
# Working with 3D Models in Design & Construction

**Alexa Mitchell, P.E.**
**CADD Services Engineer**
**Missouri Department of Transportation**

**Matthew Poston**
**CADD Technician**
**Fred Weber, Inc.**

MoDOT

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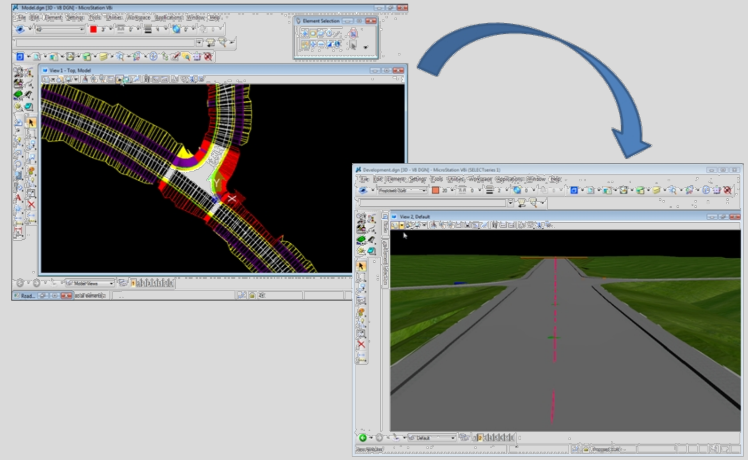
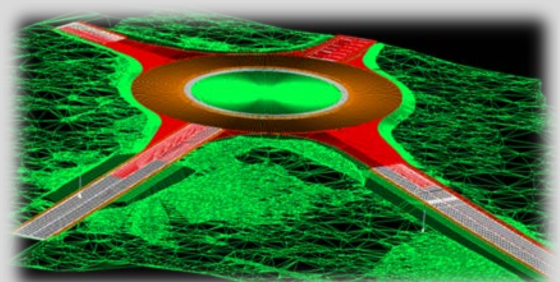
# Session Objectives

- Describe how 3D Models are created during design
- Discuss what 3D Model outputs are useful in Construction
- Describe applications of 3D Models in Construction

# Creating the 3D Design Model

## Paradigm Shift

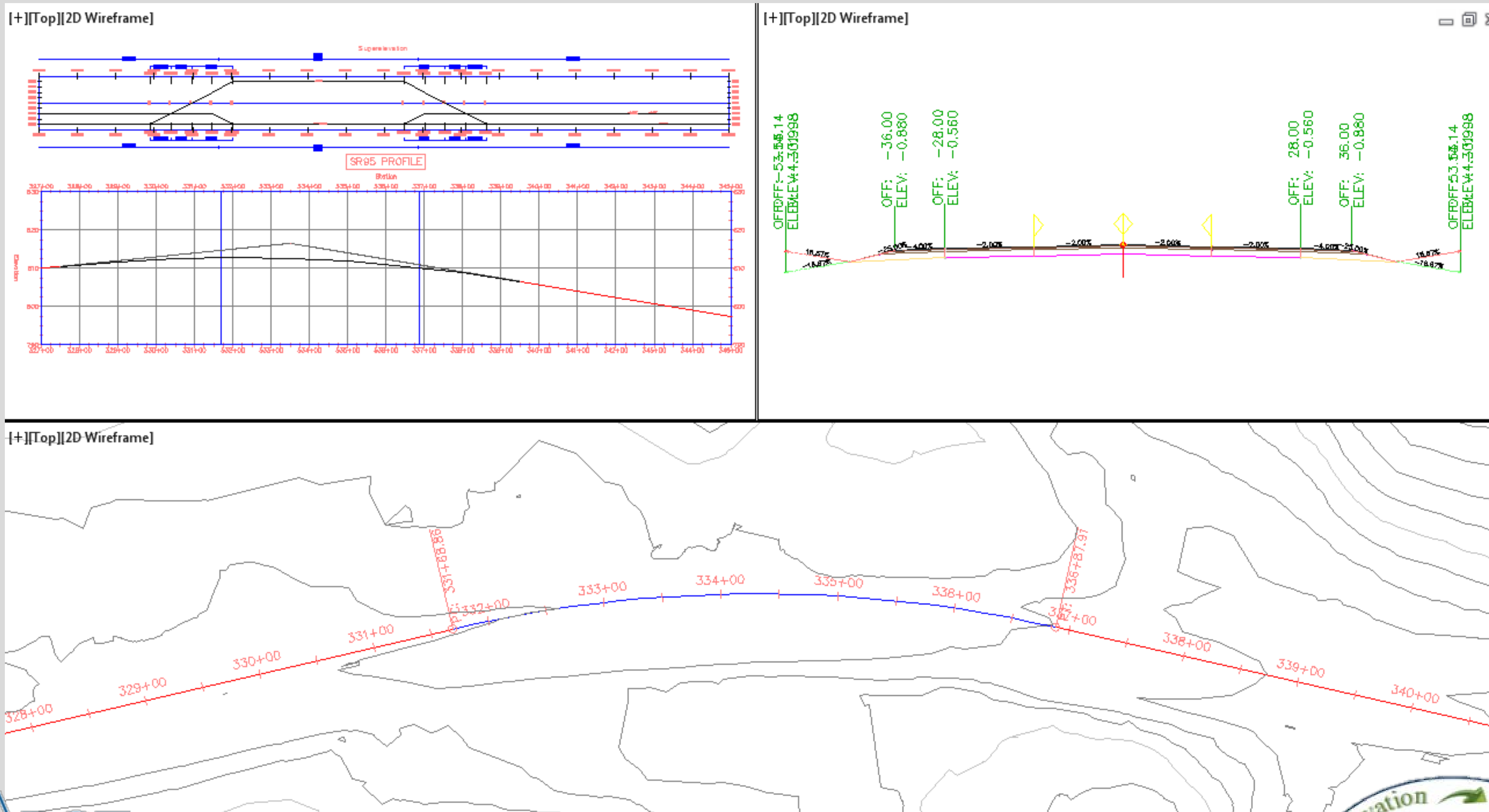




 Source: MoDOT and Bentley Systems, Inc.

# Creating the 3D Design Model

## Design Information Embedded in a 3D Model

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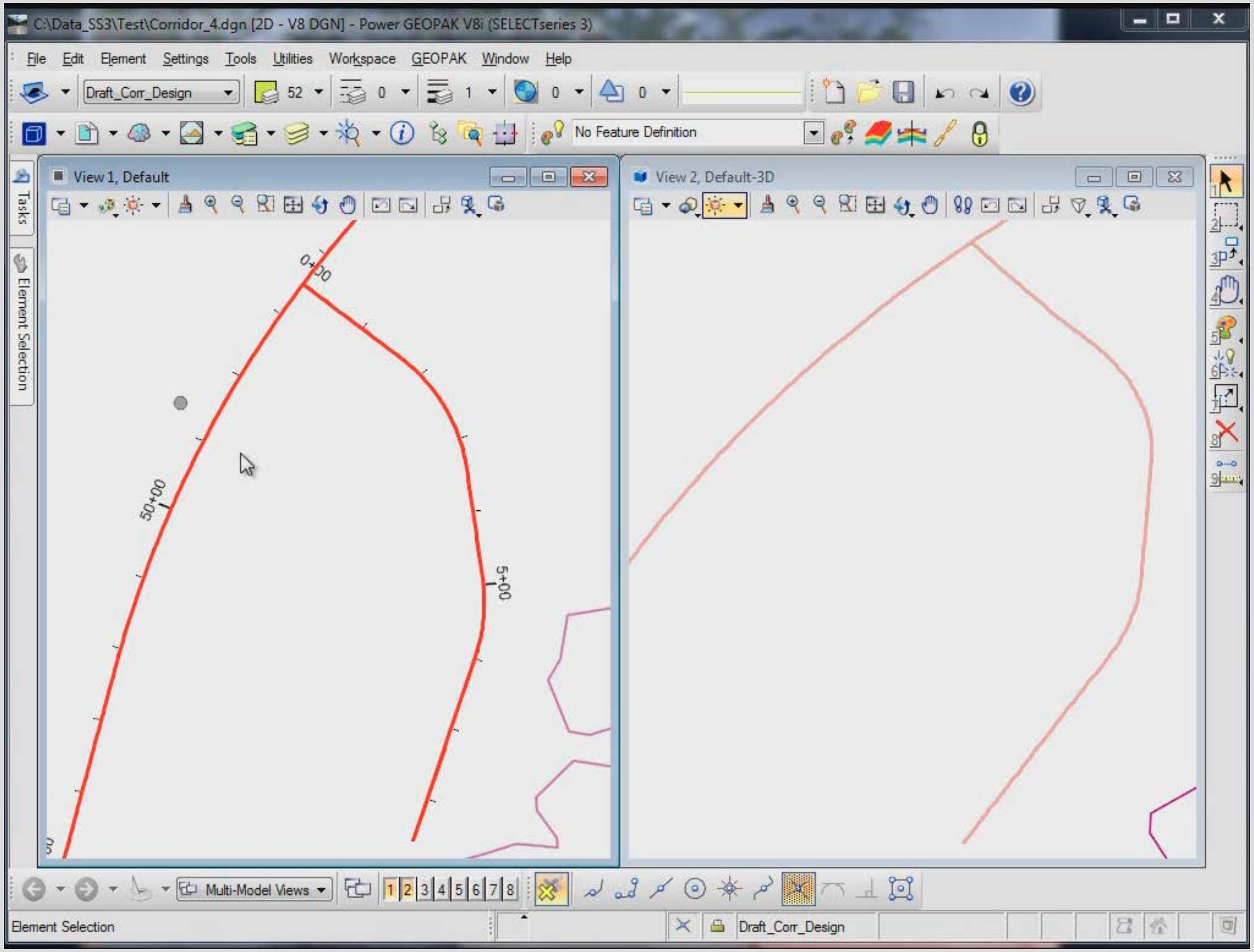
 Source: Parson Brinckerhoff

# Creating the 3D Design Model

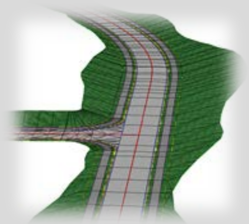
## Creating a Corridor Model



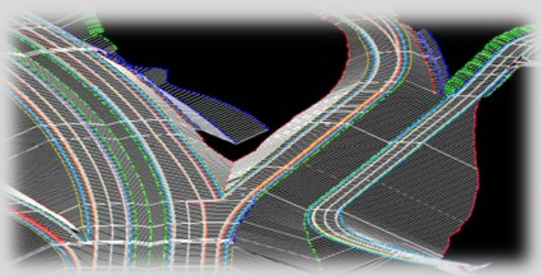

 Source: Bentley Systems, Inc.

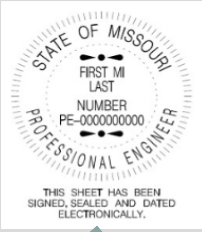
# Digital Plans Delivery

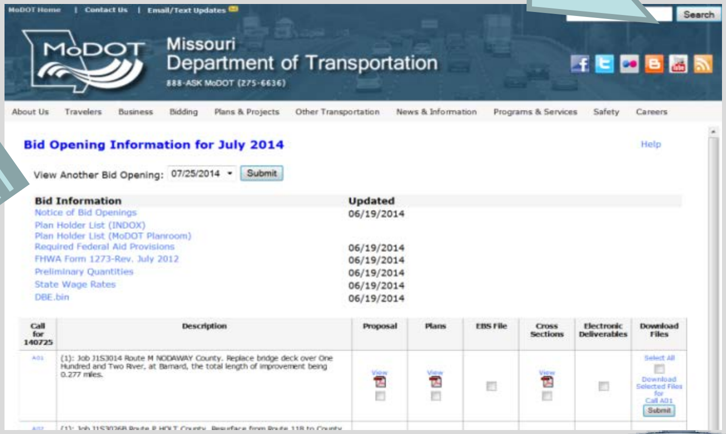
## Electronically Signed & Sealed Vector PDF's

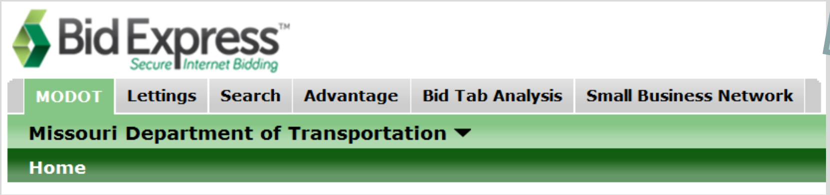


PowerGeopak




 Source: MoDOT and Bentley Systems, Inc.

# Creating the 3D Design Model

## Level of Detail

- Calculating Quantities
- Automated Machine Guidance
- Collaboration
- Visualization

# Creating the 3D Design Model

## Level of Detail –XS Interval for Quantities & AMG

- Every 10-25 feet depending on terrain, transitional areas, and length of project
- Tighter 1-5 ft interval in critical sections such as gore, intersections, etc.
- At every critical point such as cardinal points, SE transition points, high and low elevations.

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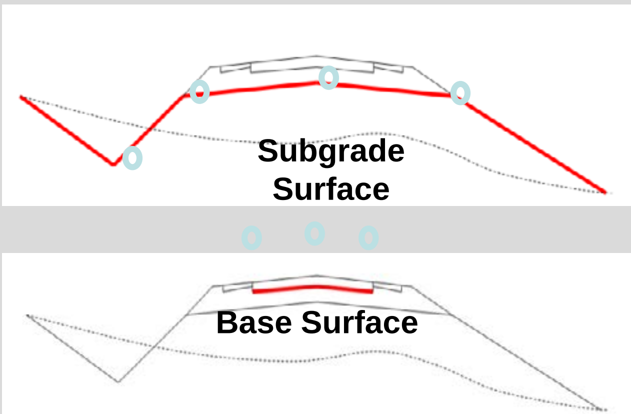
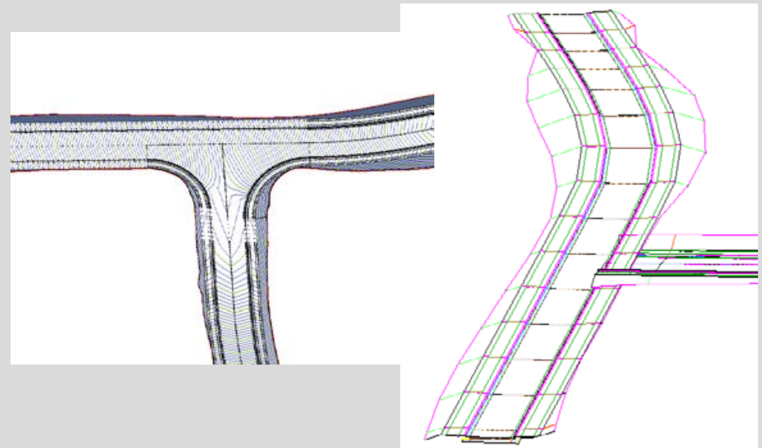
# Creating the 3D Design Model

## For the Purpose of Estimates & AMG

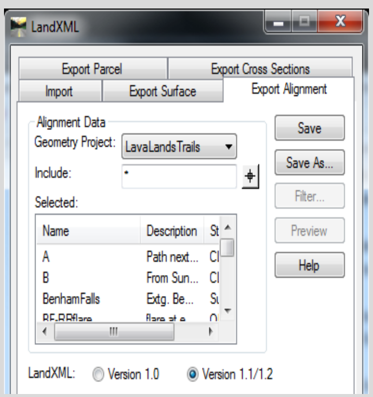
**Type**



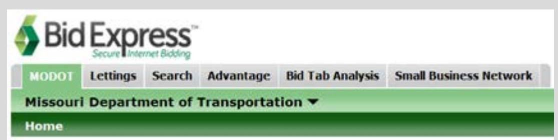

**Density**



**Format**




**Timing**




**Authorized Use**


 Source: Parsons Brinckerhoff & ARA for FHWA

# Creating the 3D Design Model

## Level of Detail – Collaboration & Visualization

| Purpose | Desired Outcome |
|---|---|
| Level 1 - AMG | Alignments, profiles, 3D string-lines, components and surfaces |
| Level 2 – Design Review/Collaboration | Raster imagery terrain with 3D components with material assignments and striping |
| Level 3 – Basic Visualization | Level 2 + trees, car simulation and basic photo matching |
| Level 4 – Intermediate Visualization | Level 3 + basic lighting |
| Level 5 – Advanced Visualization | Level 4 + high rendering visualization |

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# Digital Engineering Data Delivery -TODAY

## Provided Pre-Bid for Information Only

| Type of Project | Digital Data Provided |
| --- | --- |
| Projects with significant amount of cross-sections | Survey control points, available alignments and profiles, existing DTM, PFG surface, and when possible an alternate surface. |

237.13.5 Example Set of Electronic Design Data

| | |
| --- | --- |
| Content's File Report: | J0P0928_contents_file.pdf |
| Geometry File(s): | J0P0928_geometry.gpk |
| | J0P0928_geometry.alg |
| | J0P0928]_geometry.xml |
| Microstation Files: | J0P0928_plan_rte65.dgn |
| | J0P0928_profile_ rte65.dgn |
| | J0P0928_xs_ rte65.dgn |
| | J0P0928_drainage_ rte65.dgn |
| | J0P0928_shapes_ rte65.dgn |
| | J0P0928_3D_ rte65.dgn |
| 3D Existing Terrain Models: | J0P0928_Existing_ rte65.tin |
| | J0P0928_Existing_ rte65.dtm |
| | J0P0928_Existing_ rte65.xml |
| 3D Digital Design Models: | J0P0928_PFG_surface_ rte65.tin |
| | J0P0928_PFG_surface_ rte65.dtm |
| | J0P0928_PFG_surface_ rte65.xml |
| | J0P0928_subgrade_surface_ rte65.tin |
| | J0P0928_subgrade_surface_ rte65.dtm |
| | J0P0928_subgrade_surface_ rte65.xml |
| | J0P0928_rte65.rdp |

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# Digital Engineering Data Delivery - FUTURE

## Provided Pre-Bid for Information Only

| Type of Project | Digital Data Provided | Format |
|---|---|---|
| Bridge and/or Resurfacing | Survey control points, available alignments and profiles | LandXML, and native PowerGeopak |
| Reconstruction<br>• Widening<br>• Guardrail | Survey control points, existing DTM, available alignments and profiles, 3D string-lines, all available proposed surfaces, such as subgrade, aggregate, and pavement of the reconstruction | LandXML and native PowerGeopak for cogo & surfaces DGN for 3D line-strings and plan graphics |
| Expansion/New Construction<br>• Paving<br>• Intersection Improvements | Survey control points, existing DTM, available alignments and profiles, 3D string-lines, all available proposed surfaces, such as subgrade, aggregate, and pavement of all new construction | LandXML, and native PowerGeopak for cogo & surfaces DGN for 3D line-strings and plan graphics |

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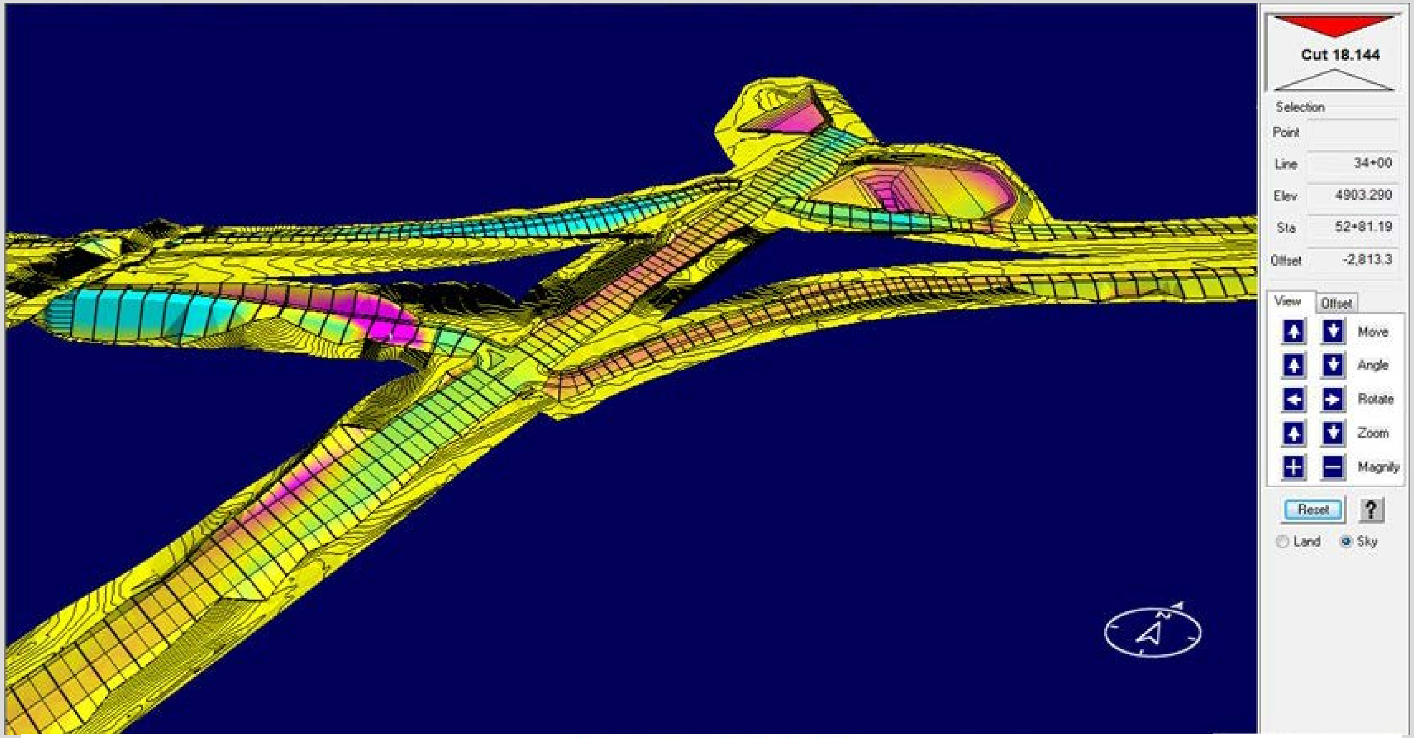
# CONTRACTORS NEEDS TO SUPPORT 3D MODELS FOR AMG AND STRINGLESS PAVING

THE DIFFERENT USES OF ELECTRONIC FILES

- BID DOCUMENTS
- AMG CONTROL
- PLAN VERIFICATION
- 3D MODELING

# Contractor Use of 3D Models

### *Bid Documents*




**Highway Sections Report**
**Design vs. Existing**

| Station Number | Total | Surface Area Cut | Fill | OnGrade | End Area Cut | End Area Fill | Raw Volume Cut | Raw Volume Fill | Comp/Ratio Cut | Comp/Ratio Fill | Compacted Cut | Compacted Fill | Net Volume Cut(Fill) | Cumulative Cut(Fill) | Borrow (Spoil) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11+00 | 0 | 0 | 0 | 0 | 0.0 | 0.0 | 0 | 0 | 1.00 | 1.00 | 0 | 0 | 0 | 0 | |
| 11+50 | 3,854 | 0 | 3,834 | 20 | 0.0 | 759.8 | 0 | 704 | 1.00 | 1.00 | 0 | 704 | 2,116 | 2,116 | 2,820 |
| 12+00 | 7,134 | 0 | 7,084 | 50 | 0.0 | 597.3 | 0 | 1,257 | 1.00 | 1.00 | 0 | 1,257 | (1,257) | 859 | |
| 12+50 | 6,628 | 0 | 6,494 | 134 | 0.0 | 325.4 | 0 | 854 | 1.00 | 1.00 | 0 | 854 | (854) | 5 | |
| 13+00 | 6,794 | 0 | 6,649 | 145 | 0.0 | 186.5 | 0 | 474 | 1.00 | 1.00 | 0 | 474 | (474) | (469) | |

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 Source: AGTEK

# Contractor Use of 3D Models

## AMG Control

Construction Management


AMG

Excavation

Trimming/Milling

Grading and Base

Concrete & Asphalt Paving

Horizontal Layouts

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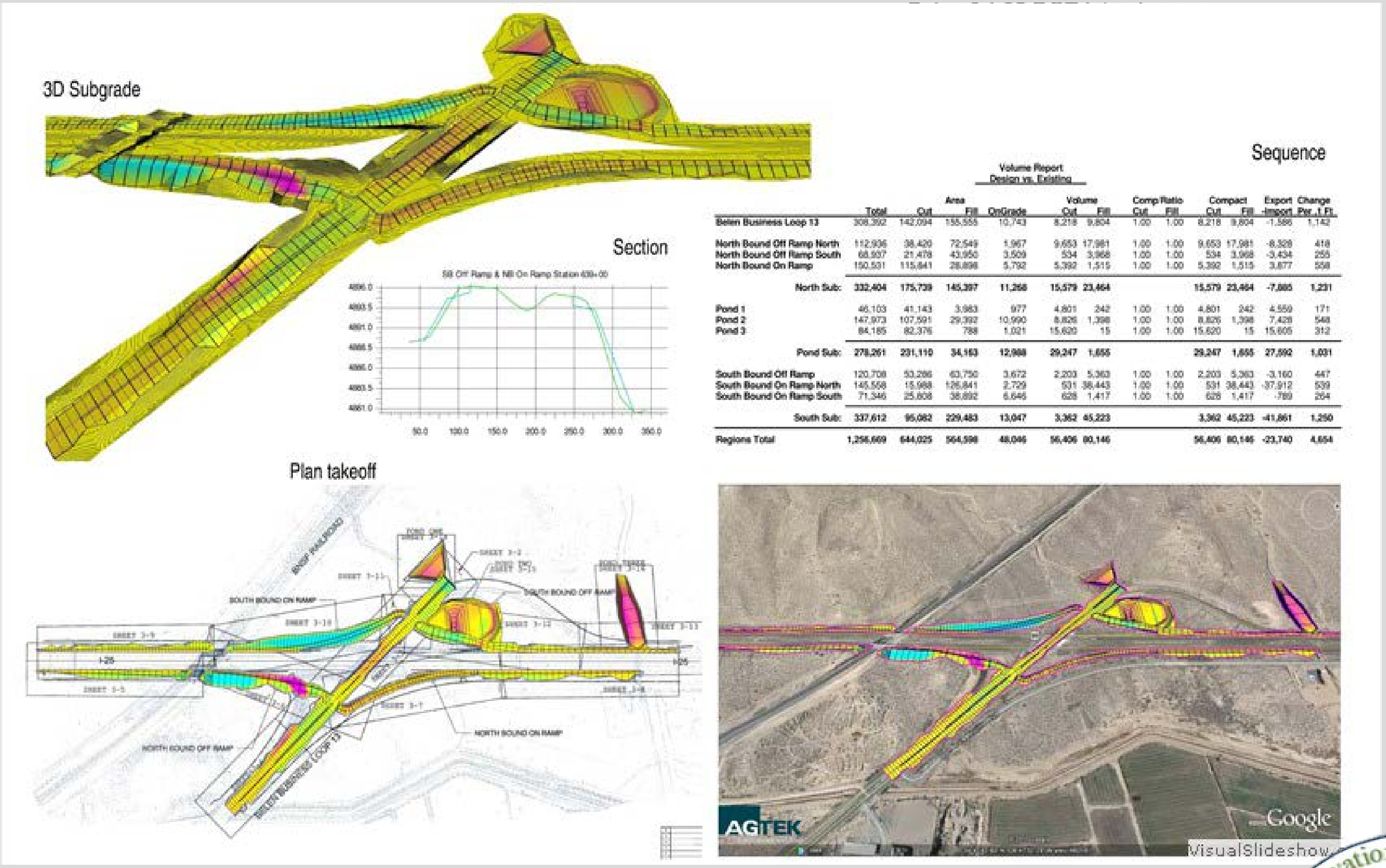
 Source: Topcon, Trimble, GOMACO, Leica, MoDOT

# Contractor Use of 3D Models

## Plan Verification




Volume Report
Design vs. Existing

| | Total | Area Cut | Area Fill | OnGrade | Volume Cut | Volume Fill | Comp Ratio Cut | Comp Ratio Fill | Compact Cut | Compact Fill | Export -Import | Change Per .1 Ft |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Belen Business Loop 13 | 308,392 | 142,094 | 155,555 | 10,743 | 8,218 | 9,804 | 1.00 | 1.00 | 8,218 | 9,804 | -1,586 | 1,142 |
| North Bound Off Ramp North | 112,936 | 38,420 | 72,549 | 1,967 | 9,653 | 17,981 | 1.00 | 1.00 | 9,653 | 17,981 | -8,328 | 418 |
| North Bound Off Ramp South | 68,937 | 21,478 | 43,950 | 3,509 | 534 | 3,968 | 1.00 | 1.00 | 534 | 3,968 | -3,434 | 255 |
| North Bound On Ramp | 150,531 | 115,841 | 28,898 | 5,792 | 5,392 | 1,515 | 1.00 | 1.00 | 5,392 | 1,515 | 3,877 | 558 |
| North Sub: | 332,404 | 175,739 | 145,397 | 11,268 | 15,579 | 23,464 | | | 15,579 | 23,464 | -7,885 | 1,231 |
| Pond 1 | 46,103 | 41,143 | 3,983 | 977 | 4,801 | 242 | 1.00 | 1.00 | 4,801 | 242 | 4,559 | 171 |
| Pond 2 | 147,973 | 107,591 | 29,392 | 10,990 | 8,826 | 1,398 | 1.00 | 1.00 | 8,826 | 1,398 | 7,428 | 548 |
| Pond 3 | 84,185 | 82,376 | 788 | 1,021 | 15,620 | 15 | 1.00 | 1.00 | 15,620 | 15 | 15,605 | 312 |
| Pond Sub: | 278,261 | 231,110 | 34,163 | 12,988 | 29,247 | 1,655 | | | 29,247 | 1,655 | 27,592 | 1,031 |
| South Bound Off Ramp | 120,708 | 53,286 | 63,750 | 3,672 | 2,203 | 5,363 | 1.00 | 1.00 | 2,203 | 5,363 | -3,160 | 447 |
| South Bound On Ramp North | 145,558 | 15,988 | 126,841 | 2,729 | 531 | 38,443 | 1.00 | 1.00 | 531 | 38,443 | -37,912 | 539 |
| South Bound On Ramp South | 71,346 | 25,808 | 38,892 | 6,646 | 628 | 1,417 | 1.00 | 1.00 | 628 | 1,417 | -789 | 264 |
| South Sub: | 337,612 | 95,082 | 229,483 | 13,047 | 3,362 | 45,223 | | | 3,362 | 45,223 | -41,861 | 1,250 |
| Regions Total | 1,256,669 | 644,025 | 564,598 | 48,046 | 56,406 | 80,146 | | | 56,406 | 80,146 | -23,740 | 4,654 |

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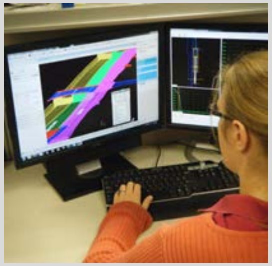
 Source: Sundt Construction and AGTEK

# How Contractors Use 3D Models

## 3D Model

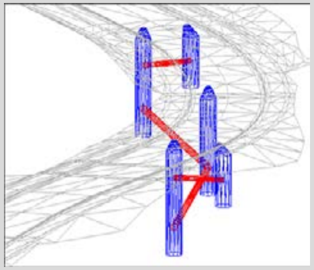
Analyze Data

Meet with Project Managers

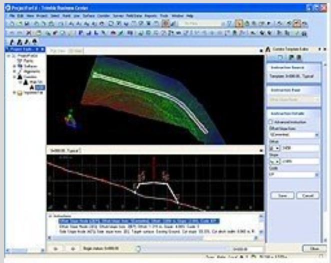


Supplement/ Recreate Models

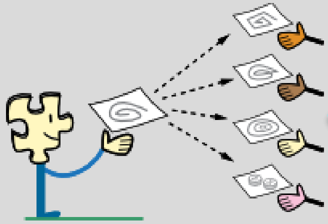
Review Means & Methods



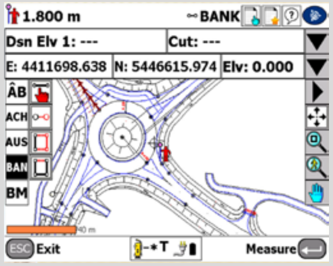
Create Grading & Utility Models



Review & Back-check Models

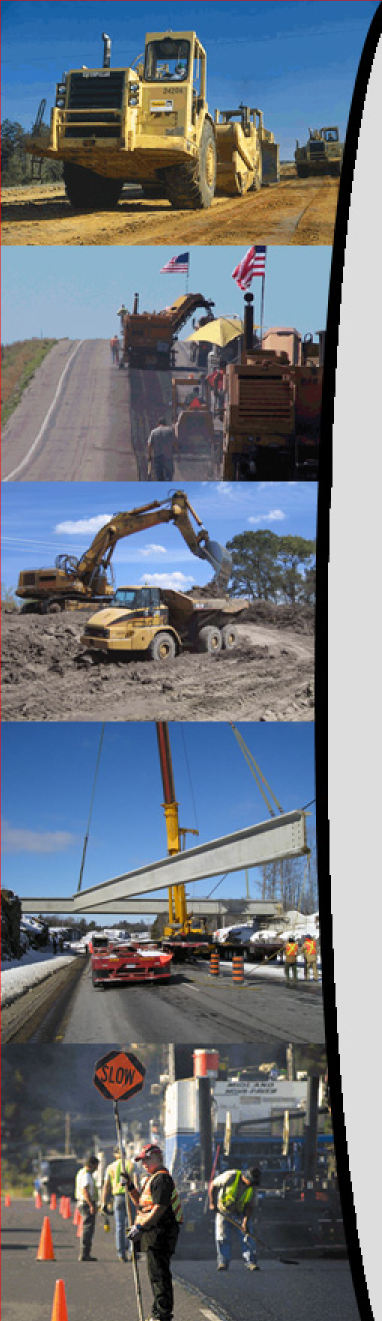


Share models with Engineering and Subcontractors



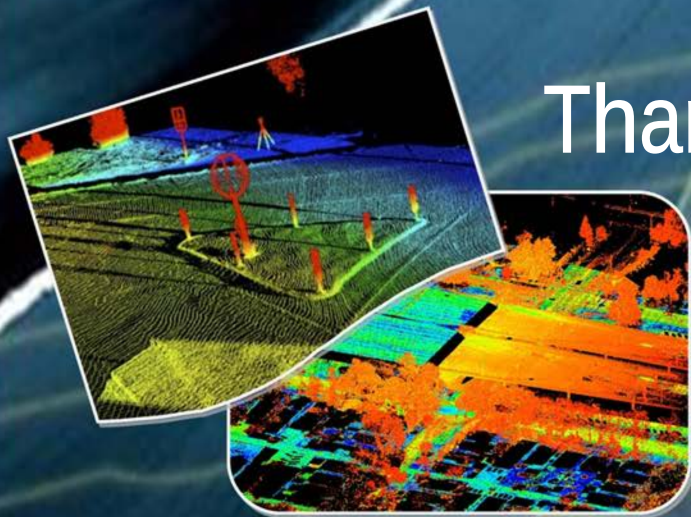

Migrate Data to the Field

 Source: Parsons Brinckerhoff and ARA for FHWA

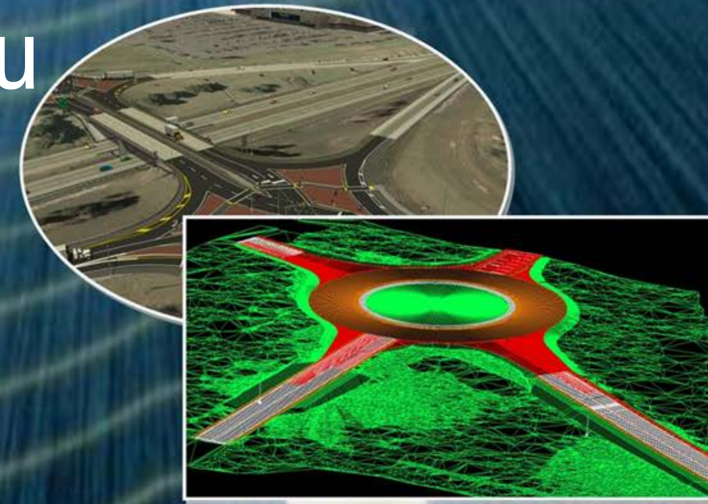


# Citation References

- Missouri Department of Transportation
- Millstone Weber
- Support for EDC Deployment Activities by Parsons Brinckerhoff and Applied Research Associates Inc. for FHWA under Contract DTFH61-12-D-00016



# Thank You



# Any Questions?