sections	Cross Sections every 25 feet and at critical points (i.e. taper points, guardrail flare transitions, impact panels, super elevation breaks, etc.) that contain Finish Grade, Existing Ground, and Subgrade in pdf format.	Yes	☑
Corridor Map Index	Exhibits showing finish grade triangles for Design Finish Grade surfaces provided as part of Surface Data, described above. Exhibits to be provided in pdf format.	Not Currently Required	☑

Data Available for Bid: Bid Ref Docs

PROJECT DETAILS

Project Detail | Item Detail | Bid Documents | Bid Reference Documents

Bid Reference Documents obtained from ODOT eBIDS will not become part of the contract, as stated in the ODOT eBIDS Terms Of Use.

Title	Type	ContentSize
Xsect_21120_Fill.pdf	LandXML	1.1 MB
LandXMLTriangles_dtmL22350_MB.xml	LandXML	0.0 MB
LandXMLTriangles_dtmL18834_MB_SG.xml	LandXML	0.0 MB
LandXMLTriangles_dtmL33690GRail.xml	LandXML	0.0 MB
CorridorIndex.pdf	LandXML	0.1 MB
Xsect_34100_GR.pdf	LandXML	2.1 MB
LandXMLTriangles_dtmL34100GRail_SG_L.xml	LandXML	0.0 MB

Download

View Holders of Plans

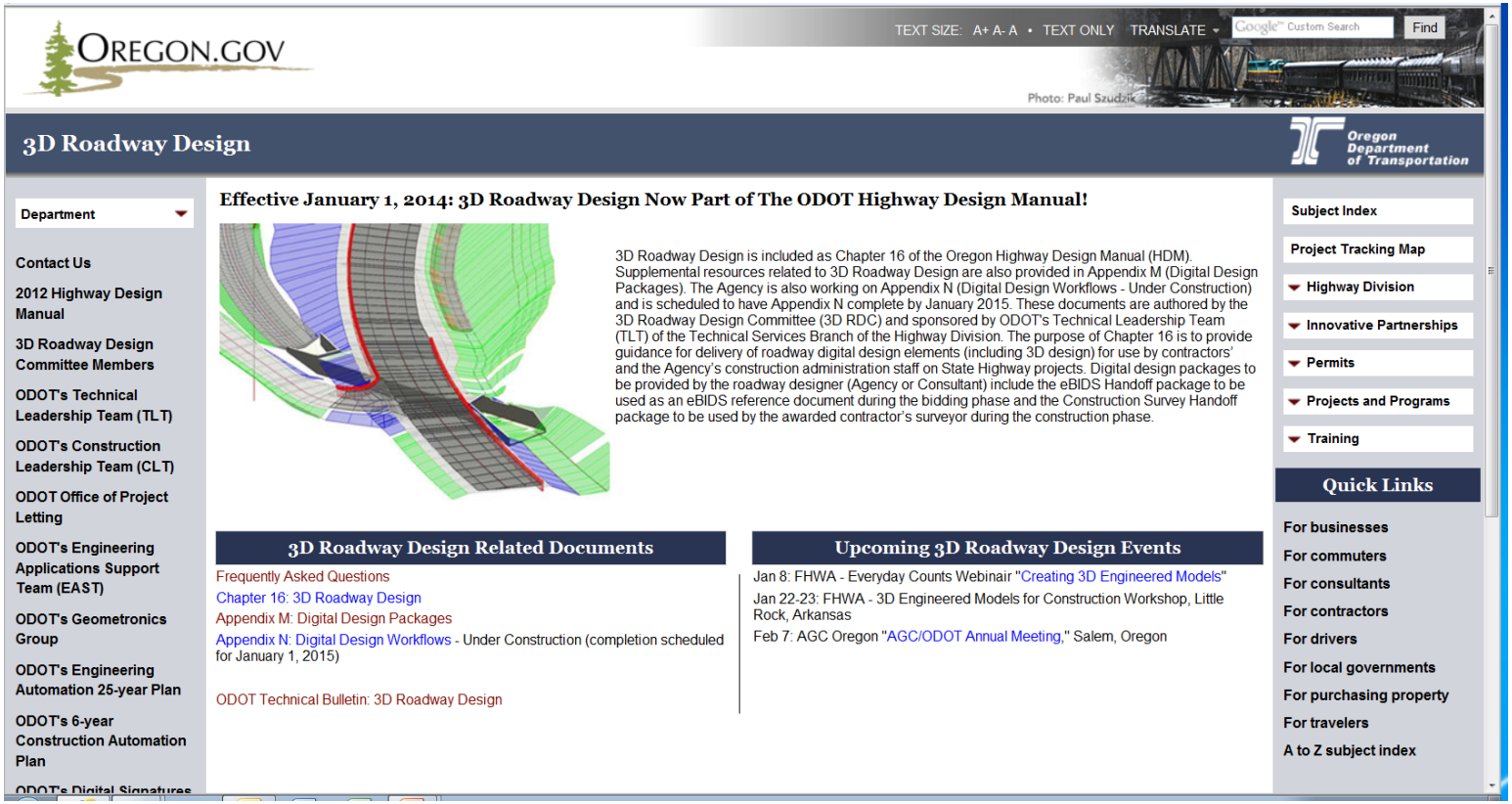
ODOT's Digital Construction Admin.

- Construction Survey Handoff Package
  - ODOT Designer Provides at Pre-Survey Mtg
  - Includes Detailed LandXML and InRoads Files

- Examples provided in AppendixM of ODOT's Highway Design Manual

More info? Check FAQs at:

http://www.oregon.gov/ODOT/HWY/3DRDM/Pages/index.aspx



Next Steps

- Bid-able Digital Design for all Disciplines
- Digital Data as part of the Contract Documents
- 3D Engineered As-built Models

3D Modeling and Machine Control:

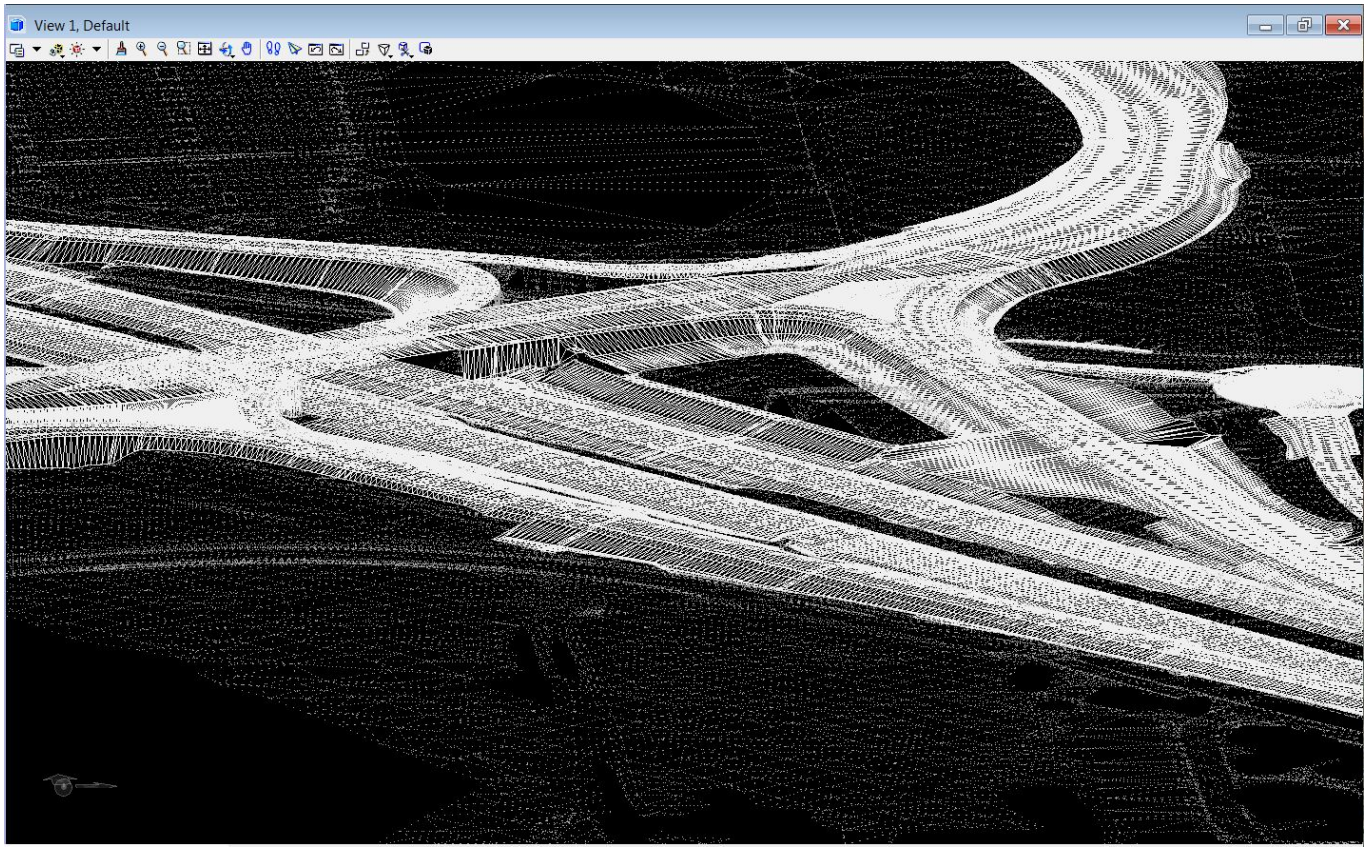
Implementation Throughout the Construction Cycle

Alex Culbertson
Machine Control Manager
K. & E. Excavating, Inc.

Examples of Implementation of 3D Modeling and Machine Control For:

- Improved Estimating
- Pre-Construction Grading Review
- Reducing Impacts of Human Error
- Speeding Up Design Revisions During Construction

3D Models for Estimating

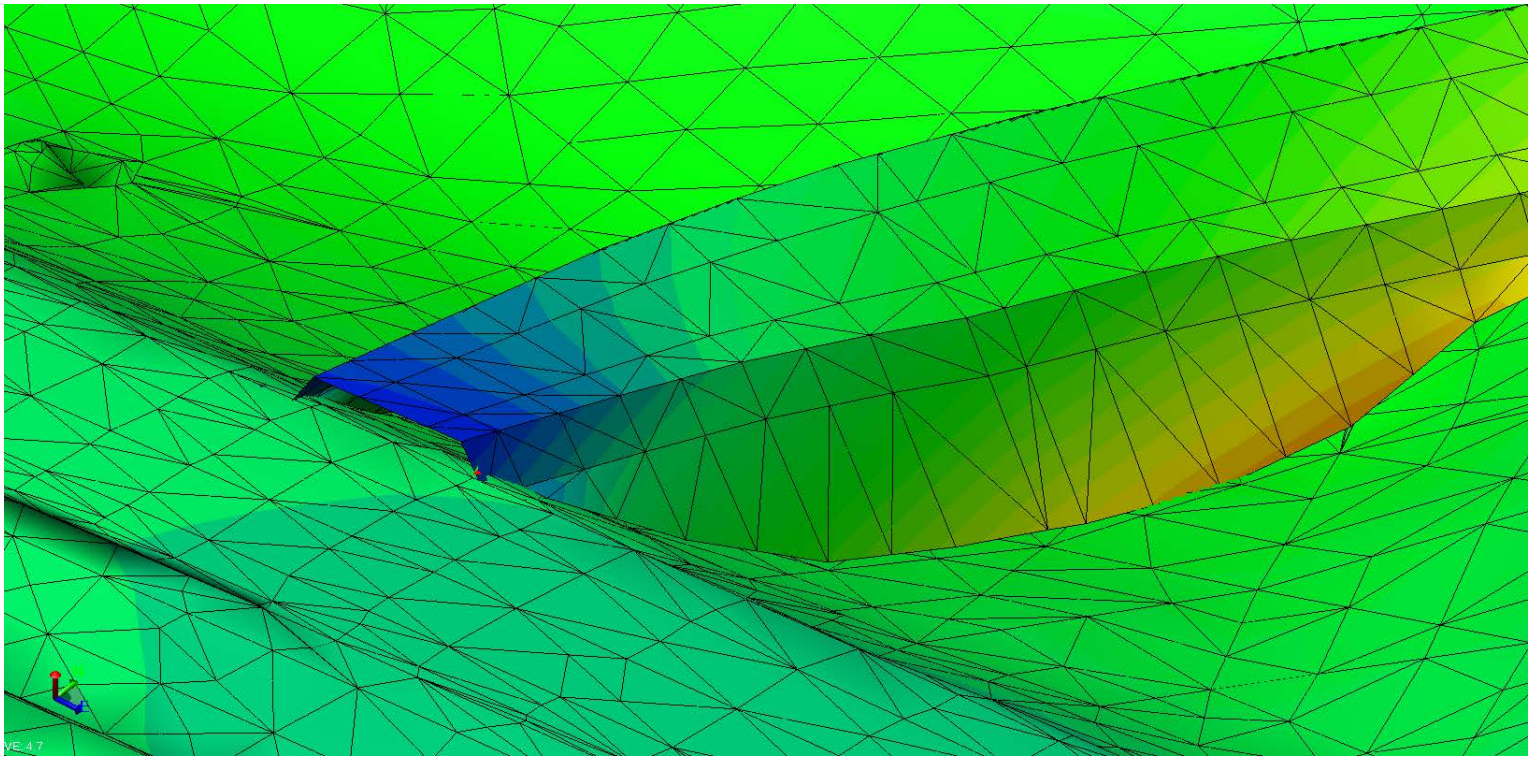


I-5 Fern Valley Interchange, Unit 2

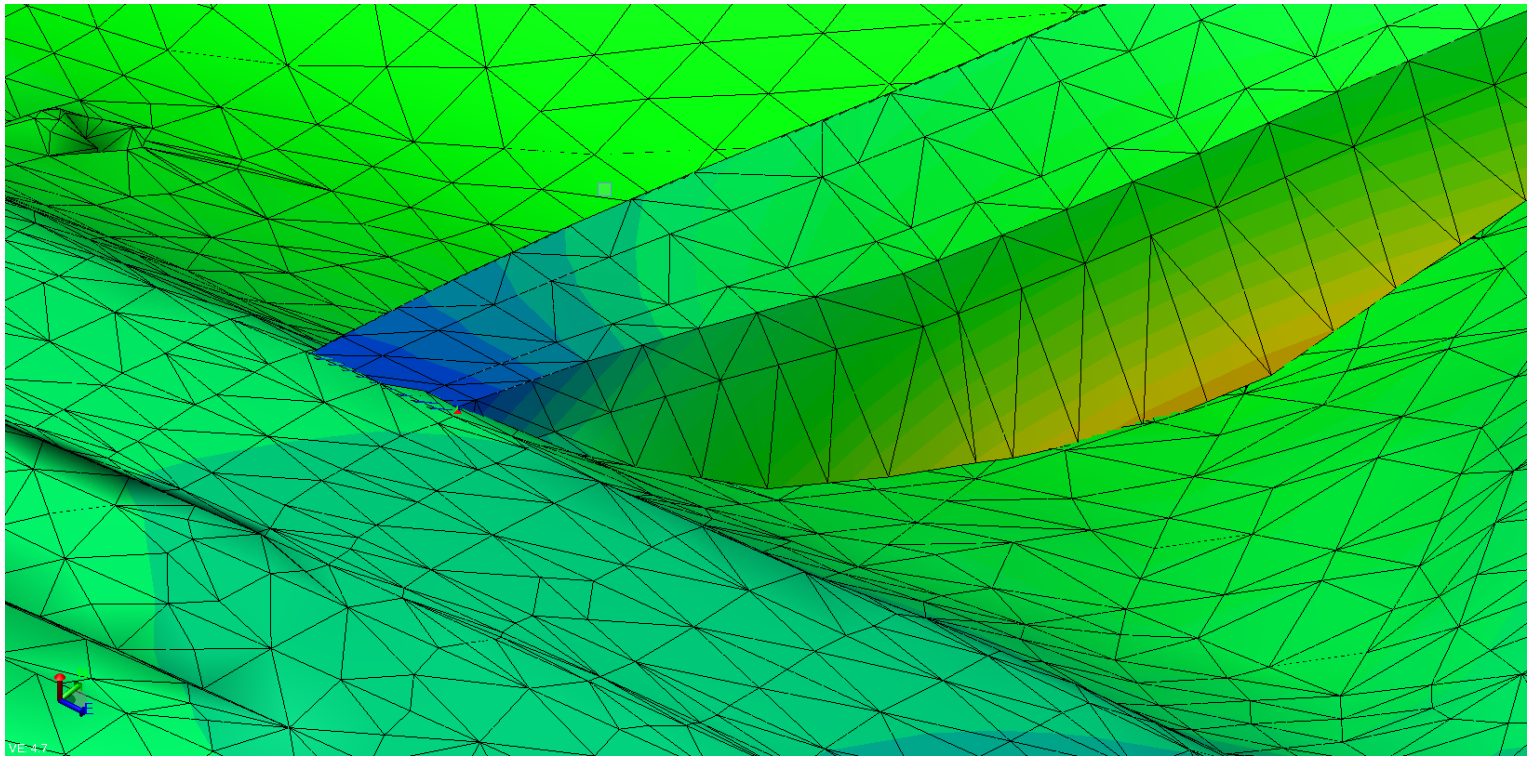
Improved Pre-Construction Grade Checking

I-5 @ Beltline Interchange Unit 3

Improved Pre-Construction Grade Checking



Improved Pre-Construction Grade Checking



Reducing Human Error in the Field

OR22 Bridge Vertical Clearance

Reducing Human Error in the Field

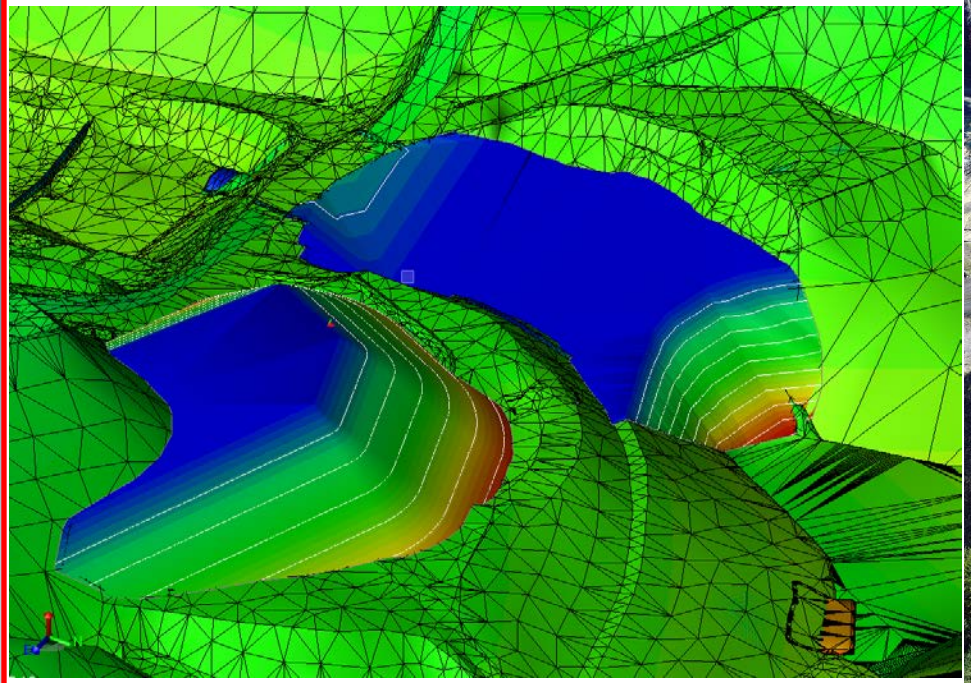
Reducing Human Error in the Field

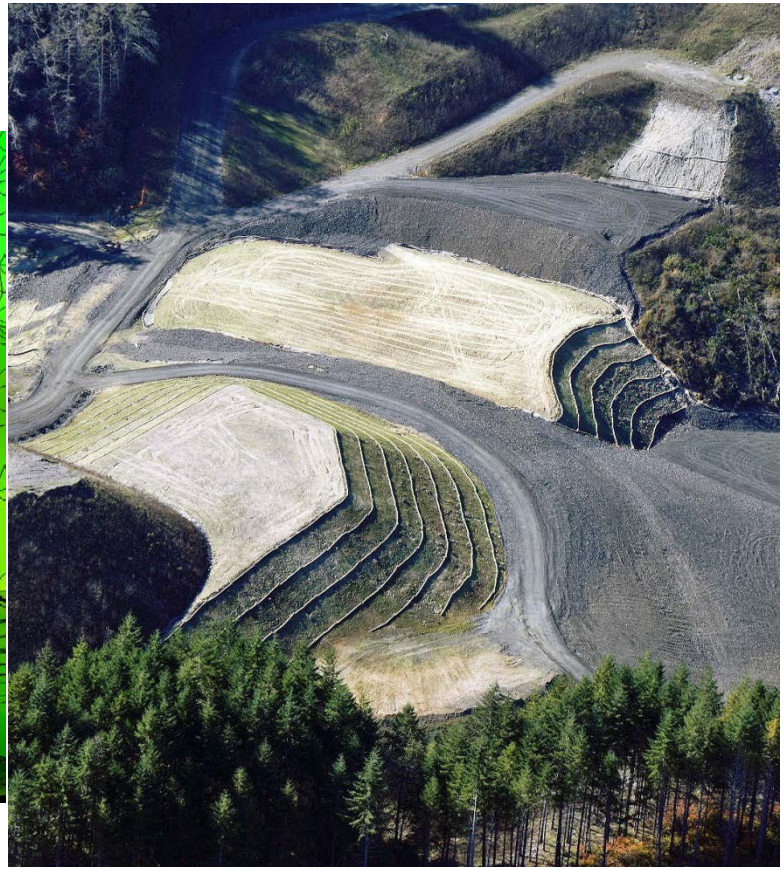
Speeding Up Design Revisions During Construction

US20 PME: UPRR – Eddyville Ph2

Speeding Up Design Revisions During Construction

Speeding Up Design Revisions During Construction





Closing

- Use of 3D modeling helps improve the entire construction cycle from bid to completion.